Sustainable Development

CRITICAL ISSUES

SUSTAINABLE DEVELOPMENT

OECD

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14th December 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

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DÉVELOPPEMENT DURABLE
LES GRANDES QUESTIONS

FOREWORD

In November 1997 the High-Level Advisory Group on the Environment to the OECD Secretary-General noted that "the OECD's comparative advantage in the field of the environment and sustainable development is its unique ability, through systematic analysis, comparisons, and peer review, to develop a shared framework of strategic policy… no other global or regional institution has the capacity to build the cross-cutting teams of policy makers necessary for the successful integration of economic, environmental, and social policy that is the basis of sustainable development".[1] The High-Level Advisory Group stressed "a need for a much stronger corporate understanding and acceptance of the need to reorient work across the Organisation in ways that underpin the policy foundations of sustainability". This recommendation was endorsed by OECD Ministers in 1998, when they asked the Organisation to carry out a three-year project on sustainable development, and to report back to them in 2001.

This book responds to that mandate. It represents the efforts of the various OECD Directorates and of its affiliates organisations — the International Energy Agency, the OECD nuclear Energy Agency, the European Conference of Ministers of Transport, and the OECD Development Centre — to apply a sustainable development framework in the areas of their particular expertise. The initiative has aimed at providing coherence, visibility and policy relevance to work carried out in response to specific sectoral priorities, and at considering — to the extent possible — the full range of implications (economic, environmental and social) of policies in each areas.

Individual chapters of this book were discussed during 2000 and early 2001 by various bodies of the Organisation, and have benefited from comments by country delegates and by OECD staff. Together they lay-out the Organisation's analytic approach to sustainable development — an approach that draws on its economic perspective and its multidisciplinary expertise. It complements and provides background to a shorter report, "*Policies to Enhance Sustainable Development*", which presents practical recommendations to improve the effectiveness of policy interventions in favour of sustainable development in Member countries.

Main authors for individual chapters were Marco Mira d'Ercole and Lars Mortensen (Chapter 1); Marco Mira d'Ercole and Jan Keppler (Chapter 2); Carl Obst and Georges Lemaître (Chapter 3); Frédéric Bouder and Jeremy Eppel (Chapter 4); Jean-Philippe Barde and Helen Mountford (Chapter 5); Yukiko Fukasaku and Ki Joon Jung (Chapter 6); Paul O'Brien and Ann Vourc'h (Chapter 7); Maria Maher, Dale Andrew, Fabienne Fortanier and Cristina Tebar Less (Chapter 8); Rémi Paris, Peter Borkey and Brendan Gillespie (Chapter 9); Ola Flaaten and Wilfrid Legg (Chapter 10); Jan Corfee-Morlot and Noreen Beg (Chapter 11); Kristi Varangu, Jonathan Pershing and Jan Keppler (Chapter 12); John White (Chapter 13): Ronald Steenblik and Wilfrid Legg (Chapter 14); Candice Stevens and John Newman (Chapter 15); Josef Konvitz and Liz Mills (Chapter 16). Tom Jones, Judy Lawrence, Marco Mira d'Ercole, Ronald Steenblik, Dorte Dalsgaard and Tracey Strange helped co-ordinate the project, and assured final editing of the full manuscript.

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Thorvald Moe
Deputy Secretary-General

1. "Guiding the Transition to Sustainable Development: A critical Role for the OECD", The Report of the High-Level Advisory Group on the Environment to the Secretary-General of the Organisation for Economic Co-operation and Development, November 1997, Paris.

Other OECD publications released in the context of the three-year project on sustainable development

OECD (2001), *Policies to Enhance Sustainable Development,* Paris.

OECD (2001), *OECD Environmental Outlook,* Paris.

OECD (2001), *The Well-being of Nations: The Role of Human and Social Capital*, Paris.

OECD (2001), *International Science and Technology Co-operation. Towards Sustainable Development*, Paris.

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UNDERSTANDING SUSTAINABLE DEVELOPMENT

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ECONOMIC, ENVIRONMENTAL AND SOCIAL TRENDS

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Chapter 1.

ECONOMIC, ENVIRONMENTAL AND SOCIAL TRENDS

Introduction

The notion of sustainable development has assumed a prominent place in policy discussions over the last two decades. As levels of material welfare have increased, so have opportunities for addressing a range of unmet social and environmental concerns and the abilities of societies to adapt to adverse impacts. Yet without sustainable practices, economic growth can also lead to the excessive degradation of natural and social resources. Governments face the complex challenge of finding the right balance between the competing demands on natural and social resources, without sacrificing economic progress.

It is increasingly recognised that this objective cannot be addressed from a purely domestic perspective. Growing economic integration has shifted policy priorities from local and national levels to regional and global ones. Economies and societies have become more closely connected, making it difficult, if not impossible, to circumscribe the consequences of policy decisions within national boundaries. How to adapt institutions and decision-making processes to a new context of more intense interactions, and how to build strong coalitions of countries to address issues of common concern are key challenges for governments.

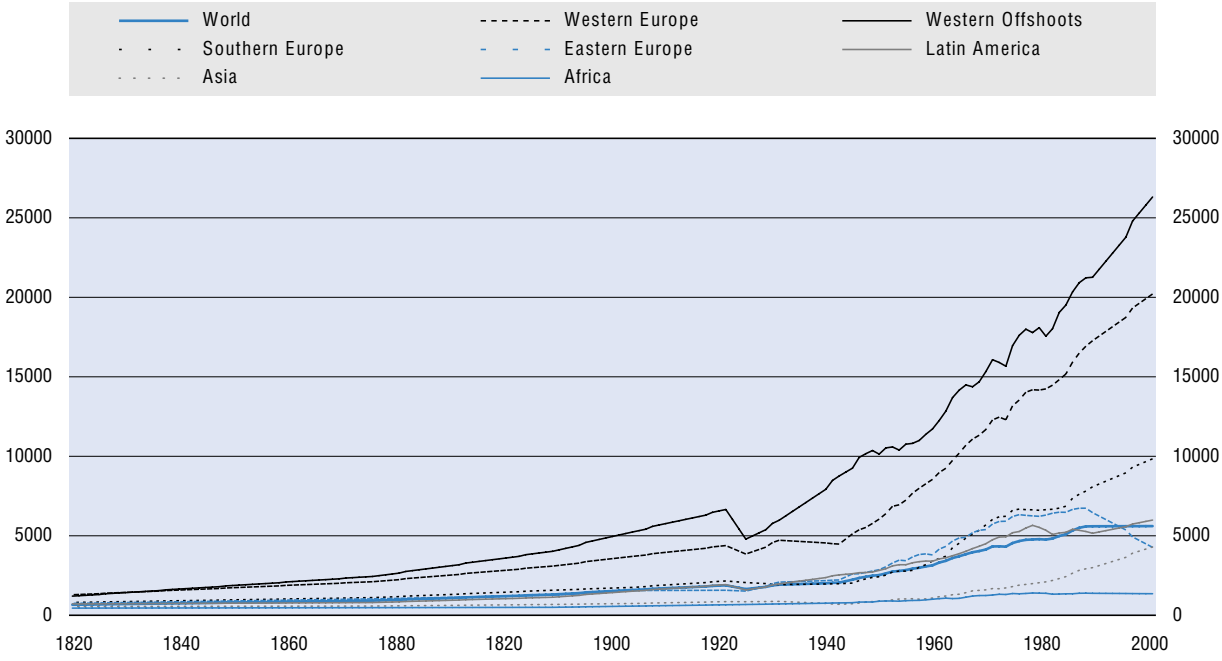
While countries differ in their priorities for economic and human development, a range of goals identified by the international community provides a set of benchmarks for assessing the sustainability of the development process. Even in areas where consensus is lacking, a number of common trends are crucially shaping countries' capacities to pursue their development goals. This chapter provides an overview of some of the main economic, social and environmental trends, and of the challenges they imply for the well-being of current and future generations. Policies dealing with the issues referred to in this chapter are discussed in greater depth in later chapters.

Economic growth, technology and globalisation

Strong economic growth — driven by technological advances and by increasing integration between countries — was a defining characteristic of the twentieth century. Figure 1.1 (which illustrates long-term trends in real per capita GDP in major world regions) highlights strong regional and global gains. These gains have been particularly strong since 1950, with real per capita GDP increasing by around four times in OECD countries and by an even larger amount in Asia. Even in Africa, the increase has been close to 70%, although growth in per capita GDP came to a halt in 1980 — and the level attained by 2000 remains lower than that of Western Europe in the mid-nineteenth century. Greater material welfare has contributed directly to human well-being and has also provided the resources to address a range of social concerns such as health and education. As a result, long-term trends in broader measures of human well-being such as the Human Development index (HDI) point to larger gains in well-being at the world level than those realised by per-capita GDP (Craft, 2000).[1]

Technological progress has been a major factor in the global increase of material well-being. It has allowed for greater efficiency in production in countries on the technology frontier (Figure 1.2, panel a) and created opportunities for catching up through technology transfer in others. These technological improvements have tended to come in discrete and long-term waves as individual technologies moved through the stages of

Figure 1.1. **Long-term trends in real GDP per capita in major world regions**



Note: 1990 USD
Source: Maddison (1995), *Monitoring The World Economy, 1820 – 1992*, OECD Development Centre, Paris. Extended to 2000 using projections from the IMF "*World Economic Outlook*".

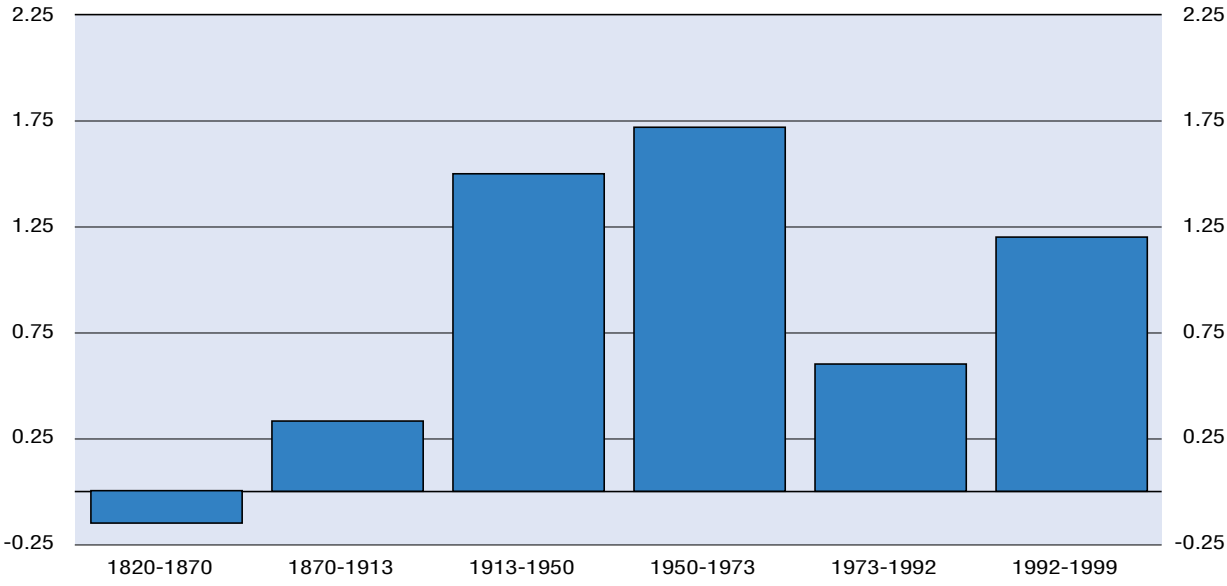
introduction, diffusion and saturation. They have also been associated with the development of specific goods and sectors of economic activity, each with its own forms of management and industrial practices (Figure 1.2, panel b). All of these technology waves have led to strong gains in economic wealth, but not all of them have come without cost to the environment. Some have also led to disruptions in established modes of social organisation, making some skills and jobs redundant at the same time that new ones are created. Today, the diffusion of information, communication and life-science technologies holds new promise for high economic returns (OECD, 2001). However, the collective reflection on these new technologies has changed, with questions now being raised about the direction and consequences of technological development. As a result, governments and the scientific community are increasingly called to address the potential risks of technological change (see Chapter 6).

The increased integration of national economies has also supported gains in material welfare. By enlarging the size of markets, this integration has allowed for greater specialisation in production, and increased benefits from economies of scale. Since 1950, the volume of international trade has grown more than twice as much as the rate of real GDP growth, and levels of trade integration (imports as a ratio of GDP) among OECD countries have now reached all-time highs (Craft, 2000). This growing trade integration has also been characterised by the increasing importance of multinational enterprises, which have come to play a key role in technology transfers across countries and in outsourcing across firms. Increasing international flows in goods and services, however, have also brought new questions about the safety of specific imports for human health and the environment, and about their effects on natural habitats in foreign countries (e.g. tourism).

Globalisation has also been driven by international financial flows, which have increased at an even higher pace than trade. Although most of these flows have been between OECD countries, they have also

Figure 1.2. **Long-term trends in productivity and key technologies**

Panel A. Total factor productivity in the United States, average annual growth in per cent



Panel B. Key sectors and technologies driving productivity increases

	1820-1890	1880-1945	1935-1995	1985-2050
Key sectors	Coal, railroads, steam power, mechanical equipment	Cars, chemical industry, metallurgical processes	Electric power, oil, aviation, radio and TV, instruments and control	Gas, nuclear, ICT, satellite and laser communications
Key technologies	Electricity, internal combustion, telegraphy, steam building	Electronics, jet engines, air transport	Nuclear, computers, gas, telecommunications	Biotechnology, artificial intelligence, space communications and transport

Sources: Maddison (1995), *Monitoring The World Economy, 1820 – 1992,* OECD Development Centre, Paris; National Research Council (1999), *Our Common Journey: A Transition Toward Sustainability,* National Academy Press, Washington D.C.; and other OECD data.

extended to others. Among these transactions, private financial flows from OECD to developing countries were almost four times larger in 1996 than public ones, and — although declining since — are still nearly double public flows. Although international financial flows have considerable potential to contribute to sustainable development, they have failed to benefit a large number of the poorest countries, and some of the sectors with greater promise for poverty alleviation and environmental protection. They have left other countries vulnerable to sizeable short-term fluctuations (see Chapter 8).

As pervasive as these economic links between countries and economic agents are, the increasing interaction of individuals — through travel, migration, information and communication — has accelerated the diffusion of ideas and consumption styles, shaping public attitudes towards global social and environmental conditions. This interaction has also produced new threats, such as the transmissions of infectious diseases and of foreign species (NRC, 2000). In this context, national policies are perceived as having become less effective in responding to the preferences of societies, prompting calls for new forms of governance at the international level to address issues of common concern. Making these calls operational, however, requires new rules and procedures for multilateral negotiations, as well as shared agreements on prioritising goals among countries at various level of development (Tubiana, 2000).

Economic growth is a fundamental driver of human welfare, and a key component of sustainable development. However, due to inappropriate incentives, economic activities have often taken a toll on the environment and natural resources, both nationally and globally. The increased scale of global economic activity has thus prompted calls to increase the efficiency with which these resources are used, so as to decouple economic growth and environmental degradation. Meanwhile, progress in material welfare has not been equitably shared across countries and individuals. Such inequality is a critical threat to sustainable development. In addition, it also makes it more difficult to address pressing environmental problems and the structural changes they entail. Major environmental and social pressures that may compromise the sustainability of economic development are reviewed below.

Environmental pressures

The urgency with which the international community has begun addressing a number of environmental challenges is reflected in several international conventions and treaties (Table 1.1). International goals for emissions of greenhouse gases, protection of biodiversity, and preventing desertification have been established since the Rio Summit in 1992. A range of other conventions and protocols at the regional level set emission limits for a range of pollutants.[2] Unfortunately, the simple existence of these conventions and treaties does not mean that concrete actions leading to their achievement are underway, as lags in implementation have translated into a growing gap between goals and outcomes.

Table 1.1. **International targets for preserving life support systems**

Systems	Goal and year of adoption	Source
Water		
	Give satisfaction of basic needs and the safeguarding of ecosystems. National water conservation activities to prevent water pollution and protect groundwater	UNCED (1992), Agenda 21 chapter 12
Atmosphere and Climate		
Sulphur	Reduce depositions of oxidised sulphur to below critical loads	Sulphur Protocol (1994)
Nitrogen oxides (NO_X)	Reduce emissions to, at most, 1987 level by 1994	NO_X Protocol (1988)
Volatile organic compounds (VOC)	Reduce emissions by 30-100% of 1988 levels by 1999	VOC Protocol (1991)
Chlorofluorocarbons (CFCs)	Complete phase-out of specified forms of CFCs and halocarbons by 1992	Montreal Protocol (1987, amended in 1990, 1992, 1997 and 1998)
Greenhouse gases (GHG)	Prevent dangerous human interference in the climate system.	Framework Convention on Climate Change (1992).
	Reduce emissions of industrial nations at least 5% below 1990 levels, by 2008-2012	Kyoto Protocol (1997)
Oceans		
	Prevent, reduce and control pollution and other hazards to the marine environment	UN Convention on the Law of the Sea (1982)
Species and Ecosystems		
Biodiversity	Conserve biological diversity	Convention on Biological Diversity (1992)
Whales	Moratorium on harvesting of exploited stocks, starting in 1986	International Whaling Commission
Fish	Ensure the optimum sustainable yield of fish and living resources	UN Convention on the Law of the Sea (1982)
Birds	Prevent destruction of indigenous or migratory species	International Convention for the Protection of Birds (1950)

Source: Adapted from National Research Council (1999), *Our Common Journey: A Transition Toward Sustainability*, National Academy Press, Washington D.C.

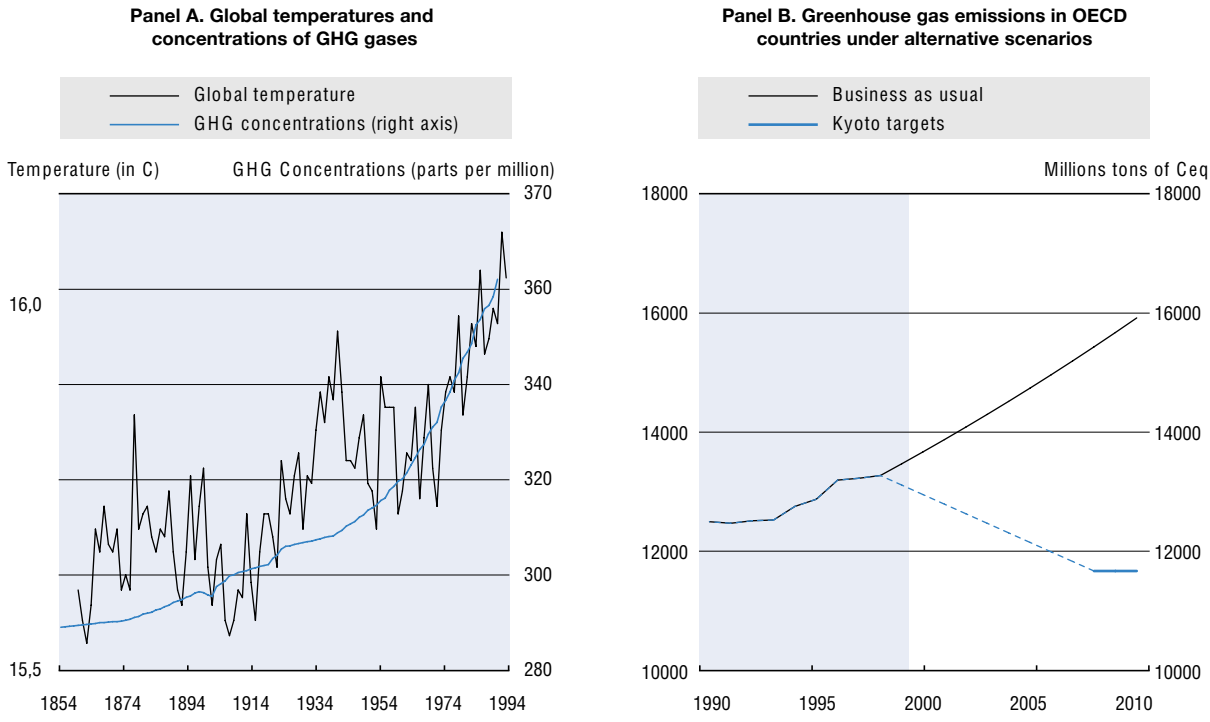
Some of the most important environmental challenges confronting the international community are global, requiring co-ordinated actions among countries in order to be effectively addressed. How to achieve the required co-operation on policies addressing these global challenges — when preferences, resources and responsibility for past damage differ across countries — is a key challenge for the international community, but one that has been successfully undertaken in the past. For example, important progress has been reached in combating the risks of a reduction of stratospheric ozone caused by air emissions of industrial chemical compounds (clorofluorocarbons, halons used as solvents in refrigeration and air-conditioning, and fire extinguishing agents) whose reaction with solar radiation destroys the ozone layer. Targets for ozone depleting substances originally agreed on in the Montreal Protocol in 1987 have been progressively tightened and extended to other substances, and phase-out dates have been brought forward. Low abatement costs due to the ready availability of substitutes, and high benefits from avoiding solar radiation harmful to human and animal life[3] have combined to provide strong incentives to countries to take determined action.[4] As a result, observed amounts of many of these compounds are now decreasing, although their long persistence in the atmosphere will cause further declines of the ozone layer for about two decade before it recovers (by 2050) to levels prevailing before 1970 (Watson *et al.,* 1998).

Human interference with the climate system is among the most serious global environmental threats now facing the international community. Consensus on the importance of addressing risks for the climate system has been increasing since the late 1980s, largely thanks to the Intergovernmental Panel on Climate Change (IPCC). Increasing concentrations of greenhouse gases in the atmosphere — carbon dioxide, methane, nitrous oxide and a range of other chemical compounds — are trapping increasing amount of heat in the earth's atmosphere and adding to the natural greenhouse effects. The amount of time which these gases remain in the atmosphere also suggests that their concentration would increase even after stabilising new emissions. Economic activities contribute to greenhouse gas emissions mainly through the burning of fossil fuels, but also through deforestation and land conversion, animal husbandry, rice production, natural gas venting, municipal waste disposal, and leakage of chemical compounds used in refrigeration and manufacture of aluminium and magnesium (OECD, 2000*a*). Over the past century, concentrations of carbon dioxide in the atmosphere have increased by around 30%, with average temperatures raising by around 0.6 C° since the whole period of record since 1860 (Figure 1.3, panel a). These trends are consistent with predictions from climate models, which suggest that continuation of recent emissions trends into the current century — possibly doubling concentration levels by 2100 — might increase average temperatures between 1.4 and 5.8 C° (Watson, 2000). This is expected to lead to changes in precipitation patterns[5], higher sea levels[6], interference with the atmospheric and water circulation and greater weather variability. Effects could include the loss of coastal areas, forests and endangered species, the disappearance of small island states, reduction in crop yields, impacts on water systems and irrigation, higher air pollution, health impacts of heat waves and the spread of infectious diseases.[7] While estimates of economic damages from these changes are uncertain[8], they are likely to disproportionately affect less developed countries, increasing calls for financial assistance to compensate those most affected.

The Kyoto Protocol sets binding targets for industrialised and transition countries to achieve differentiated reductions of greenhouse gas emissions from 1990 levels over the period 2008-12. Recent emission trends in OECD countries, however, are far from these targets (Figure 1.3, panel b), and the coming into force of the Protocol remains uncertain. Over a longer term, the Protocol represents only a step towards more ambitious goals to stabilise concentrations of greenhouse gases.

In several other cases, pressures on the environment have global significance as their consequences are not confined to national territorial jurisdictions, even if they can be addressed through domestic or regional policies. While there are often uncertainties about the size and significance of many of these threats, in many cases they risk approaching and exceeding key thresholds, and undermining the welfare of present and future generations. One such case is the loss of biodiversity, and of the ecosystems that support it (freshwater, oceans, coasts, soils and forests). Although estimates of these losses are uncertain, 11% of birds, 18% of mammals, 5% of fishes and 8% of plants are estimated to be threatened by extinction (see Chapter 10). Overall, analysis of selected vertebrate species living in forests, freshwater and marine ecosystems suggests that their numbers may have declined by about one-third over the last thirty years

Figure 1.3. **Global temperatures and emissions of greenhouse gases**



Note: Data on GHG concentrations are based on records from ice-core data up to 1960, and from observations at the Mona Loa observatory, Hawaii, since 1960.

Sources: Panel A: GHG concentrations are from C. D. Keeling and T.P. Whorf, Scripps Institution of Oceanography, University of California, United States, for measurements taken at Mauna Loa Observatory, Hawaii; and Atmospheric Environment Service, Environment Canada for records from Alert, NWT, Canada. Global temperatures are from Jones *et al.*(1999) and Parker *et al.*(1995). Panel B: GHG emissions include emissions of CO2, CH4 and NO2 and are for the OECD GREEN model.

(WWF *et al.*, 2000). Biodiversity loss is driven by extinction of native species following alterations of their natural habitats — such as tropical forests, coral reefs and mangrove areas — as well as by the introduction of foreign species into new habitats as a result of travel and transport. While loss of species has occurred throughout history, current extinction rates are dramatically higher than past rates calculated on fossil records (Barbault and Sastrapradjia, 1995). As loss of biodiversity is irreversible, its protection insures against the loss of resources that could be valuable in the future, as well as securing the well-being of communities relying on these natural habitats.

Human activities impact on natural habitats in a variety of ways (Table 1.3). Oceans are affected by human settlements and economic activities along river estuaries and coastal zones, as well as by commercial fishing — with around one quarter of major fish stocks being over-exploited in 1996. Similarly, human induced changes in land use have contributed to large reductions in forest coverage world-wide, mainly in the tropical regions.[9] Grassland and agricultural soils are affected by transport and urban settlements, as well as by unsustainable management practices for livestock herds and agriculture, leading to land erosion and salinisation. In addition to biodiversity losses, these alterations compromise the capacity of natural habitats to perform functions that enable important economic activities and ultimately underpin human survival, such as carbon storage, water and air purification, nutrient decomposition and recycling (UNDP *et al.*, 2000).

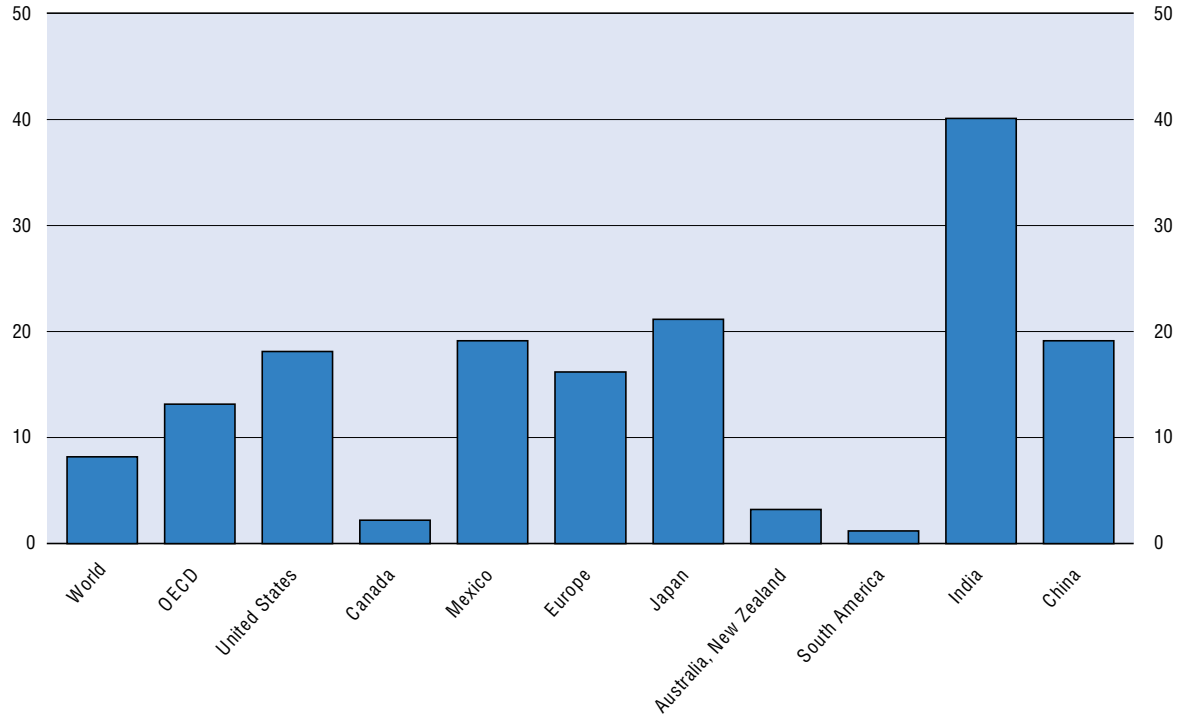
Table 1.2. **Economic pressures on biodiversity**

Sector	Direct pressures		Indirect pressures	
	Positive	Negative	Positive	Negative
Agriculture and plantation forests	• Creation of diverse ecosystems • Support for biological functions	• Ecosystem conversion to agriculture or forest • Fragmenting habitats • Introduction of non-native species	• Maintenance of ecosystem services, enrichment of biological diversity in some cases	• Pollution of ecosystems through farm chemical run-off • Genetic homogenisation through monoculture use • Erosion, siltation, etc.
Fisheries		• Destruction of habitats through damaging fishing practices • Potential over-fishing of target species or by-catch species • Introduction of non-native species		• Pollution of marine and freshwater ecosystems through effluent discharge, excessive nutrient and chemical loading (aquaculture), noise, etc.
Natural forests		• Habitat loss or fragmentation through forest clearing and infrastructure construction		• Pollution of forest ecosystems through effluents and noise • Erosion and associated effects • Colonisation of natural areas facilitated through infrastructure and access provision
Oil production		• Pollution of ecosystems through spills • Destruction of ecosystems through infrastructure construction	• Decrease dependency on renewable natural resources (e.g. wood fuel) • Reduced resource extraction through recycling	• Pollution of ecosystems through extraction (e.g. effluents, noise, etc.)
Mining		• Pollution through leaching etc. • Habitat destruction through infrastructure construction		• Pollution of ecosystems linked to use of inputs in extraction (e.g. effluents, noise, etc)
Transport and related infrastructure		• Facilitating access to fragile ecosystems, fragmenting habitats, pollution • Use of land for transport infrastructure • Water pollution and over-use destroying habitats and ecosystems	• Bringing people to conservation sites, increasing awareness	• Pollution associated with transport use, including greenhouse gas and air pollution emissions
Water and sanitation	• Creation of special habitats		• Water conservation, measures beneficial to ecosystems	
Industry		• Pollution of ecosystems • Loss of habitat through infrastructure development		

Source: OECD (2001), *OECD Environmental Outlook*, Paris.

Specific threats are also associated with unsustainable use of fresh water resources. Water problems are generally local, affecting particular regions, and thus requiring domestic policies. However, some of the consequences of inadequate fresh water supplies cannot be circumscribed along geographical lines. Human needs for fresh water are not currently met in several low-income countries, where around 30% of individuals lack access to safe drinking water. Meeting these needs would significantly improve the conditions of the poor, but would require balancing competing demands from alternative uses on limited resources. Annual freshwater withdrawals display large differences across countries (Figure 1.4). Comprehensive assessments of freshwater resources suggest that around 2 billion individuals (one third of the world's population) are currently living in 41 countries suffering medium-high to high water stress, and that this could increase under a variety of scenarios to more than 5 billion (close to two thirds of total population, spread over 53 countries) by 2025.[10] Affected populations would be mainly concentrated in China, Central Asia, India, the Middle East and North Africa.

Figure 1.4. **Annual freshwater withdrawals, 1997**



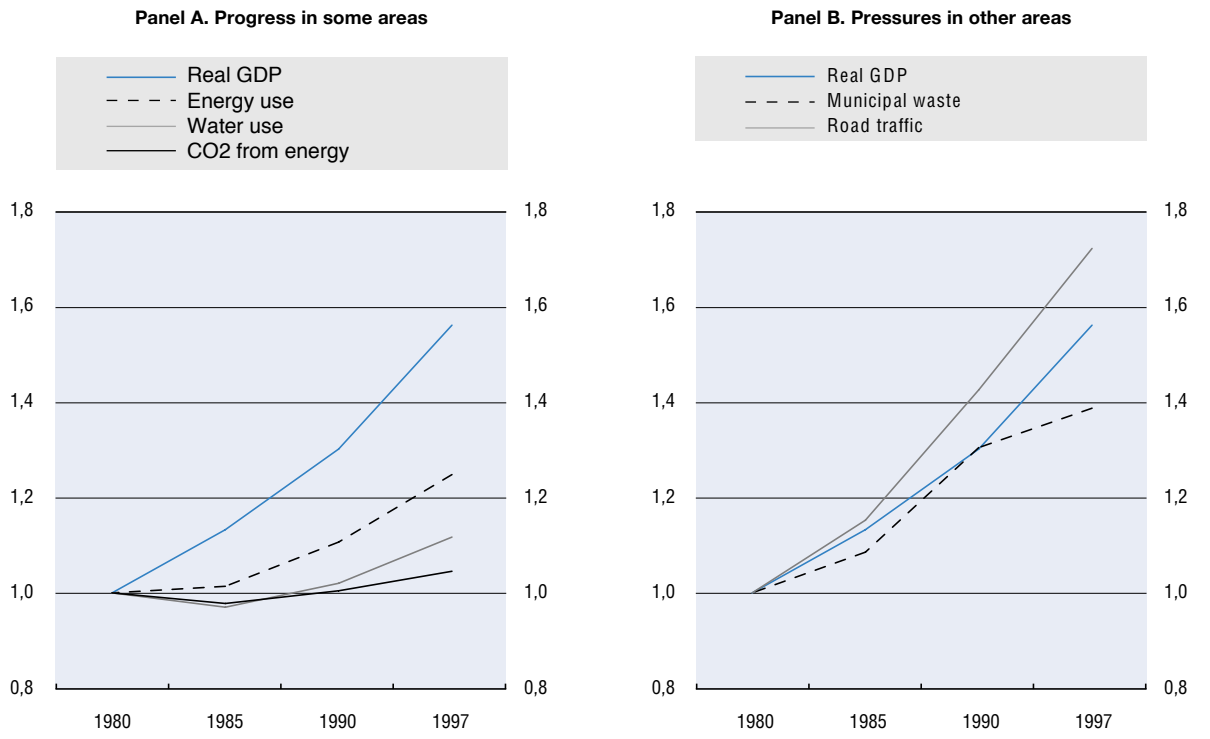
Note: As a percentage of the average annual flow of internal renewable resources. Internal renewable resources refers to the average annual *flow* of rivers and recharge of groundwater aquifers generated from endogenous precipitation (i.e., rain and snow that falls within the country's borders). Caution should be used when comparing different countries because the estimates are based on differing sources and dates, and because averages disguise large seasonal, inter-annual, and long-term variations. Total withdrawals may exceed 100 percent due to groundwater drawdowns, withdrawals from river inflows, and the operation of desalinization plants.

Source: UNDP, UNEP, the World Bank and World Resources Institute (2001), World Resources, 2000-2001, Washington D.C.

Even within OECD countries, the nature of environmental challenges has been changing. Most of the environmental threats confronting OECD societies in the 1960s and 1970s were related to domestic point-source pollution, leading to short-term and locally circumscribed public health concerns. Some of these environmental challenges have now been successfully addressed, at least in part. Progress has been made, for example, in dealing with industrial pollution from point sources, including air pollutants such as lead, sulphur oxides, carbon monoxide and some particulate matters, and pollution of surface water. Other areas of improvements in OECD environmental conditions identified in the OECD *Environmental Outlook* include extensions in forest coverage and protected areas, improvements in waste management, the expansion of organic and other sustainable agricultural practices, and the development of "green" procurement policies

in the public sector. In other cases, environmental conditions have further deteriorated but at a slower pace than the increase in economic activity, reflecting improvements in energy and resource efficiency (Figure 1.5, panel a). Finally, pressures from more diffuse sectors and household consumption patterns have led to higher volumes of municipal waste and groundwater pollution from run-off of agricultural nutrients, lower urban air quality from motor vehicle emissions (Figure 1.5, panel b). Acid deposition from industrial emissions, often originating in neighbouring countries, is also causing acidification of surface waters, damage to forests and freshwater resources in large parts of Europe, North America and Asia. The complexity, uncertainty and long-term nature of these challenges, and the large number of parties affected by mitigation policies, have made policy implementation in these areas more difficult than before.

Figure 1.5. **Trends in environment and natural resources in OECD countries**



Sources: OECD (2001), *Environmental Outlook*, Paris.

Current impacts of environmental degradation

Addressing the long-term effects of environmental degradation is crucial for the well-being of future generations. But environmental degradation also translates into high costs for human well-being today. Estimates of the burden of disease from various forms of environmental degradation — as measured by the number of potential years of healthy lives lost because of premature mortality and morbidity — range from 5% of the total in high-income OECD countries, to 15% in lower-income OECD countries and to 22% in non-OECD regions (OECD, 2001*a*). While environmental hazards to human health have traditionally been linked to household access to clean water, community sanitation (affecting the spread of infectious diseases), prenatal care/childbirth and nutrition, new health risks are associated with industrial and agricultural emissions to water, air and food. These emissions lead to respiratory and cardiovascular diseases, cancers

and other risks. Approximately one half of the global burden on chronic respiratory illness is associated with air pollutants, while asthma — whose incidence has increased among children — is exacerbated by poor air quality (Table 1.3). Environment-related health expenditure (at PPP rates) in OECD countries is estimated to be between USD 36 and USD 113 billion (1.6 to 5.1% of total health expenditure) and much larger when considering lower quality of life for affected individuals (OECD, 2001*a*).

Table 1.3. **Environmental factors affecting health**

	Air pollution	Sanitation and waste disposal	Water pollution	Polluted food	Unhealthy housing	Global environmental change
Acute respiratory infections	•				•	
Diarrhoea diseases		•	•	•		•
Other infections		•	•	•	•	
Malaria and other vector-borne diseases		•	•		•	•
Injuries and poisoning	•		•	•	•	•
Cardiovascular diseases	•					•
Cancer	•			•		•
Chronic respiratory diseases	•					

Source: WHO (1998), *The World Health Report*, Geneva.

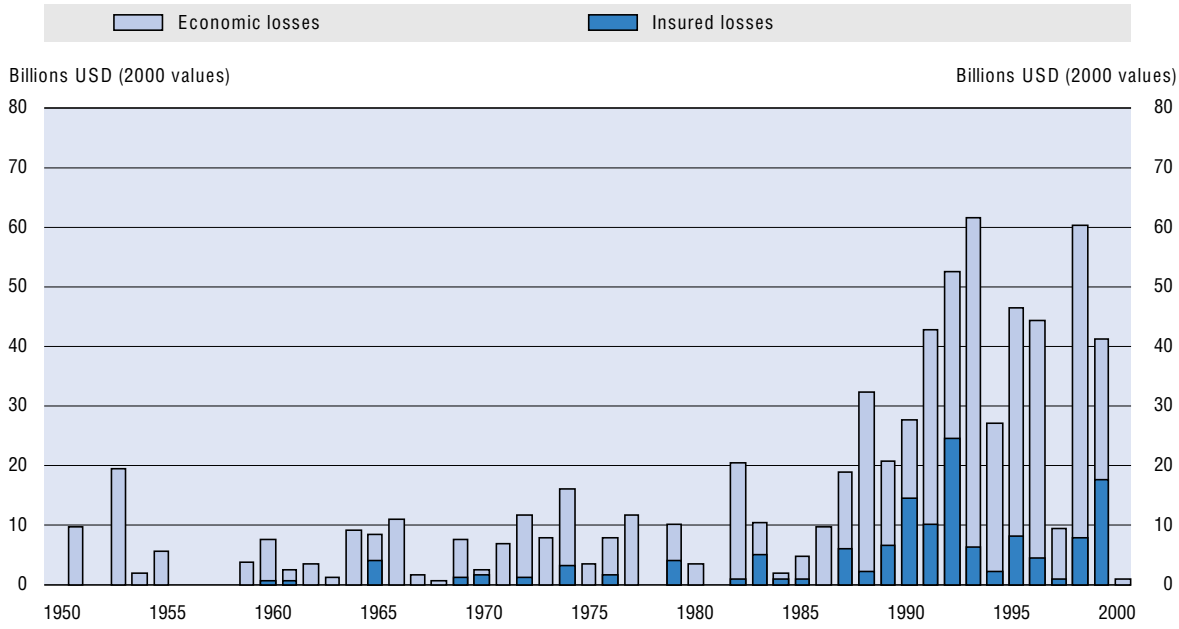
Environmental degradation also impacts current well-being through the economic and human costs associated with natural disasters. In a significant number of cases, these disasters reflect human interference with the ecosystem and human-induced environmental degradation. Weather-related natural disasters accounted for more than two thirds of the worst natural disasters recorded between 1970 and 2000 and translated into a rapid increase in real economic losses over the last decades (Figure 1.6). While these higher economic losses partly reflect the influence of population growth, higher material wealth, insurance coverage and degree of re-insurance, a major part of them reflects increased frequency of natural events (Münich Re., 2000).[11] Example of such weather related disasters include record rains in the Yangtze basin in 1998 that, compounded by extensive deforestation and urban expansion on the river's flood plains, caused 3,600 deaths, 14 million homeless, and economic losses totalling over USD 30 billion. Recent research has stressed the link between these extreme weather events (heat stress episodes, droughts, storms and hurricanes) and changes in air and ocean circulation systems linked to greenhouse gas effects (Vellinga *et al.*, 2000). Major industrial accidents in the 1980s and 1990s (e.g. Bhopal chemical accidents in 1984, Chernobyl nuclear accident in 1986, Exxon Valdez in 1989 and other oil spills in the 1990s) also translated into large social and environmental impacts.

Drivers of future pressures

OECD countries have a key role to play in addressing the pressures on the environment from human activities. With 18% of the world population, they account for over half of today's total energy consumption, over 60% of cereals consumption, 31% of consumption of food fish, 44% of consumption of forest products, and for a large fraction of the cumulative damage imposed on the environment globally. At the same time, large shifts in economic weight among regions suggest that participation from other countries will be increasingly important for effective policy responses.

In the absence of appropriate policies, pressures on the environment and natural resources are expected to increase over the next 20 years due to economic and demographic trends. On the economic front, the volume of world GDP is projected to expand by 75% in the 1995-2020 period, with two thirds of this increase in OECD countries. Non-OECD countries are expected to increase their weight — from less than 20% of world GDP today, to 25% in 2020 — and to play an increasing role in shaping global environmental conditions. The share of non-OECD countries in total energy consumption may increase from 47% in 2000 to 58% by

Figure 1.6. **Economic losses from large weather-related disasters**

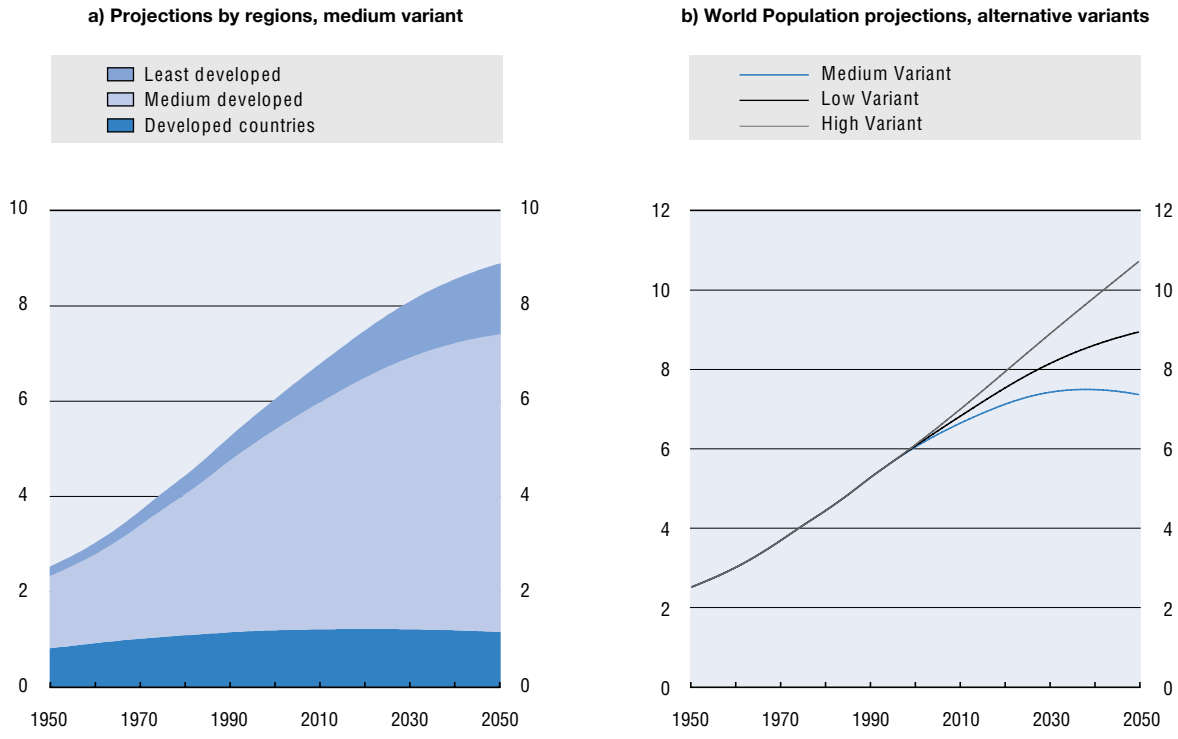


Note: Values adjusted to 2000 USD. Great weather-related disasters are those exceeding 100 deaths and or USD 100 millions in claims. Data on insured losses are based on loss reports from affected primary insurers. Economic losses are estimated based on insurance density in the affected countries; they include estimates of direct losses to buildings and structures, at new replacement values, and of indirect losses, such as increased transport costs due to destruction of transport infrastructure.
Source: Data provided by Munich Reinsurance Company.

2020, and that in total motor vehicles kilometres travelled from 36% to 54% (OECD, 2001*a*). While improvements in efficiency and better management of existing technologies will support higher demand, in some areas production will be constrained by resource limitations (e.g. water and land). For example, most of the 80% increase in world agricultural production over the next 20 years is expected to reflect productivity gains linked to intensification, and to a much lower extent land conversion to agriculture — with an increase of around 8% for pastureland and of 4% for cropland (OECD, 2001*a*). The intensification of production through irrigation and greater application of nutrients and pesticides, however, risks damaging or depleting a wide range of natural systems, including wildlife habitats and biodiversity, scarce water resources (through use of water in irrigation, and pollution of groundwater from leaching of nutrients, pesticides and animal wastes) and soil (through compaction, salinisation and acidification).

On the demographic side, global population tripled in the past fifty years, to a level of 6.1 billion, and is expected to grow to a range between 7.3 and 10.7 billion by 2050. The UN medium fertility projection projects a population of 8.9 billion in 2050 (Figure 1.7), with most of its increase in less and medium developed countries. While the rate of population growth has been gradually declining over time, and more rapidly than expected by demographers,[12] such population increase raises the scale of pressures on the environment. Beyond population size, its distribution also implies serious challenges for public health and environmental protection. The proportion of the world's population living in urban settlements is expected to rise from 45% in 1994 to 60% by 2025, eventually approaching the level now prevailing in OECD countries (80% to 90%). Urbanisation will increase the number of mega-cities[13], especially in developing countries, requiring large investment in infrastructure to avoid exposing urban populations to a range of environmental risks and impacts.[14]

Figure 1.7. **World population projections**



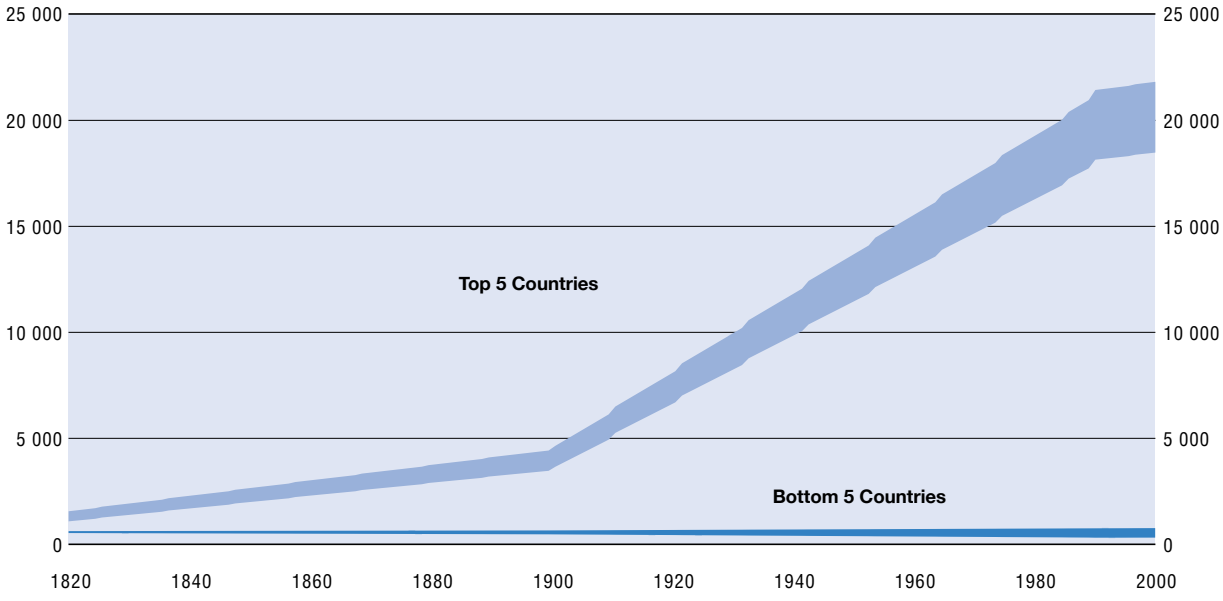
Note: Billions.
Sources: United Nation (1998), *World population prospects,* 1998 revision, United Nation Publications, New York.

Social pressures

Implementing appropriate responses to these environmental pressures is made more difficult by the existence of competing policy priorities and, in particular, of important unmet social needs in many parts of the world. This tension is most evident at the international level. Despite strong growth in economic and social welfare on average, income disparities among countries are much larger today than at the beginning of the century. One measure of this, focusing on the two extremes of the country ranking, is provided by Figure 1.8, which compares the income range of the five countries with, respectively, the highest and lowest real per capita income in any given year. From values of around 3 to 1 in 1820, this ratio increased to 35 to 1 in 1950 and to 72 to 1 in 2000. Increased disparities are also evident when looking at broad regions, with Africa and Eastern Europe losing most ground in relative terms. Several countries in these regions have experienced not just relative, but also absolute declines in living standards, with 16 countries (which together account for 165 million people) showing lower levels of real per capita income today than thirty years ago. These disparities in economic conditions affect domestic policy priorities, and the willingness to engage in collaborative action to address common challenges.

Larger disparities between rich and poor countries have also been accompanied by the growing differentiation in economic conditions within both developed and developing countries. As a result, differences in real GDP per capita between middle income countries (which together account for over a fourth of the world population) and high income countries are now smaller than those within OECD countries themselves. Also, approximately 20 non-OECD countries (accounting for 7% of world population) have a higher real GDP per capita than the lower-end of the OECD league.

Figure 1.8. **Trends in inequality in real GDP per capita between countries**



Note: 1990 USD. Inequality between countries is measured by the income range of the five countries at the top and bottom of the income league in selected years.
Source: Maddison (1995), *Monitoring The World Economy, 1820 – 1992,* OECD Development Centre, Paris. Extended to 2000 using projections from the IMF "World Economic Outlook".

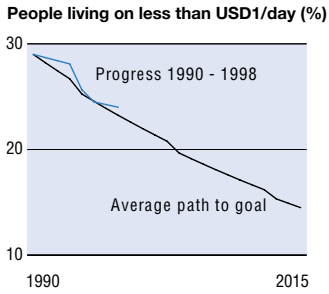
Beyond disparities in income, large numbers of individuals — mainly in developing countries — cannot satisfy fundamental human needs. Around the world, around one person in five lives on less than USD 1 per day and an additional one in three on less than USD 2 per day; one in seven suffers from chronic hunger, one in four lives in cities where air pollution exceeds healthy levels, one in three has no access to electricity. Some of the consequences of absolute poverty will persist over time, as under-nourishment of pregnant mothers increases the probability of underweight babies, a factor which may inhibit mental and physical development. Progress in addressing many of these dimensions of poverty has occurred over the last decade — as witnessed by a reduction in the proportion of the world population living on less than USD 1 per day from 28% in 1987 to 24% in 1998 — but has often proved fragile. For example, the share of the population living in extreme poverty in some Asian countries increased significantly following the recent financial crisis, and tripled in countries of the former Soviet Union. The consequences of absolute poverty often spread across countries in the form of conflicts, migration and disease.[15] Poverty also affects environmental quality, as natural resources — which often make up the largest share of the resources of poor — risk being further reduced in adverse conditions, while low environmental quality often disproportionately affects the poor. Poverty reduction in developing countries will require unprecedented efforts from governments, business, civil society and international donors, and is an integral element in the quest for more sustainable patterns of economic development worldwide.

Building on the resolutions from UN conferences and summits in the 1990s, the international development community has agreed to focus on seven development goals covering the three dimensions of sustainable development: economic well-being, social development and environmental regeneration. The goals cover extreme poverty; primary enrolment of children; gender equality in primary and secondary education; infant, child and maternal mortality; access to reproductive health services; and implementation of national strategies to reverse the loss of environmental resources. The achievement of these goals over the next 15 years will improve the lives of millions of people (Box. 1.1). The establishment of a limited set of quantitative goals, and of a time horizon for their attainment is important to focus donor support, to monitor the efficacy of support, and to identify countries that have made the greatest progress.

Box 1.1 International development goals

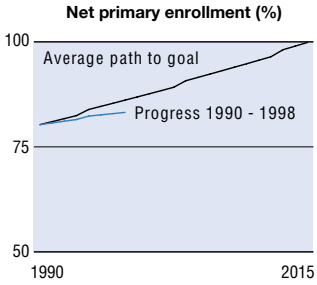
Reduce the proportion of people living in extreme poverty by half between 1990 and 2015

As growth increased globally in the mid-1990s, poverty rates fell — rapidly in Asia, but little or not at all in Africa. Income inequality is a barrier to progress in Latin America.



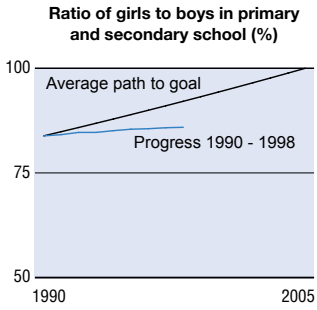
Enrol all children in primary school by 2015

Although enrolment rates continue to rise, they have not risen fast enough. On current trends, more than 100 million school-age children will not be in school in 2015.



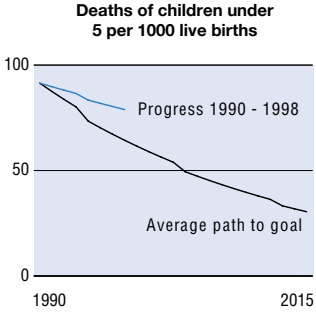
Make progress towards gender equality and empowering women by eliminating gender disparities in primary and secondary education by 2005

Getting more girls through school is essential but not enough. The gender gap may be narrowing, but girls' enrolments remain persistently behind those of boys.



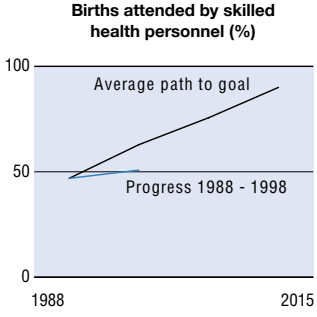
Reduce infant and child mortality rates by two-thirds between 1990 and 2015

For every country that cut infant and under-5 child mortality rates fast enough to reach the goal, 10 lagged behind — and another one moved backwards, often because of HIV/AIDS.

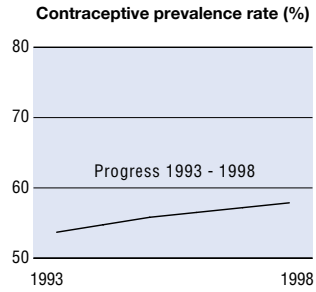
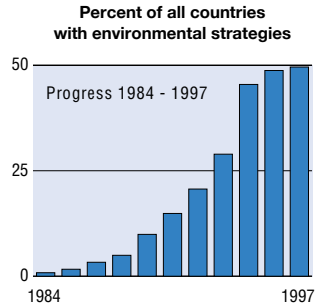


Reduce maternal mortality ratios by three-quarters between 1990 and 2015

Skilled care during pregnancy and delivery can do much to avoid many of the half million maternal deaths each year. But the proportion of births attended by skilled personnel rose slowly in the 1990s.



Box 1.1 The international development goals

Provide access for all who need reproductive health services by 2015	Contraceptive use is one indicator of access to reproductive health. With increasing access to reproductive health services, the rate of contraceptive use is rising in all regions.	
Implement national strategies for sustainable development by 2005 so as to reverse the loss of environmental resources by 2015 *	Despite their commitments at the Rio Earth Summit in 1992, fewer than half the world's countries have adopted strategies, and even fewer are implementing them.	

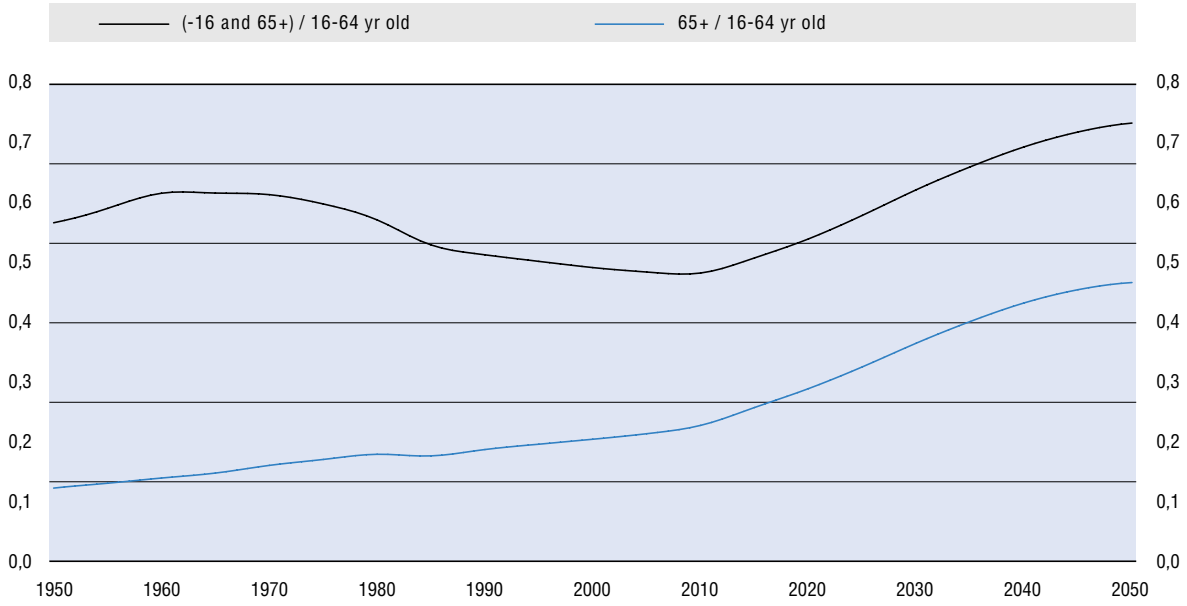
* This goal is not easily amenable to quantitative monitoring. The OECD is working to develop guidelines to support processes for sustainable development, including ways to assess countries' progress towards implementing sustainable development strategies.

Source: IMF *et al.* (2000), *A Better World for All*, Paris

Even in OECD countries, concerns about some of the short-term social consequences of these environmental protection policies may create resistance. These concerns are not unique to policies aimed at environmental goals, but are representative of some of the challenges faced by societies as they adapt to new patterns of work and living, and to modes of production and consumption that are less intensive in natural and environmental resources. As in other areas, structural adjustment will be easier in countries that have been more successful in addressing the most pressing social needs, be they related to shifts in labour demand for different skills, to exclusion from mainstream economic activity, to changes in family and demographic structures or to shifts in the distribution of resources among groups.

Over the past 50 years, gains in material welfare in OECD countries have brought substantial improvements in social conditions, in terms of health, education, living and working conditions. These improvements have been supported by the large amount of resources devoted to social protection, resources which — although with large differences across countries in the relative role attributed to governments, families, employers and voluntary care — have approached 20% of their GDP and sometimes higher proportions (OECD, 1999). Progress in social well-being in many areas, however, has led to the emergence of new challenges in terms of health (e.g. patterns of early death by infectious diseases being replaced by later death by cancer and circulatory diseases, with life-style and environmental factors becoming more important determinants of health status) and education (e.g. lower youth entries into school and work increasing the importance of lifelong learning in order to adapt the supply of skills to firms' demands, and to avoid adult illiteracy). Demographic trends towards population ageing and higher dependency ratios (Figure 1.9) are also leading OECD countries to re-consider the prevailing combination of study, work and retirement over the life-time, so as to limit growth in pension liabilities, and to respond to the requirements of labour markets and individual preferences.

Figure 1.9. **Dependency ratios in OECD countries**



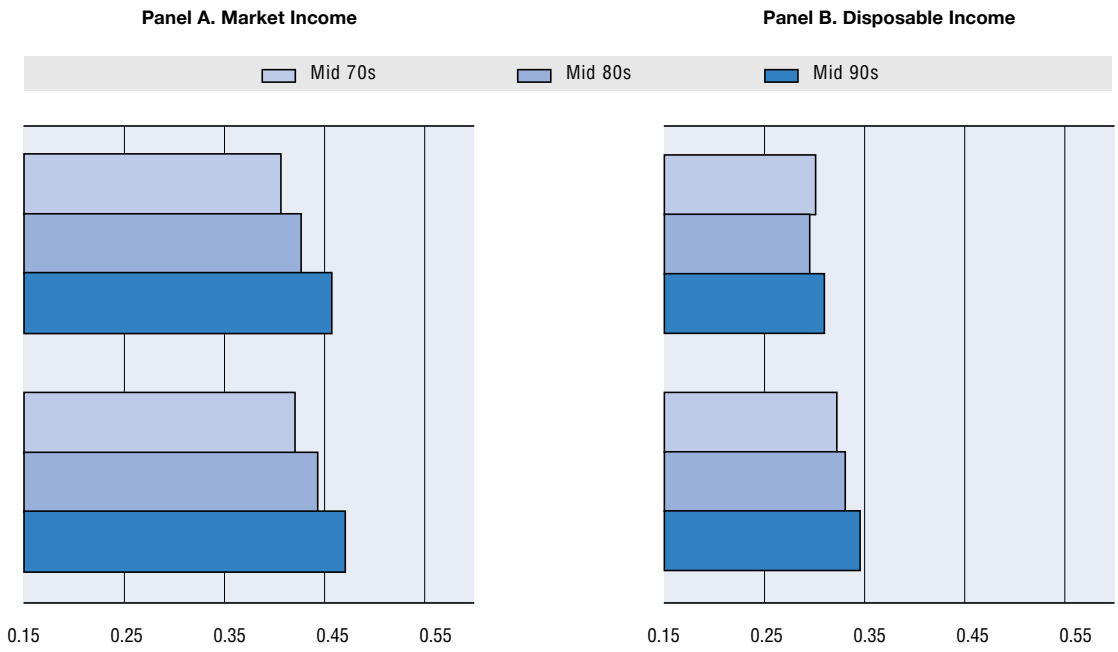
Note: Proportion of the population aged over 65 as a percentage of the population of working age (lower line); proportion of the population under 16 and over 65 years of age, as a percentage of the population of working age (upper line);. Projections based on the UN medium population variant.

Source: OECD calculations, based on United Nation (1998), *World population prospects,* 1998 revision, United Nation Publications, New York.

Shifts in the risks facing individuals among various demographic groups pose a significant challenge for social protection systems in OECD countries. These systems have, by and large, focused on temporary support to individuals of working age temporarily out-of-work, and on old-age pensions to those in retirement. With structural adjustment in labour markets, life-styles and family structures the model of male bread-winning households which shaped most types of social interactions has become less prevalent, leading to new types of risks and inequalities, and to shifts in the economic and social conditions of certain groups. As illustrated in Figure 1.10, the distribution in market income among households has become more unequal in a majority of OECD countries (panel a) and this trend has been only partially offset in most countries by the tax and transfer system (panel b). Risks of low income and poverty have also shifted from older persons in retirement towards families with children and single parents. While many individuals exit a poverty spell after a short period, a large part of income support goes to individuals and families that are either persistently or recurrently poor. Poverty for children is a special concern, as it may compromise their future development. OECD countries have recognised the importance of helping individuals to confront these new risks and avoid economic exclusion. Employment-centred social policies, which give priority to integrating transfer recipients into employment, reflect this priority. Policies aimed at integrating social and economic needs contribute to sustainable development in their own right, but they also strengthen support for pro-growth policies and structural adjustment more generally.

Successfully addressing these social objectives is often a necessary condition for more determined action to preserve long-term environmental integrity. Societies characterised by pressing social problems are likely to pay less attention to environmental problems while, conversely, those with abundant employment opportunities and less polarised distribution of resources are more likely to accept the employment and distributive effects that could follow a reduction in magnitude of high-polluting activities. More generally, societies with higher levels of social inclusion may better withstand external shocks — including those affecting the environment — through co-operative strategies (Ritzen, 2000).

Figure 1.10. **Trends in income inequality within OECD countries**



Note: Gini coefficients of household income per individual over the entire population (equivalence scale elasticity of 0.5). Simple and weighted (population) average for 12 OECD countries for which observations were available in years covering the three decades. Average trends for 15 countries in the 1990s are similar to those shown in the Figure. These average data, however, hide significant changes among individual countries (see Annex Figure A.6.

Source: Förster *et al.* (2000), "Trends and Driving factors in Income Distribution and Poverty in the OECD Area", OECD Labour Market and Social Policy Occasional Paper, No. 42.

Conclusions

With inappropriate incentives towards the use of natural capital, economic activities can lead to pressures that risk reaching critical thresholds in the regeneration capacity of resources and of inducing irreversible effects. Improving the efficiency with which a range of natural resources are used is a key requirement to de-couple environmental pressures from continued economic growth. Addressing some of the most pressing global environmental challenges such as climate change requires the co-operation of countries at different levels of economic development. Other critical environmental challenges, like biodiversity loss and water security, can be addressed with domestic actions, but the consequences of inappropriate or inadequate policy responses risk rapidly reaching other countries and regions. In both cases, international governance and co-operation among countries become critical to reach viable solutions. At the same time, disparities in economic conditions and unmet social needs in many parts of the world may make it more difficult to establish strong coalitions of countries who can respond to these challenges. Countries characterised by pressing social problems are likely to pay less attention to environmental problems and to be less willing to accept the structural adjustment associated with shifts towards more environmentally sound patterns of production and consumption. While a description of individual challenges does not determine the sustainability of current development paths, the linkages between these challenges and their policy responses demonstrate the need for their integrated consideration.

NOTES

1. The HDI, as developed over successive issues of the UNDP *Human Development Report,* is an average of measures of longevity (life expectancy at birth), knowledge (a weighed average of literacy and school enrollment) and per capita income, where each component is measured in terms of its distance from the minimum and maximum values ever observed, and where per capita income is heavily discounted when it exceeds a level of around USD 5,000 (at 1990 prices), i.e. around one fifth of that observed in the United States today.

2 . For example, protocols applying to various parts of Europe have been developed to limit acidification, eutrophication and ground-level ozone (Gothenburg, 1999); to curb emissions of harmful heavy metals such as cadmium, lead and mercury (Aarhus, 1998); to eliminate discharges of persistent organic pollutants, including a range of pesticides, industrial chemicals and by-products (Aarhus, 1998); to reduce sulphur emissions (Oslo, 1994); and to control emissions of volatile organic compounds (Geneva, 1991), nitrogen oxides (Sofia, 1988), and their trans-boundary fluxes.

3. These consequences include higher incidence of skin cancers and eye cataracts, lower air quality, and negative effects on the productivity of world fisheries and agricultural production.

4. For the United States, the Environmental Protection Agency estimated in 1988 that the benefits of the Montreal targets for ozone depletion would exceed costs by a factor of 170. Subsequent official estimates of the abatement costs turned out to be even lower than originally expected. (Barrett, 2000)

5. While an increase in average temperature is likely to lead to more evaporation and precipitation, these effects are expected to differ at different latitudes. In recent years, an increase in mean precipitation has been observed at latitudes between 30°N and 70°N, and between 0° and 70°S. Most climate change models project increases in global mean precipitation between 4 to 20%, with some models projecting both heavier rains per event and a higher number of dry days in some areas.

6. Average sea levels world wide have risen between 10 and 25 centimetres over the last century, and most sharply over the last 50 years, and are projected to rise by a further 46 to 58 centimetres by 2100.

7. Neuman *et al,* 2000 estimate that about 24,000 km^2 could be inundated in the United States by a 50cm sea level rise, with a loss in coastal property of USD 20-150 billions (i.e. up to 2% of current US GDP).

8. Several authors have provided estimates of the annual costs of a doubling of greenhouse gases concentrations for the United States in a range of 1.1 to 1.6% of GDP (Barrett, 1999).

9. According to UNDP *et al* (2000), estimates of the current rate of deforestation vary from about 50,000 km^2 to 170,00 km^2 per year. FAO estimates the total loss of original forest coverage at roughly 20% (see UNDP *et al.*, 2000).

10. Scenarios of water availability are based on Raskin *et. at,* 1997. Water sustainability can be measured by a variety of indicators. The one referred to in the text is the use-to-resource ratio, i.e. the ratio between annual water withdrawals to the annual renewable water resources. Water stress, according to this measure, it is considered to be high when this ratio exceeds 20%. For values above this limit, expert assessments suggest that water availability may become a limiting factor on economic development.

11. The number of great weather disasters recorded by Munich Re's Geoscience Research Group increased from 16 in the 1960s, to 29 in the 1970s, to 44 in the 1980s and to 72 in the 1990s (Münich Re, 2001).

12. In 1994, the UN projected that world population (under the medium variant) would reach about 10 billions by 2050.

13. The number of cities with more than 5 million inhabitants is expected to increase from 2 in 1950, to 21 in 1970, and to 33 in 2015. In the case of cities with more than 1 million inhabitants, the increase is from 81 in 1950, to 270 in 1970, to 516 in 2015.

14. More than 1.1 billion people in developing countries are currently living in urban areas where air pollution exceeds healthy levels.

15. Infectious diseases are already imposing a devastating toll on some of the poorest countries. Life expectancy at birth in the 29 African countries most affected by HIV is projected to decline from above 50 year in the early 1980s to 47 in 2000-2005, 9 years less than it would have prevailed in its absence (www.popin.org/pop1998/6.htm).

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Chapter 2.

KEY FEATURES AND PRINCIPLES

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Chapter 2.

KEY FEATURES AND PRINCIPLES

Introduction

Sustainable development stresses the long-term compatibility of the economic, social and environmental dimensions of human well being, while acknowledging their possible competition in the short-term.[1] Two central conclusions stem from this realisation. First, development must *balance* different objectives and exploit their synergies, as progress in a specific area may be short-lived if not accompanied by simultaneous advances in others. Second, development must be undertaken with a long-term view of its implications, and of the uncertainties that surround them. In other terms, today's policies must ensure that the costs of one generation's activities do not compromise the opportunities of future generations, as some key features of the environmental and social system cannot be easily restored once damaged. These interactions invoke new complexities and new risks for policy-makers and communities. An important challenge for governments is to better incorporate sustainability concerns into economic policies, since economic objectives play a dominant role in day-to-day policy formulations and in the priorities of many voters and of most policy-makers. For this to happen, the concept of sustainable development has to be more strongly anchored into standard economic discourse and into the practice of government policies.

Historical background

Discussions about the limits and implications of economic growth have been recurrent in economic history. In the early 1970s, the debate spurred by Meadows *et al.* (1972) mainly focused on the prospects of shortages in material stocks of non-renewable natural resources, and on whether economic growth would inevitably lead to environmental degradation and social collapse. At that time economic growth and environmental quality were largely perceived as *opposing* each other. In the 1980s, the importance of *reconciling* economic growth with the environment had come to be generally recognised, providing an intellectual underpinning to efforts to elevate the importance of environmental issues in policy making.

Interventions to improve environmental conditions had a longer lineage, but most of these had relied mostly on a piece-meal approach, where each environmental problem was addressed only when it became so acute that ignoring it was politically risky (Helm, 1998). Hence, emphasis in much of the 1960s and 1970s focused on pollution-related problems, notably air and water quality, toxic chemicals and waste management. This changed in the late 1980s, with the recognition of a more complex set of transboundary environmental problems, like acidification and ozone depletion; of limits to the sink and purification capacity of the environment, as in the case of climate change; and of stresses imposed on various renewable resources, like biodiversity (Long, 2000). The 1987 Report of the World Commission on Environment and Development (the 'Brundtland Report') was extremely influential in stressing the pervasive environmental implications of many economic and policy decisions. Building on this report, the Rio Conference on Environment and Development (UNCED) in 1992— together with the approval of Agenda 21, the Rio Declaration and a number of conventions — set things in motion at the national and local level. Responses included the adoption of Sustainable Development Action Plans in several countries and the establishment of a dedicated international Secretariat (The United Nation Division for Sustainable Development and the Interagency Committee on Sustainable Development.) to follow-up progress in their implementation.

Interactions among key dimensions of sustainable development

Economic policies have typically identified "development" with the growth of real per-capita income or consumption. Enshrined in the concept of sustainable development is a concern with the *quality* of economic growth as well as its *quantity,* and with human well being *alongside* economic growth. *Economic* sustainability covers the requirements for strong and durable economic growth, such as preserving financial stability, a low and stable inflationary environment, and capacities to invest and innovate. *Environmental* sustainability focuses on maintaining the integrity, productivity and resilience of biological and physical systems, and on preserving access to a healthy environment. *Social* sustainability emphasises the importance of high employment, of safety nets capable to adapt to major demographic and structural changes, of equity and of democratic participation in decision making. These conditions are distinct from, and as important as, economic efficiency. Sustainable development emphasises the links among these three dimensions, their long-term complementarity, and the need for balancing them when conflicts arise in the short-term.

Synergies can provide "win-win" solutions that allow for the achievement of multiple objectives, for example, by phasing out support that is damaging for both the environment and the economy. But trade-offs are sometimes unavoidable, as national priorities for various objectives differ, and objectives can at times conflict. For example, policies aimed at environmental goals may lead to short-term losses in economic output, and conversely policies that support economic activities of specific sectors or regions may negatively impact on environmental quality. Similarly, policies aimed at improving economic efficiency can run counter to objectives for equity and cohesion, while policies to achieve equity may do so in ways that impinge on the well functioning of markets.

A simplified representation of some of the links between the social, economic and environmental dimensions of sustainable development is provided in Figure 2.1.

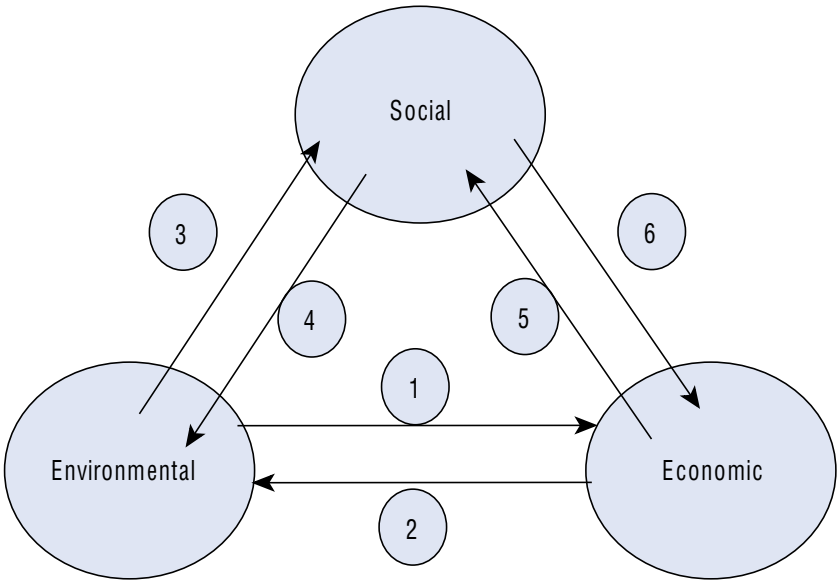
- The *interaction between the economic and environmental dimensions* encompasses, on one side, the productive services provided by environmental resources, as well as the economic impacts of measures to protect the environment [1]. On the other side, are the effects on the environment of economic activities and policies, as a result of firms' behaviour or of government interventions that harm (e.g. support environmentally damaging activities) or benefit (e.g. restore wetlands) the environment, as well as the property rights that govern the use of natural and environmental resources [2].

- The *interaction between the environmental and social dimensions* includes the provisions of environmental amenities, which are important to individuals but often in non-quantifiable ways. Environmental degradation and scarcities may result in health hazards for exposed populations, while policies to limit this degradation may improve working and living condition and prevent civil and military conflicts [3]. Conversely, social conditions will impact on the environment through consumption patterns (such as an increase in car transport), while education and awareness affect environmental protection. Features of social organisations such as norms and trust may also reduce behaviour damaging to the environment [4].

- The *interaction between the economic and social dimensions* includes the provision of human inputs to economic activities (in the form of labour, skills, knowledge and creativity), and the way in which social norms, attitudes and institutions affect the functioning of markets, for example, by reducing transaction costs and the need for policy interventions [5]. Conversely, most economic processes will affect society, providing the foundation for greater prosperity and for the durable financing of social security programmes, but also affecting the distribution of economic benefits and sometimes leading to pressures on social and cultural systems, disruptions and migrations [6].

The nature and size of many of these interactions are not known with certainty, and much of the research on sustainable development is directed at better understanding them. To explore these interactions, economists and scientists have built models of increasing complexity. Most of these models, however, have

Figure 2.1. **Some interactions between economic, social and environmental factors**



Key interactions

From the environment to the economy
1. Productive functions of the environment (natural resource and sinks functions); economic costs of environmental protection.

From the economy to the environment
2. Pressure on environmental resources from productive activities; investment in environmental protection; property rights on natural and environmental resources.

From the environment to society
3. Importance of environmental amenities for human welfare; Health and safety hazards from environmental degradation.

From society to the environment
4. Pressure on environmental resources from consumption patterns; environmental awareness of citizens.

From society to the economy
5. Quantity and quality of the labour force; importance of social arrangements for market transactions.

From the economy to society
6. Employment opportunities and living standards; income distribution; resources for the financing of social security programmes; pressures on social and cultural systems, leading to disruptions and migrations.

Source: Adapted from OECD (1999), "The OECD Three-Year Project on Sustainable Development: A Progress Report", Paris.

proven more successful in dealing with the costs of environmental policies than with the benefits provided by a healthy environment. The nature of these interactions also depends on the time frame under consideration. As these objectives are not always mutually compatible in the short-term, societies need to find good solutions for dealing with the unavoidable trade-offs.

Needs, resources and productivity

Although there have been innumerable attempts to refine the concept of sustainable development, the definition provided by the Brundtland Report remains the essential point of reference (World Commission on Environment and Development, 1987). Sustainable development is progress that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[2] The Brundtland Report further notes that this definition relies on two key concepts. One is that of "needs", "in particular the essential needs of the world's poor, to which over-riding priority should be given." The other is "the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs." These two concepts are shared by most definitions of sustainable development.

Needs

The concept of "need" stretches beyond the focus on per-capita consumption as a yardstick of human well being. Desires for a clean and healthy environment, and preferences in terms of fairness and social development also form part of this concept. Needs and desires also vary across time, groups and cultures.

Broadening the consideration of well-being beyond one centred on material needs reveals two limitations of GDP as a measure of well-being. The first is that GDP is only a partial measure of *economic* well-being. Some of the activities that contribute to GDP (such as pollution) may in fact lower economic well-being, while other economic activities that are not mediated by markets (such as household production for direct consumption) are excluded. GDP also considers as income what is often a reduction in society's stock of assets (as is the case with income accruing from the exploitation of natural resources beyond their reproduction limits, see Chapter 3). Second, economic well-being is itself only a subset of *human well-being*, as some societal goals (e.g. child welfare or social inclusion) matter irrespective of their economic importance.

Capital

The capacity to satisfy a society's needs depends on the different types of *capital* available to it. One condition for sustainability is that the sum of these different types of capital does not decline over time. The practical implications of this condition will depend on how broadly we define "capital". For the purpose of this Report, capital includes:

- *man-made capital*, i.e. the produced means of production like machinery, equipment and structures, but also non-production related infrastructures, non-tangible assets, and the financial assets that provide command over current and future output streams;

- *natural capital*, i.e. the renewable and non-renewable natural resources[3] which enter the production process and satisfy consumption needs, as well as environmental assets that have amenity and productive use, and are essential for the life support system.

- *human capital*, i.e. the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal well being (OECD, 2001*d*). Thus defined, human capital encompasses education (both formal and informal) and health.

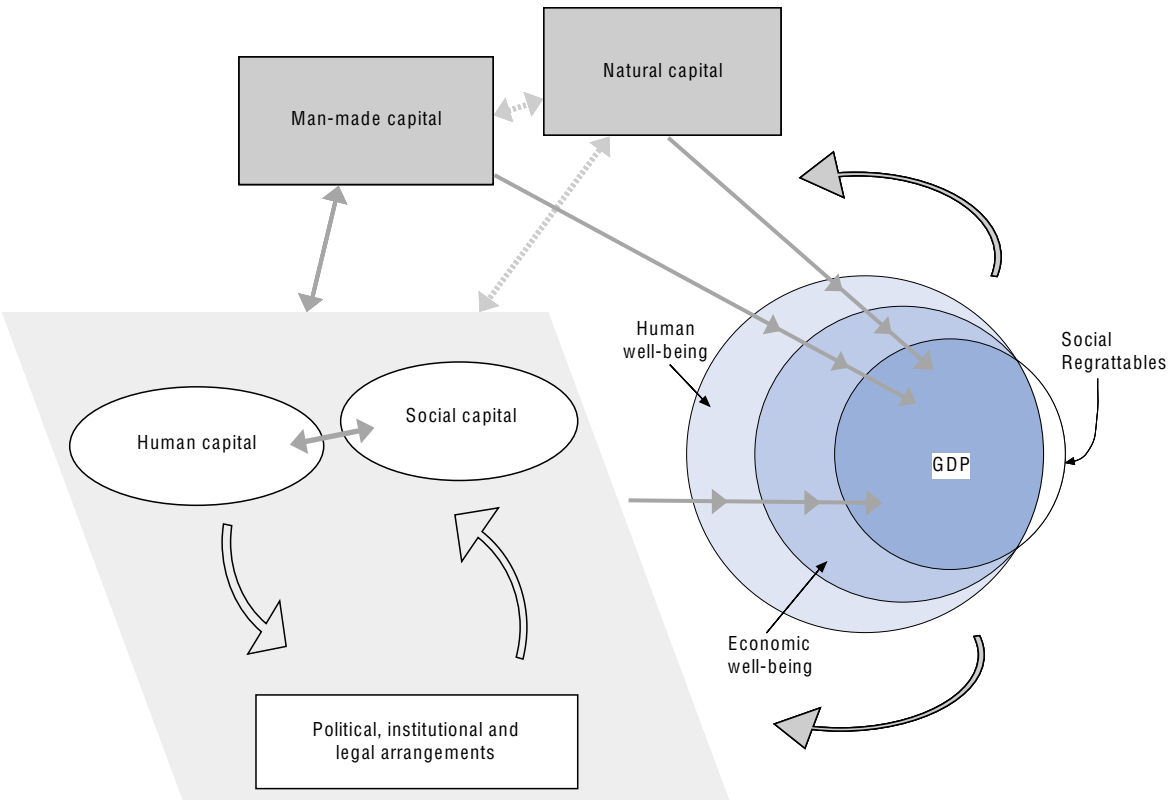
- *social capital*, i.e. the networks of shared norms, values and understanding that facilitate co-operation within and between groups (OECD, 2001*d*).

Because of their long-life span, and of the impacts of current-period investments and scrapping decisions, different types of capital provide one of the main mechanism through which generations are connected to each other. Underlying all different types of capital is a common dynamic structure, whereby stocks depreciate over time and increase through investment and (in some cases) natural regeneration. For all these resources, changes in flows take time to affect the underlying stock. Different types of capital

have different characteristics and degrees of persistence, but share the common feature that they build-up and are restored slowly, while they can be dissipated quickly if not used sustainably. If capital stocks cannot meet rising human needs, future generations may face heavy liabilities.

Different types of capital affect well-being through a variety of channels and produce an array of returns. These returns can be economic or non-economic, and accrue to individuals or groups. Education, for example, increases the earnings prospects of individuals but might also impact favourably on non-economic variables — e.g. by lowering crime rates. Also, returns can accrue directly to their owners (as in the case of returns to man-made capital) or to other family members (as in the case of the impact of parents' education on their children), to the community where individuals live (for example, the impact of social capital on neighbourhood crime) or to societies at large (natural capital). For some types of capital, optimal levels of investments by society may be higher than those justified from the individual's perspective. From this perspective, maximising growth in per capita well being over time would require equalising the social rates of returns on these different types of capital stocks, and periodically re-assessing the allocation of investments flows into these assets categories. Lastly, the effects of different types of capital on human well-being are mediated by political, institutional and legal arrangements (such as those establishing property rights and enforcing contracts and obligations) and by the extent to which these institutions are accountable and democratic (see Chapter 4). Different types of capital, and their links to GDP, economic and human well-being are illustrated in Figure 2.2.

Figure 2.2. **Different types of capital and human well-being**



Source: Adapted from OECD (2001), *The Well-Being of Nations: The Role of Human and Social Capital,* Paris.

Productivity

In addition to the physical availability of resources, opportunities available to the next generations will also depend on how technological progress enhances the productivity of existing assets.[4] While the role of technological improvements has long been a source of debate in the literature on economic growth, much of this debate is also relevant for discussions of sustainability. For example, some authors have suggested that the empirical magnitude of future technological change may well swamp the effect of depletion of natural resources and environmental pollution (Weitzman, 1997). In these circumstances, future generations will enjoy higher rates of well being than today, even if the physical availability of different types of capital declines.

A key point for assessing the importance of technological progress for sustainability is the way in which it comes into being. As emphasised by new growth theories, technology is the result of identifiable processes — such as expenditures on research and development, improvements in the skills of the workforce, and changes in firms' practices in using these skills. All these processes have opportunity costs in terms of foregone consumption. This "endogenous" component of technological progress — which is generally included in measures of current output as consumption rather than investment — has implications for policies intended to preserve different types of resources. First, it reduces the long-run costs of policies to meet sustainability goals, as higher initial costs elicit cost-reducing innovations at a later stage. Second, it increases the benefits from early actions, as higher initial costs may translate into technology leadership at a later stage (Grubb *et al.*, 2001).

Beyond its impact on material welfare, technology may also help to de-link economic growth from environmental degradation and to respond to the needs of the world's poorest. This impact is not automatic, though. While technological change generally responds to incentives, needs that do not translate into market demand will not elicit appropriate responses. Appropriate technological progress is therefore not a given, but its pace and direction can be steered by interventions, such as the creation of markets that make polluters pay for the externalities they create (see Chapter 6). The diffusion of less damaging technologies will also generate positive spillovers. These may offset the environmental effects of higher economic activity, and the possible migration of polluting industries to countries with less stringent environmental standards. Well-designed public support programmes for technology creation and diffusion may allow these positive spillovers to be enhanced.

Complementarity and substitutability among types of capital

A key issue for making operational the notion of non-declining capital stock is to what extent the different types of capital can be substituted for each other. Substitution, in an economic sense, is understood at the margin (substitution of a unit of capital of a given type with a unit of a different type of capital) rather than in absolute terms (substitution of the totality of a given type of capital with a different type). To the extent marginal substitution is possible, depletion of one type of capital would be consistent with sustainability if offset by an increase in other forms of capital. This corresponds to the concept of "weak sustainability" — i.e. of bequeathing to future generations the means to maintain or increase their standards of living. In this view, substitution may be allowed among natural resources, and even between natural resources and other forms of wealth. For example, the irreversible depletion of a properly managed non-renewable resource (such as oil) will be compatible with weak sustainability if offset by the accumulation of man-made and human capital whose benefits will accrue to more than the present generation.[5] "Strong sustainability", by contrast, assumes that some types of capital have no substitute and that their degradation would lead to an irreversible loss for future generations. "Strong" sustainability requires the maintenance of certain stocks of natural capital as a separate category of assets (Atkinson *et al.*, 1997).

Historically, substitution of natural by man-made capital has been one of the main features of economic growth, but preserving critical levels of some natural assets may be crucial for development to last. This perspective is most relevant when the loss of capital is irreversible, as in the case of some non-renewable resources (those which cannot be recycled) or of renewable resources that are exploited beyond their

capacity to reproduce. For example, many biological resources, and the ecosystems that support them, are nowadays viewed as falling into that category (see Chapter 10). In a similar way, there are no known alternatives to the carbon cycling services provided by nature (see Chapter 11). As critical levels of these resources are reached, more stringent sustainability criteria will require respecting the limits to the *regeneration* and *substitutability* of natural resources, to the *assimilation capacity* of the environment, and the need to avoid major environmental effects which may be *irreversible* (OECD, 2001*b*). Further analysis will allow scientists to better understand the functions of the different components of capital stock in human and natural processes. But conditions for sustainability that call for preserving capital stock must still make value judgements on the degree of substitutability among its different components.

While the previous discussion has focused on the degree of substitution of the different types of assets, to a large extent the various forms of capital complement each other in producing well being, and each of them may be more productive if accompanied by sufficient supply of the others. The economy, in particular,

Box 2.1. **The role of social capital in sustaining human well-being**

OECD (2001d) defines social capital as "networks together with shared norms, values and understandings which facilitate co-operation within or among groups." Networks, civic traditions and trust take time to build but can be dissipated quickly, and are frequently a by-products of activities in families, schools, communities, firms and other institutions. Social capital is a resource that resides in the relationships within and among groups. It can lower transaction costs, increase creativity and innovation, and improve the well being of individuals and communities. However, it can also undermine social harmony and impair economic performance, for example when networks are used to pursue narrow group interests.

While measuring social capital is problematic and still in its infancy, most empirical applications have focused on proxy measures of (survey-based) levels of inter-personal trust, and of (survey- or administrative-based) levels of engagement or interaction in social or group activities. Despite differences in the proxy used, a range of studies suggests that social capital can deliver important benefits. Some of these benefits are economic, such as increased firm productivity, effective job search and better career prospects, at the micro level; and higher investment and GDP growth at the macro level — although, in the latter case, evidence is weaker when analysis is restricted to OECD countries. Perhaps most significant is the evidence of impacts on other aspects of well-being, including education outcomes, child welfare, health status, avoidance of crime, neighbourhood vitality, quality of democratic governments, subjective measures of personal happiness. Some of these benefits accrue directly to the individual investing in social capital (e.g. positive health impact for elderly with high level of social connectedness), others spill-over to other group members (e.g. better educational outcomes for children that benefit from a high degree of parental involvement) and to communities at large (e.g. better residential quality in neighbourhoods with active community life). While directions of causality are difficult to establish, there is evidence that much of the impact of social capital on outcomes such as productivity may be indirect, through its facilitating role in enhancing the quality of human and physical capital investment and of institutions (OECD, 2001*d*). There is also evidence that social capital along with human capital impacts strongly on health and personal well-being, whereas the effect on these variables of higher income may diminish beyond certain thresholds.

Evidence of trends in social capital among OECD countries is mixed. Putnam (2000) points to a long-term decline in social and civic engagement in the United States. In general, a decline of some forms of social connection (through families, neighbourhoods and traditional mass organisations) is accompanied by the emergence of other forms of social connection (e.g. internet, work-based contacts and single-issue movements), often more distant, transitory, and self-interested. Some of these trends may be the outcome of unavoidable changes in our economies and societies as they develop, and may be offset by increases in the supply of other types of capital. However, in a number of circumstances, the scope for substitution may be limited. In these cases, the public-good characteristics of social capital might lead to under-investment and declining future well-being.

OECD (2001), *The Well-being of Nations: The Role of Human and Social Capital*, Paris.

would not be able to function without some of the basic services provided by the environment, including shelter, food and a well-functioning climate system. Examples of this complementarity abound. A clean environment means a healthier population and higher productivity; lower atmospheric (ground-level ozone, acid-rain precursors) and water borne (heavy metal) pollutants may result in higher crop yields; and maintaining the high-quality of naturally available water may be less expensive than purifying polluted water through man-made technologies. Indeed, with respect to commercially valuable renewable resources such as fish stocks, ensuring that they are sustainably used (i.e. not overexploited) allows for higher revenues from their continued use over time, as well as preserving employment opportunities in the sector. Complementarities between social and human capital are also important, as are those between social and natural capital — as norms of reciprocity at the community level will encourage behaviours which are more benign to the environment (Box 2.1)

Valuation and aggregation of different types of capital

Comparing different types of capital requires a matrix for measuring the different components, with relative weights representing the contribution of these stocks to human well-being. In the presence of opportunities for marginal substitution, prices are an obvious choice for weighting assets that are exchanged in markets. But monetary valuation is more difficult for other types of assets. Non-observable values may have to be estimated in indirect ways in the case of natural capital, as market prices often do not reflect the values of environmental services, and the "willingness to pay" for such services is not always observable. As shown in Figure 2.3, these values include:

- *use values*, i.e. the benefits accruing to people who directly use the environmental assets (forests, soil, water, air, outdoor recreation);

- *option values*, i.e. the benefits accruing not from the actual use of environmental assets, but from retaining the option to use them in the future (as in the case of tropical plants);

- *bequest values*, i.e. the values attached to environmental assets that people want to transmit to future generations (such as biodiversity, recreation and scenery);

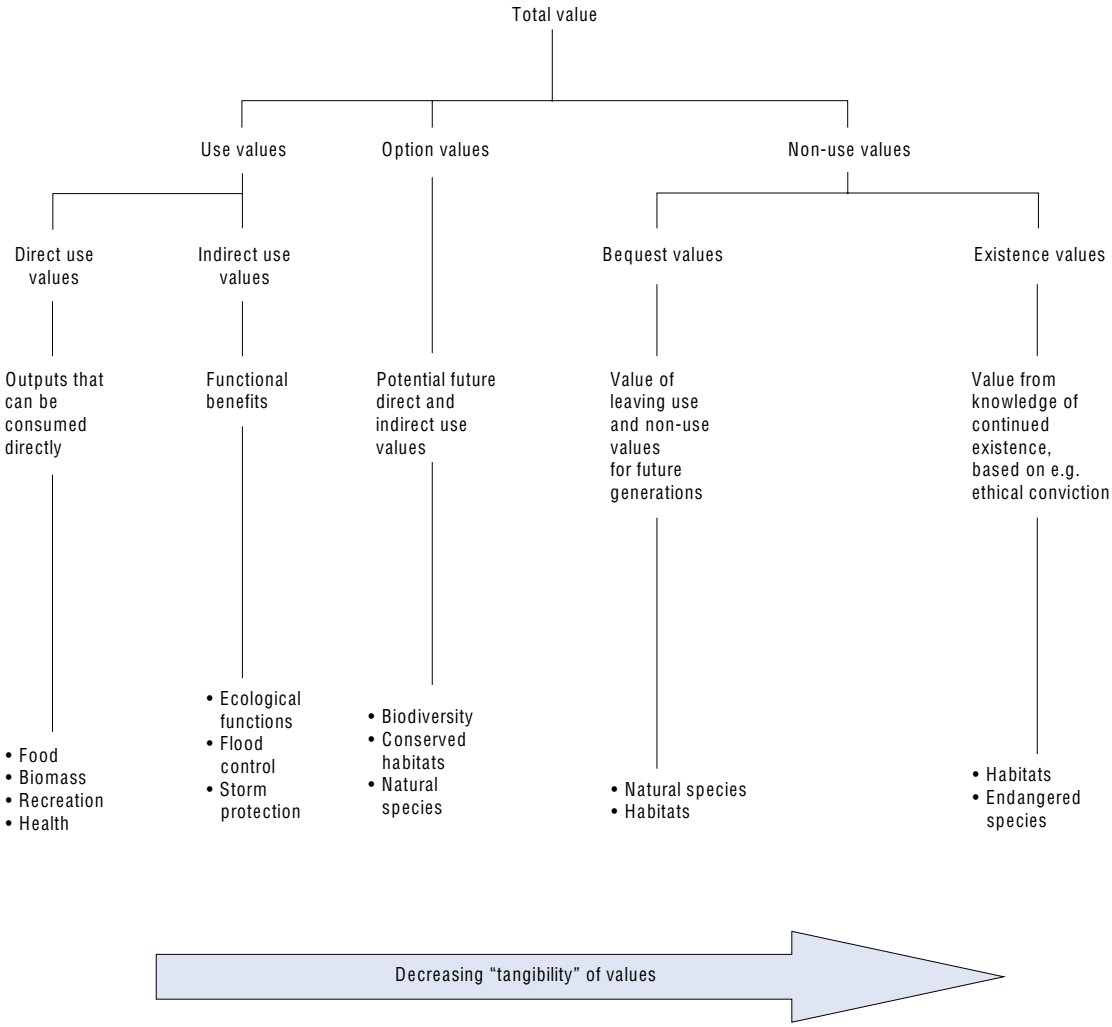
- *existence values*, which are derived from the mere existence of environmental assets, even if people will never use them (as in the case of habitats).

Different techniques may be used in assessing these values for different environmental resources (e.g. observation of market prices, revealed preferences and direct surveys of individuals' willingness to pay for preserving a given asset, see Chapter 5). These techniques, however, are not easily applied to some ecological resources like biodiversity, and most economic models have failed to take into account the value of natural resources and of the services that they provide. Furthermore, the environmental or social effects of human activities may persist long after the products or services have been used and disposed of, raising questions on the usefulness of methods based on the preferences of today's consumers for estimating resource values. Finally, thresholds and irreversibilities question the notion of marginal substitution underlying monetary valuation. Similar difficulties arise as we extend the asset boundary to human and, especially, to social capital. In conclusion, valuation of different types of capital is a difficult exercise, requiring a combination of physical and monetary measures, and aggregation of these measures remains a long-term goal (see also Chapter 3).

Internalising externalities and providing public goods

Prices used for economic valuation should reflect the full cost to society of activities. However, even for goods and services that are exchanged through markets, this does not always apply. A major cause for unsustainable practices is the presence of (technical) externalities that lead to sub-optimal development

Figure 2.3. **Total value of natural capital**



Source: Based on Munasinghe, M. (1992), "Environmental Economics and Valuation in Development Decision-making", World Bank Environment Working Paper No. 51, Washington DC.

of man-made, natural, human and social capital. In the environmental field, the presence of external costs and the lack of well-defined property rights for many resources often mean that producers lack incentives to take the full costs of degradation into account. Externalities are pervasive also in other areas such as technology, training and education, where the divergence between private and public returns may lead to under-investment. Thus getting prices right by correcting externalities is a key element in the pursuit of sustainable development.[6] From the perspective of society, such prices should reflect the weights to be given to the agreed economic, environmental and social objectives.

Externalities may arise from both policy and market failures. Policy failures may result from actions that, in many cases, hinder sustainable development. For example, subsidised prices may encourage the depletion of capital stocks. Market failures may stem from limits and asymmetries in information. For

example, prices may fail to reflect the costs to society of a reduction in the availability of clean air or water, leading to insufficient conservation of these resources. When positive or negative externalities occur[7] market prices will give the wrong signals, and under or over-supply of goods and services will result. Market failures may also reflect the absence of competition, as monopolistic producers can maintain selling prices above costs and have little incentive to improve quality. As with market failures due to external effects, government interventions may be required to reduce these inefficiencies.

Both policy and market failures partly stem from an inadequate understanding of the functions of different assets. For instance, wrong market signals may imply an over-exploitation of environmental resources. With corrected market signals policy makers may secure a more efficient resource use, meaning higher well being today and in the future. The quality of the policy measures taken to correct these failures will determine how closely the resulting prices truly reflect societal preferences. In many cases, present knowledge is adequate to correct for externalities, but in practice conflicts of interests and resistance to change have been more important in limiting progress in policy reforms for sustainable development.

Beyond the correction of externalities, unsustainable patterns of economic development may also reflect inadequate provisions of public goods. Public goods — whose benefits cannot be easily limited to a group of individuals (benefits are not-excludable) and where more own-consumption does not reduce that of others (non-rivalrous) — will tend to be under-provided by markets, leading to static inefficiencies. Mechanisms to increase the provision of these goods, in ways that avoid unintended effects and that reflect societies' preferences, may improve the allocation of resources and contribute to sustainability. Public goods such as law enforcement and defence are a well-established case for interventions by national governments.[8] But, as a growing number of concerns straddle national borders, so does the role of interventions capable of delivering public goods at the global level. Examples of these global public goods include aspects of the global environment (such as climate system and the ozone layer) but also international co-operation to prevent regional conflicts, monitor the spread of infectious diseases, preserve cultural heritage, promote trade integration and avoid financial instability (Kaul *et al.*, 2000). Benefits from more sustainable patters of economic development often have the nature of global public goods, as they accrue to more than one individual, country and generation. To deliver these global public goods efficiently governments may need to establish institutional mechanisms to determine shared priorities for actions, in ways that reflect the preferences of all countries; and overcome obstacles to collective actions and co-operation among countries (Tubiana, 2000).

Population size and per capita well-being

Maintaining over time per capita well-being requires that our capacity to satisfy human needs expand in line with population. While increasing the supply of human resources, growing populations also increase the demand on natural resources and other environmental services, possibly stretching resource use beyond its critical carrying capacity.[9] This will be especially the case when the population is also striving to meet legitimate human needs, and to approach levels of per-capita well-being prevailing in more developed countries (see Chapter 9). Beyond population size, human settlements and concentration of the population in specific areas will also affect sustainability at the local level (see Chapter 16).

Perceived risks for sustainability are most commonly associated with prospects for a growing population (scale effect), as less-developed countries undergo the demographic transition from high to low fertility when mortality rates have already declined rapidly. But even shrinking populations, as expected in many OECD countries over the coming decades, may imply challenges for preserving adequate levels of different types of capital. The concerns most frequently voiced on population ageing are those associated with a build-up of prospective liabilities in publicly funded pension and health schemes. But the influences of a shrinking OECD population extend to human and natural capital. Lower inflows into the labour market imply a smaller influence of initial education in changing the skills and competencies needed by economy. Population ageing may also affect natural capital through shifts in consumption and residential patterns, although the net implications are not well-understood.

Future generations: time horizons and discount rates

Different approaches to sustainable development also hinge on the interpretations of several criteria for inter-generational equity. One issue concerns how far into the future to plan. The relevant time horizon for a number of environmental effects may range from few years (in the case of several local-pollution problems), to decades (greenhouse gas emissions or radioactive waste) and to eternity (extinct species). As seeking guarantees for the very distant future is surely too demanding, one approach is to develop rules that commit any one generation to care for the next two or three, with each subsequent generation inheriting these commitment and looking forwards to the next ones (Pearce, 1999). This sequencing of obligations allows some room for manoeuvre, as each generation steers the path of development in the lights of its own preferences. In practice, a time-horizon of one generation allows for long-term objectives, and provides enough time for business to adapt their technologies and practices.

Sustainable development requires explicitly valuing activities within a long-time perspective. The discount rate measures how much we value consumption possibilities today compared to the future, and is an important tool for the analysis of individual projects and programmes. Zero discount rate implies that the present and future benefits are valued equally. A positive discount rate, on the other side, implies an asymmetry in the treatments of present and future generations that is especially troubling when dealing with environmental matters. In practice, decisions based upon a high discount rate are almost uninfluenced by costs and benefits that will occur beyond a few decades. Hence, the importance of reconciling market-behaviours and political realities, characterised by heavy discounting of future benefits and costs, with ethical arguments against discounting benefits accruing to future generations.[10] These may include interventions to favour long-term planning horizons for investment, and to encourage the use of lower discount rates for projects that are most respectful of the environment. Alternatively, assuming higher relative prices for the benefits of increasingly scarce environmental services — such as those provided by biological diversity, habitats and landscapes — or taking explicitly into account the impacts of natural resource degradation on total factor productivity, would offset the effects of high discount rates in cost-benefit analysis. Robust and dynamic financial markets, subject to effective supervision and regulation, make a vital contribution to lowering risks and discount rates for project with a long-term planning horizon, and to facilitate the financing of firms that adopt the best social and environmental practices in their operations (OECD, 2001*a*).

Risks and uncertainties

Sustainable development implies avoiding breakdowns that would endanger the basis for future development. As the future is uncertain, it is imperative that flexible economic, environmental and social systems, able to withstand unforeseen shocks, are maintained. As with decisions in many other areas, decision-making takes place in the face of uncertainty. To a large extent, these risks and uncertainties reflect limits in our understanding of the nature of interactions between the economic, environmental and social spheres. Other limits stem from the increased complexity of the challenges facing societies, often characterised by small but non-negligible probabilities of catastrophic break-down in the long-term.

Managing risks implies three complementary strategies for policymakers — risk assessment, communication and management. Learning, research and information-management are essential tools for risk assessment. Better risk assessment should rely on research about biophysical relationships and technical solution, as well as learning about societal preferences and attitudes towards risk. Because the issues involved in sustainable development are often complex and multi-dimensional, much of the research necessary to answer these questions needs to be interdisciplinary in nature and international in scope. Communication of these results to the general public and to potentially affected agents is also crucial to win support to implementation. Risk management — i.e. maintaining response options in the face of unexpected developments — implies diversification (e.g. in the energy sector), reducing system vulnerability and developing hedging or insurance strategies (OECD, 2001*c*). Approaches to risk assessment and management are especially important when dealing with environmental hazards with low probability of occurrence but high costs — due to human risk aversion and the high costs of sudden disruptions.

The notion of precaution, as set out in Principle 15 of the Rio Declaration, is an expression of this need for risk management and is referenced in a range of (binding and non-binding) international instruments dealing with the environment.[11] Two considerations apply, one re-enforcing the need to apply precaution, and the other cautioning against a naïve interpretation. First, the increasing scale of economic activities and the rigidity of the existing capital stock can increase the disruptive potential of serious or irreversible threats to the environmental or the social system, which may require investment into response options. Second, such investment may be costly. As risk-free decisions are exceptional, trade-offs need to be taken in a well-informed, consensual and science-based manner. Policies often have to balance economic costs that are sure and short-term, with the benefits of avoiding or minimising risks, which are uncertain and long-term.

Intra-generational equity and social sustainability

Many definitions of sustainable development, including the one proposed in the Brundtland Report, include the notion of intra-generational equity. In other words, concerns about the distribution of welfare, both among and within countries, are the counterpart to the consideration of equity between generations. In some perspectives, an increase in average well-being would not be acceptable if the world's poorest were not sharing its fruits. Hence, sustainable development implicitly requires a balancing between environmental and social priorities, and between the needs of current and future generations. For example, policies to mitigate climate change, the benefits of which will accrue in the future to generations with higher levels of material well-being, should be balanced against measures to improve health, infrastructure and education, benefits of which will accrue earlier to individuals who may need help more urgently (Schelling, 1997).

As argued in Chapter 1, the connections between concerns for intra-generational equity and those more traditionally associated with sustainability exist at two levels. Better integration of social concerns is often a pre-condition for more successful environmental interventions. This is most obvious when addressing global challenges, where the distribution of benefits from avoiding environmental degradation across countries may differ from their relative contribution to the emergence of the environmental problem. Building strong coalitions of countries to address these global problems can only occur if the legitimate development needs of the poorest countries — especially the overriding importance of eliminating poverty — are recognised and better integrated into policy responses. The challenge, in this case, is to identify ways for less-developed countries to increase their material well-being while minimising negative impacts on the environment.

Links between social and environmental goals are equally important when dealing with national and local environmental problems, so as to overcome obstacles to implementation. Trends towards greater use of economic instruments to correct for existing environmental externalities — which raise the price of pollution-related activities such as energy and potentially reduce the size of large polluting sectors — may impact in the short-term on income distribution and employment levels, often requiring offsetting measures to ease political resistance (see Chapter 7).

Social needs such as avoiding social exclusion and securing a durable financing of social security programmes in the light of changes in the risk patterns of populations are fundamental components for the well-being of societies, while human and social capital are among the resources that societies may use in order to improve their well-being over time.[12] Economic processes operate and interact upon social processes, even if this interdependence is often not recognised, while social organisations are essential for economic development. Hence the importance of designing social arrangements that the economy can afford to support in the long run, and of interventions to prevent a deterioration of social assets. While acknowledging the importance of the social dimension of sustainability, this Report also recognises the difficulty in developing operational criteria to integrate social issues into policy areas. The limited discussions of the social dimension in the different chapters of this Report reflect this difficulty.

Sustainability at the sectoral and local levels

Though sustainable development is most obviously interpreted at the global level, specific sectors (e.g. agriculture, industry, transport, energy) through the range of goods and services that they provide, play an instrumental role in meeting human needs. Further, through their activities, they may impinge on the resources available to other sectors and to future generations. In general, the first-best solution to avoid unsustainable practices is correcting for externalities and proving economic agents with appropriate incentives, irrespective of the sector or locality where they operate. This may imply reducing the weight of specific sectors and moving away from the use of support programmes targeted to them in favour of general interventions that address directly their social and environmental aims (e.g. rewarding those who provide environmental services, and general income support for workers in formerly subsidised sectors). When this is not feasible, policies should ensure that the activities of specific sectors satisfy human needs without compromising the resources available to others (see Chapters 12 to 15).

In this sense, policies aimed at assuring that an individual sector contribute to sustainable development depart radically from those aimed at sustaining its level of economic activity. In several cases, support policies to specific sectors have been justified by the need to secure adequate provision of non-market benefits that are provided jointly with economic production.[13] However, economic production by a specific sector is often not the sole means of supplying these benefits, as substitutes may be available, at least at the margin. And provision of these non-market benefits may often be de-coupled from economic output. The concept of sustainable development is useful in highlighting inconsistencies among sectoral policies, which may lead to unsustainable practices. Correcting these inconsistencies is crucial for sustainability.

In the same way as sectors may differ as drivers of unsustainable practices, territories may differ in their exposure to the consequences of unsustainable practices. Policy responses will depend on the nature of these consequences. In some circumstances, societies may accept a decline in the well-being of some areas as part of the structural adjustment process that they undergo as they develop. Migration of individuals and economic activities are among the mechanisms through which regions adjust to shocks and restore their well-being. In other circumstances, declines in local activities may lead to permanent disruptions in local communities and the resources on which they depend for re-generation. Public policies may be used, in these circumstances, to ease the adjustment process and to support endogenous development in these region. The rational for such interventions will be strongest when these regions house local cultures and traditions that are part of the national identity, and which society may want to preserve.

Conclusions

Sustainable development can be interpreted in economic terms as a path along which the maximisation of human well-being for today's generations does not lead to declines in future well-being. In economic models, requirements for sustainability are best conceived as a set of boundary conditions for non-declining capital that economic development should respect. Even when limiting the welfare function to material well-being, conventional models of economic behaviour may produce unsustainable results — where stocks of different types of capital decline over time.[14] In the real world, a combination of inappropriate prices and short-term horizons in decision-making are responsible for unsustainable outcomes. This observation underscores the importance in sustainable development of getting the prices right so as to modify the incentives that shape behaviour. A range of important elements for sustainable development policies are shown in Box 2.and used in other chapters of this book.

Interactions between the economy, the environment and society must be taken into account in formulating different policies. All too often, measures targeted to specific dimensions of development do not consider effects on other dimensions, leading to unforeseen effects and costs. Responding to the challenge of sustainable development requires the institutional and technical capacity to assess the economic, environmental and social implications of development strategies, and to formulate and implement appropriate policy responses.

Box 2.2. Important elements of sustainable development policies

The discussion presented in this report highlights the importance of a number of cross-cutting elements to guide policies towards sustainable development. These include:

Long-term planning horizons. In the absence of an adequate framework for assessing the impact of policies on different types of resources, measures targeted at short-term objectives may be selected even if they have negative long-term impacts. While trade-offs between different goals may prevail in the short-term, in the long-term man-made, natural, human and social capital will complement each other in supporting welfare improvements.

Pricing. For markets to support sustainable outcomes, prices should reflect the full costs and benefits to societies of the goods and services being produced. This may require the elimination of incentives to over-use natural resources and to degrade the environment, or the introduction of new incentives to improve the environment.

Delivery of public goods. Many of the benefits from government interventions needed to promote sustainable development have the characteristics of public goods (basic research, information, health and education). Also, many of these public goods are global, as they will benefit several countries (e.g. information on the state of global ecosystems). Effective delivery of these public goods requires overcoming obstacles to co-ordination, through burden-sharing rules that recognise the different responsibilities and response capacities of individual countries.

Cost-effectiveness. Policies should aim at minimising their economic cost. This will require ensuring that the costs of each extra resource spent are equal across the range of possible interventions. Cost-effectiveness allows the minimisation of aggregate costs and the setting of more ambitious targets in the future.

Environmental-effectiveness. Policies should secure: *(i) regeneration* — i.e. renewable resources should be used efficiently and their use should not be permitted to exceed their long-term rates of natural regeneration; *(ii) substitutability* — i.e. non renewable resources should be used efficiently, and their use limited to levels that can be offset by renewable resources or other forms of capital; *(iii) assimilation* — i.e. releases of hazardous or polluting substances to the environment should not exceed its assimilative capacity, and concentrations should be kept below established critical levels necessary for the protection of human health and the environment. When assimilative capacity is effectively zero, zero release of such substances is required to avoid their accumulation in the environment; *(iv) avoiding irreversibility* — i.e. irreversible adverse effects of human activities on ecosystems and on bio-geochemical and hydrological cycles should be avoided. The natural processes capable of maintaining or restoring the integrity of ecosystems should be safeguarded from adverse impacts of human activities. The differing levels of resilience and carrying capacity of ecosystems should be considered, in order to conserve their populations of threatened, endangered and critical species.

Policy integration. Unsustainable practices may result from incoherent policies in different domains. Sectoral policies, in particular, are often introduced without due regard for the externalities being targeted by environmental policies, leading to inconsistencies and spill-over effects. Improving policy coherence requires better integration of economic, environmental, and social goals in different policies.

Precaution. Threats of exceeding critical thresholds in the regenerative capacity of the environment are subject to uncertainty. Accordingly, when designing policies for sustainable development, countries should apply precaution as appropriate in situations where there is lack of scientific certainty.

International co-operation. With deepening international interdependency, spill-overs become more pervasive. A narrow focus on national self-interest is not viable when countries are confronted with a range of environmental and social threats that have global implications.

Transparency and accountability. A participatory approach is important to successfully meeting the challenge of sustainable development, as the criteria for sustainability cannot be defined in purely technical terms. This requires that the process through which decisions are reached is informed by the full range of possible consequences, and is accountable to the public.

NOTES

1. Short-term competition between goals pertaining to the economic, environmental and social dimensions is one of the main causes of the large gap in the implementation of sustainable development policies.

2. A related definition is that provided by Pearce (1999), who defines sustainability as "development that lasts, and which is not therefore threatened by actions we take now and which will have their major consequence in the future."

3. Renewable resources are those which can render services over an indefinite period, as new supplies are generated by nature to replace those that are harvested. Non-renewable resources are those which are regenerated only very slowly over geologic time and which can be restored only at prohibitive costs. The distinction between the two types of resources is sometimes blurred, as some non-renewable resources may be recycled (hence regenerated) at the end of their product life.

4. While, in practice, new technologies introduced in production processes become embedded in capital goods, the above discussion refers to technological progress as the "residual" of conventional growth accounting studies (or total factor productivity, i.e. the proportion of the rate of output growth that cannot be accounted for by the growth rate of inputs). Beyond its effect on productivity of existing assets, technological progress can also modify the quantity of different types of capital, for example by improving the efficiency of extraction and recovery of mineral operations.

5. This corresponds to the so-called "Hartwick's rule" — i.e. that a constant consumption path can be maintained as long as all rents from depleting non-renewable resources are invested in reproducible capital which substitutes for resource inputs in the production function (Pezzey, 1992).

6. In this context, Pezzey (1992) notes that conventional environmental policies aimed at correcting externalities will also make the economy more sustainable as a side-effect.

7. Externalities may also be positive, when production or consumption creates benefits for people besides the producers, sellers and buyers of the products. In some cases, the producers of goods generating positive externalities can develop markets to capture their value, e.g. the positive externality of an enhanced landscape associated with the use of better agricultural practices can be exploited through markets for rural tourism.

8. Even at the national level, optimising the supply of public goods is problematic. For example, it may not be feasible to collect charges from individual users over large parts of the network. Even when revenues can be raised to match expenditure, evaluating which part of the network should be developed will need to rely on indirect methods (such as cost-benefit assessment), where the value of time ascribed to users will dominate the calculations.

9. The notion of carrying capacity is drawn from biology, and suggests that a given area can only support a given population of a particular species. In the context of sustainable development, this concept suggests the existence of a saturation point to human population, beyond which the yield of ecological resources will start to decline, possibly translating into declining welfare per capita for a given level of investment.

10. As suggested by Heal (1997), logarithmic discounting, as opposed to conventional geometric models, would result in higher values attached to future events and is more consistent with experimental studies suggesting that (implicit) discount rates used by individuals tend to drop as the horizon extends and as his income increases. A different approach is one based on discounting within but not between generations.

11. The 1992 Rio Declaration on Environment and Development states (Principle 15): "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

12. While the concept of capital is most relevant in an inter-generational perspective, it is also important for the *intra-generational* one. Empowerment of individuals and poverty alleviation are themselves a function of control over resources and of access to different types of capital (Pearce, 1998).

13. Agriculture, for example, may provide a variety food and non-food products as well as ecosystem services and amenities, such as landscape and habitat and food for wild flora and fauna (see Chapter 14).

14. For example, forward-looking economic models with overlapping generations which explicitly link current decisions to future consumption may generate paths where optimal consumption is either declining (not sustainable) or declining below subsistence levels (not survivable). This may occur, for example, when the discount rate used exceeds the regeneration capacity of the resource considered (Pearce *et al., 1994*).

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Chapter 3.

MEASUREMENT

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MEASUREMENT

Introduction

The concept of sustainable development poses a significant challenge for measurement. Its agenda — in succinct terms, ensuring current and future needs — is a broad one, covering virtually all aspects of national life and government policy. Satisfying *current* human needs, however, can hardly be described as a new objective of government policy in OECD countries.[1] National statistical systems in most OECD countries already include panoplies of statistics covering the social and economic well-being of their populations, even if these have not yet been integrated into a single framework. The question then is: which of these are pertinent in the context of sustainable development?

To the extent that societies have a self-preserving character, the focus on predicting the potential downstream impact of current actions (or inaction) and on satisfying future needs is not entirely new either. What *is* new about sustainable development is the attempt to introduce a concern for future welfare systematically throughout government policy. The challenge for measurement becomes how to translate this perspective statistically, so that the objective of sustainability is reflected in more than rhetorical terms.

An additional challenge for measurement lies in the fact that some key threats to sustainability (climate change being the most notable example) are affected by phenomena and actions that cross national borders. Although national statistics may be able to measure the impact of these effects inside a given country, assessing sustainable development also requires monitoring what is happening *outside* national jurisdictions. This international dimension makes it difficult to measure sustainable development on the basis of national or even OECD-wide statistics alone.

This chapter presents an approach for statistically monitoring sustainable development that draws heavily on prior ground-breaking works, and takes advantage of statistical infrastructures already present in most OECD countries. In particular, it seeks to develop the statistical implications of the key features and principles outlined in Chapter 2. Emphasis here will be on conveying the concept of sustainability in clear statistical terms.

Measurement considerations

What is meant by needs? And what is required to ensure that these are being met? Answering these two questions is an important step in understanding the implications for measuring sustainable development. We will treat these questions in reverse order, since it turns out to be easier to identify the necessary conditions to ensure sustainable development than it is to define the scope and level of needs.

Meeting needs

Strictly speaking, output is a function of available assets: in particular, produced (man-made) capital, human capital, and raw materials. In a broader sense, it also depends on technology, social harmony, and governance, as well as the functioning of institutions, and the regulatory framework. While intangible public

goods like these present difficulties for measurement, there is general agreement that they significantly impact total production. And though production (or even disposable income) per capita is not a completely satisfactory measure of human well-being,[2] the notion that *assets* determine the ability to produce a certain level of *output* can be applied to the problem of satisfying needs.

From this perspective, the requirement that future generations be able to satisfy their needs is tantamount to ensuring that they have a sufficient level of assets (or wealth) to do so. In the absence of concrete knowledge of future needs and the asset levels required to satisfy them, the necessary condition for sustainability is generally stated in terms of a "constant capital rule", namely that the trend in the real aggregate value of national assets per person must not be negative. Although there seems scarcely any prospect of *precisely* defining, let alone *valuing* features such as social harmony or well-functioning institutions, formulating a broad view of national wealth that finds meaningful ways of accounting for these features is the central focus of sustainable development.[3]

In statistical terms, this rule suggests the need to establish national balance sheets that reflect, on an on-going basis, current additions to and subtractions from national wealth. An analogy with firm accounts is useful here, because it is precisely the enterprise balance sheet that reveals the long-term viability of an enterprise, rather than the current income and expenditure statement. In effect, sustainable development amounts to balancing the emphasis on current development — as embodied in the income and expenditure accounts of the system of national accounts — with the prospects for longer-term development — as reflected in the national balance sheet.

A number of countries have attempted to construct national balance sheets that go beyond a narrow accounting of produced capital stock and financial assets and liabilities, to include valuations of natural and environmental resources, factoring in depletions and degradations of these. Human capital, however, does not generally figure in such balance sheets, because of the perceived difficulty in assigning it a monetary value. Estimates of the wealth of nations developed by the World Bank (Kunte *et al.,* 1998) represent an attempt to establish national balance sheets for countries around the globe that include a figure (obtained residually) for all non-produced or non-natural assets that contribute to economic production.[4] These "human resources" encompass a broader view of resources than that normally conveyed by the concept of human capital.

Conventional national accounts — based as they are on agents producing and consuming goods and services whose value is reflected in prices — are ill-equipped to measure these resources comprehensively.[5] In the words of Hulten (2000), "a complete set of economic accounts would include information on the price and quantity of every variable that enters into the production or utility function of every agent in the economy. The required list of variables would extend far beyond the boundaries of the market economy … and would include everything that correlates with the production of goods and services and affects economic welfare." Such a description clearly departs from what can be realistically and reliably measured.[6]

In practice, it may be sufficient (and easier) to measure changes to the balance sheet rather than the accumulated value of total assets. The genuine savings concept (see below) introduced by Pearce and Atkinson (1993) is in fact a measure of change in net worth, the bottom line of a more broadly defined but still limited national balance sheet — with the components confined to those that can be measured in monetary terms.[7] The concept of green GDP — the sum of genuine savings and current consumption flows — is likewise an attempt to incorporate measures of environmental liabilities (i.e. degradation of the natural environment and depletion of natural resources) into standard GDP. This calculation is done in the same way as depreciation and disposal of produced capital in the national accounts.

Accounting for changes to national wealth means measuring investment and discoveries on the one hand, and depreciation, destruction or disposal on the other. Although there exist some measurement conventions for addressing changes in produced assets and natural resources, progress with respect to broader environmental capital and social assets is still in its infancy. While investments (in pollution-prevention technology, water sanitation, education, health, etc.) are generally amenable to quantification in monetary

terms — by virtue of there being actual expenditures on these — the extent of degradation and depreciation in social or environmental capital can rarely be measured so simply.

For instance, while there is general agreement on some consequences of human activities on underlying stocks (for example, that emissions of NO_X and SO_X have an adverse effect on air quality and human health, or that prolonged unemployment results in a depreciation of human capital), evaluating either the extent or the societal costs of these effects is at best problematic. Many existing statistics in the social and environmental domains (such as poverty measures, crime rates, and pollution emissions) are in effect the elements which one would include in a broad view of national wealth: factors which affect health, human capital, social cohesion, air and water quality, land and soil, etc. Thus, although an exact accounting of liabilities attributable to externalities of human and government action may be difficult to achieve, in practice many current statistics do reflect, if only implicitly and imprecisely, degradation and depreciation of human, social and environmental capital.

Defining and measuring needs

It would not be difficult to define a list of human needs with which most observers could agree: an adequate means of livelihood, a decent living environment, good health, harmonious social relations, security, freedom of action. But the relative importance accorded to each of these will vary according to individuals and societies over time. So while it may be relatively easy to compile a set of indicators related to the satisfaction of needs, it is not obvious what level of satisfaction would be compatible with sustainability. Different societies seem to be able to tolerate very different levels of strains like poverty, unemployment or crime.

Pearce (1998*a*) has suggested that the conditions for sustainable development are likely to be invariant with the definition of development. The extent to which needs are being met should be reflected, on an on-going basis, in changes to certain components of the national balance sheet, and in particular to the value of human and social capital. On the other hand, not all development paths are compatible with the constant capital rule. For example, the satisfaction of current human needs may be achieved at the expense of a depletion of produced capital and, in particular, natural capital.

Although well-being and capacity are closely linked, a detailed monitoring of what is happening to the national balance sheet may not suffice to provide all the necessary information on whether current needs are being met. In any event, the current state of knowledge about the precise consequences of phenomena such as pollution, poverty and crime is simply inadequate to forego their standard statistical measures in favour of measures of their effects on the balance sheet. Certainly, measuring the costs to society of such phenomena would help guide assessment of the necessary trade-offs between current and future needs, hence contributing to better decision-making. In practice, though, a monitoring of trends and progress may be all that statistics can realistically provide in the short-term.

Measurement implications: summary and practice

In statistical terms then, sustainable development requires:

- Establishing national balance sheets on the basis of a broad notion of national wealth, one that includes man-made, natural, human and social capital.

- Monitoring the balance sheet to ensure that net national worth is not declining.

- Monitoring the satisfaction of current needs or, more broadly, of factors that contribute to enhancing / diminishing national wealth or the value of its components.

There are numerous efforts underway both nationally and internationally to implement this broad measurement agenda.[8] Of particular note is work undertaken by the United Nation Commission on Sustainable

Development, the World Bank, the Wüppertal Institute, the International Institute for Sustainable Development and by a number of countries, particularly the United Kingdom (UK, 2000), the United States, Finland, Sweden and the Netherlands.[9] Work is also being carried out at the European Union level by Eurostat and the European Environment Agency.

These efforts use a variety of different approaches, from the construction of composite indicators that attempt to provide an assessment of overall prospects for sustainable development, to broad compilations of available statistics intended to reflect the economic, social and environmental dimensions of development (UN, 2000). Whether such approaches provide, implicitly or otherwise, for the possibility of balancing current needs and future prospects is unclear. While measurement in *either* of these areas presents a formidable challenge, assessing the nature and appropriateness of societal trade-offs *between them* is an even greater one.

The approach taken in this chapter is to attempt a limited but explicit presentation of, on the one hand, indicators of resources (intended to reflect the level and change in national wealth) and, on the other, indicators of outcomes (reflecting various aspects of human welfare). This compilation draws on a number of data sources (Box 3.1) that, although not explicitly developed for the purpose of measuring sustainable development, can be adapted to the measurement objectives described above. The original data sources are far richer than what is presented here and, in practice, may be more useful for addressing specific policy issues related to such things as energy conservation, pollution emissions, or effects on household expenditures of energy price changes. However, a limited set has its usefulness in highlighting major issues, even if the data presented cannot definitively determine whether the correct balance between current needs and future development is being achieved.

Box 3.1. **OECD work relevant to sustainable development measurement**

ENVIRONMENTAL INDICATORS. The OECD has been involved in the development of environmental indicators over the past 10 years. Work on this subject includes the construction of: *(i)* a *Core Set* of environmental indicators, i.e. a minimum set of indicators common to OECD countries and applicable to different uses and purposes; *(ii)* several sets of *sectoral indicators*, including sets for agriculture, transport and energy, to promote integration of environmental concerns into sectoral policy making; and *(iii)* indicators derived from *environmental accounting*, to promote both integration of environmental concerns into economic policies and sustainable use and management of natural resources. This work has used the so-called "pressure-state-response" (PSR) model as a common framework. Environmental indicators are regularly used in the context of the OECD's environmental performance reviews. Current efforts aim at improving the quality of existing indicators, linking them more closely to policy objectives and targets, and at further developing indicators to monitor the linkages between the environment and other sectors, with emphasis on environmental-social linkages (OECD 1998*d*). The OECD is also active in the development of techniques for environmental accounting and for the valuation of environmental assets.

SOCIAL INDICATORS. A list of social indicators was developed by the OECD in the early 1980s (OECD, 1982) but regular reporting was not implemented. In June 1998 Ministers for Social and Health Policy mandated the OECD to develop a comparable set of indicators to summarise social conditions in OECD countries and to assess the effectiveness of measures taken to pursue social objectives. The provisional list developed in OECD, 2000, reflects current social policy concerns and objectives: promoting autonomy, equity, healthy living and social cohesion.

ECONOMIC INDICATORS. To underpin its economic analysis the OECD maintains databases containing a wide range of statistics on such subjects as national accounts, balance of payments, trade, prices and finance. The OECD is also active in the development of best practices for the measurement of economic variables, and of techniques for measuring productivity, capital stock, research and development and prices.

Assessing overall sustainability

Although generally available statistics provide useful information on various aspects pertinent to sustainable development (changes in energy intensity, the extent of investment in human capital, etc.), they do not — by themselves — answer whether countries are on a sustainable development path. Because sustainable development covers such a wide terrain and involves many trade-offs, measurement of progress is difficult to assess. Moreover, progress in a number of dimensions may not provide information on whether *overall* sustainability objectives are being met. As a result, a number of measures have been developed that attempt to assess overall sustainability. These measures summarise data covering diverse issues, come from varied sources and are expressed in different units.

Composite indicators of sustainability

A large number of composite indicators have been developed to focus on environmental variables. Examples of such indicators include the "Ecological Footprint indexed" developed by the World Wildlife Fund, the United Nations Environmental Program (UNEP) and other agencies; the pilot "Environmental Sustainability Index" developed by the World Economic Forum; and the "Total Material Requirement" indicator developed by the World Resources Institute.[10] While these indicators have generally limited coverage, they help in identifying stresses on the environment.

Other composite indicators combine information from economic and social variables so as to provide an overall measure of current-period welfare. Although GDP per capita is the most commonly used indicator

Box 3.2. **Genuine savings as an indicator of sustainable development**

The genuine savings approach builds on the notion that sustainable development requires creating and maintaining wealth. It takes the logical step of adjusting traditional measures of domestic saving (the sum of investment in fixed assets and of the current account surplus) for factors which add to or deduct from wealth, where wealth is defined to include economic, environmental and social assets. The first cross-country estimates of genuine savings were completed by Pearce and Atkinson (1993). This approach is currently being pursued and extended by the World Bank. A number of OECD countries, such as Denmark and Sweden, are also developing their own measures of genuine savings.

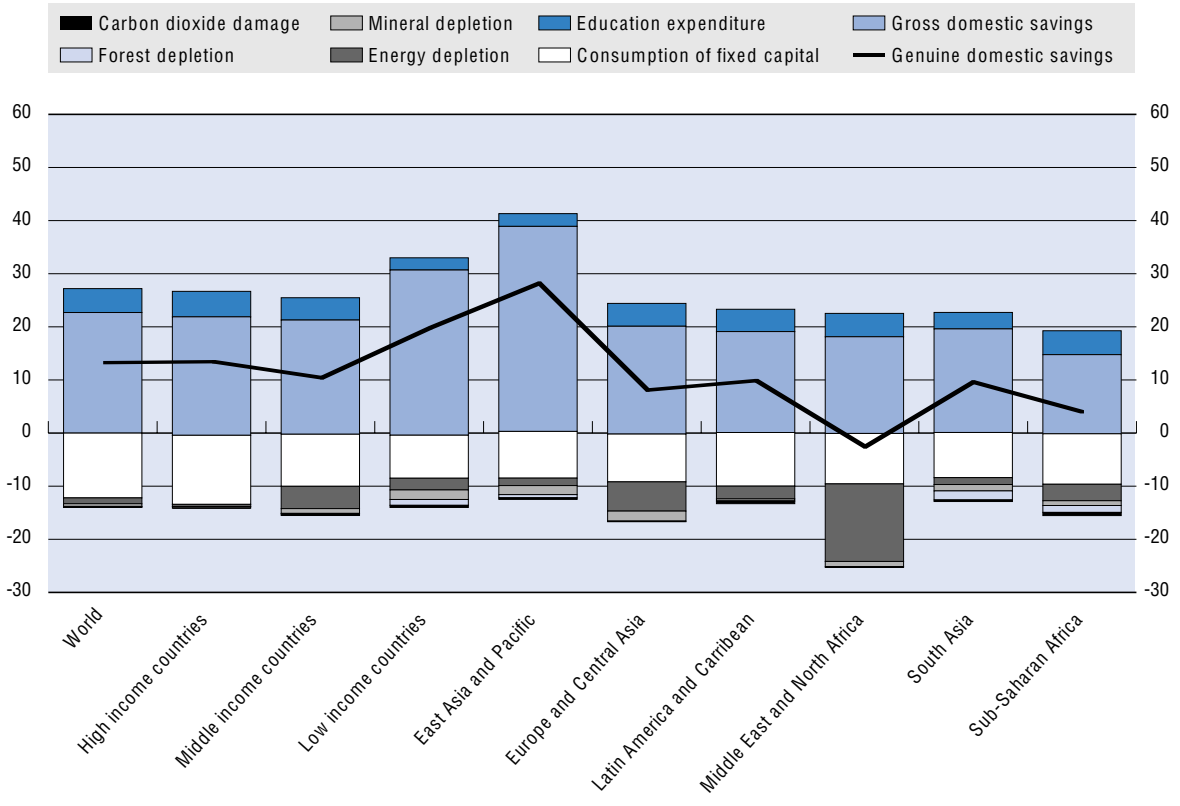
Genuine savings starts with the traditional economic measure of gross savings (Gross National Disposable Income less consumption), to which it adds total education expenditure (a measure of investment in human capital). It then subtracts consumption of fixed capital, depletion of minerals, forests and energy resources, and damage from carbon dioxide (all expressed in monetary terms). Conceptually, genuine savings has the advantage of a natural reference point that allows assessment of sustainability: persistently negative genuine savings imply a continuing reduction in overall wealth that will compromise the ability to maintain or improve welfare over time. (Atkinson *et al.*, 1997)

Genuine savings rates (as a proportion of GDP) for major world regions in 1998 highlight the fact that correction to gross savings for human capital investment and for natural capital degradation can be substantial, pushing genuine savings rates into negative values in those regions (e.g. Middle East and North Africa) highly dependent on natural resources (Figure 3.1). However, the data seem to suggest no significant sustainable development concerns for other regions. This in part reflects the difficulties of valuing environmental impacts such as carbon dioxide emissions and the fact that high-income countries are gradually de-coupling economic growth from environmental impacts. Thus, even though the level of environmental impacts may be increasing, their value relative to GDP may decline. Positive genuine savings is *only* a necessary condition for (weak) sustainability — it does not measure the pace of asset accumulation (or welfare growth) along a sustainable path. Countries with similar rates of genuine savings may experience different growth rates of sustainable income or of total assets. Although there are important gaps in the accounting of depletion of natural resources, and of pollution costs, genuine savings represents a promising approach.

of welfare, measures of GDP are often criticised for not including important components of welfare.[11] To counter some of the deficiencies of GDP as a measure of welfare, the Human Development Index developed by the UN Development Program combines indicators of health (life expectancy), education (ratio of population in education) and per capita income into a single measure. However, this index has also been criticised and, at present, no single indicator of welfare appears to command general consensus.

Other indicators combine information on a much broader range of variables pertaining to either the satisfaction of current human needs, or to the resources required to meet needs in the future. These indicators are based on a selection of information for relevant issues, which are then either adjusted in monetary terms or aggregated (with subjective weighting) into a composite index. Examples include the "Genuine Progress Indicator", which takes GDP as its starting point and makes several adjustments; and "Indicators of Sustainable Economic Welfare", which adjust the final consumption expenditure of households.[12] Another example of this approach is the "Index of Economic Well-Being" by Osberg and Sharpe (2000). In these approaches the choice of components and of weights is critical in determining the overall outcome. Measures based on "sustainable income". (or green GDP) uses GDP as a starting point, then deduct costs of depreciation of produced assets, depletion of minerals, energy and biological (fish, forests) resources. Problems of valuation have generally limited attempts to deduct degradation of air and water. A variant of this approach is the notion of "genuine savings" (i.e. sustainable income less consumption) described in Box 3.2.

Figure 3.1. **Genuine savings rates, 1998**
as a proportion of GDP



Source: World Bank (2000), *World Development Indicators,* Washington D.C.

Such composite measures are useful for summarising large amounts of information, but are subject to the usual reservations expressed about synthetic measures. These relate in particular to questions of exhaustivity (they may not cover all relevant aspects); overlap (different statistics may to a certain extent be measuring the same thing); and balance (aggregation requires making choices about the relative importance of different phenomena). Integrating different types of information will continue to pose a challenge for sustainable development and indeed for all composite measures that are not based on a common numeraire.

Frameworks for measuring sustainable development

Frameworks are important for linking information pertaining to different areas, and for relating indicators to analytical questions and policy issues. Different frameworks are currently used in the various areas of sustainable development, with the choice of framework varying according to the purpose of the measurement. Two types of frameworks are considered here: accounting and analytical frameworks.

The main aim of frameworks is to show relationships between different variables. There is no requirement that all data within a framework be presented in a common measurement unit. Indeed, the use of a common measurement unit may unduly restrict the number of relationships that can be examined, since data from different sustainable development dimensions are of many types. Frameworks, which allow the comparison of monetary and physical data, can be useful tools.

Frameworks for measuring sustainable development should:

- Integrate the economic, environmental and social dimensions of sustainable development.

- Have sound conceptual foundations.

- Capture key information needed to measure sustainable development by selecting indicators.

- Clarify relationships between different indicators and between indicators and policies.

Accounting frameworks

Economic accounting

In economic discussions, national accounts have long been considered the measurement framework of choice. National accounts record the economic transactions of a country in monetary terms. Coverage is broad and encompasses concepts of economic production, consumption and saving, assets and productivity, employment, and the role of different economic agents (government, households and businesses). However, to a large extent, the national accounting framework has focused on economic production and the role of fixed assets. Following the release of the latest manual on national accounts, the System of National Accounts 1993 (EU *et al.*, 1993), attention is now being paid to the measurement of a broader range of economic assets, including intangible assets, as well as the links to environmental accounting (Box 3.3). Measuring sustainable development may also require alternative presentations of the accounts of various institutional sectors such as government, households and businesses. Recognising the important role played by government in the pursuit of sustainable development, for example, requires careful presentation of existing data on taxes and subsidies relating to environmental and social issues.

Despite these extensions, it is recognised that traditional national accounts do not incorporate environmental issues appropriately, nor do they measure well-being in a broad sense. Much recent work has considered how the traditional national accounts framework could be extended to take account of environmental and social issues. In terms of an accounting framework for sustainable development, the aim is to augment the existing accounts with other relevant accounts, linked either by monetary measures

or through the use of common classifications and presentations. The following sections examine some of the accounts that may be incorporated.

Environmental accounting

One starting point for extending the traditional national accounts is accounting for environmental resources.[13] At its most basic level, resource accounting measures the quantitative changes in stocks and flows for different environmental assets. Examples include accounting for water, forests and mineral resources. Many resource accounts have been developed in OECD countries for different types of assets (Box 3.3). Resource accounts are generally presented in terms of the supply of resources, matched against the demand for these resources from industries and other economic actors. Usually, the accounts are first compiled in physical units, and then valued in monetary terms.

Box 3.3. **Examples of resource accounting for subsoil assets: European Union pilot study results**

In the document "Directions for the EU on Environmental Indicators and Green National Accounting" (Commission of the European Communities, 1994) the Commission called for further work on satellite accounts. Subsoil asset accounts are one part of this agenda. The aim of an account for subsoil assets is to describe stocks and flows of these assets in both physical and monetary terms. The results are presented in the form of balance sheets and accumulation accounts, similar to those found in the European System of National Accounts (ESA).

The Task Force established to undertake this work has focused primarily on the valuation of reserves, more than on the accounting for pollution from extraction and consumption of subsoil assets. Also, such work has concentrated mostly on oil and natural gas, since these are the subsoil assets of greatest importance in EU member and candidate countries (both sets of countries being covered in the assessments of the European Environmental Agency, EEA).

At the end of 1996, total reserves of oil and natural gas liquids in EEA countries were estimated at 6.3 billion tonnes —- around 3% of the estimated world total (World Energy Council estimates, 1998). Reserves of natural gas for the EEA were 10.4 trillion cubic metres at the end of 1996 (between 2-3% of world reserves). Norway, the Netherlands and the United Kingdom combined account for 94% of EEA oil reserves and 89% of EEA gas reserves. The value of the reserves of oil and gas is based on estimates of the net present value of future resource rents. Since estimated resource rents fluctuate significantly from year to year in response to commodity price changes, these value estimates also show large year-to-year changes. At the 1996 rate of extraction, oil reserves in the EEA would last about 20 years and gas reserves for 38 years. Stocks of these reserves have generally decreased less over time than the amount extracted, reflecting the effects of new discoveries and of higher assessments of existing stocks.

Source: Adapted from European Commission, *Accounts for subsoil assets – Results of pilot studies in European countries,* Luxembourg (2000)

A specific extension of resource accounting is material flow accounting, which traces physical flows (inputs and outputs) of different types of "materials".[14] Materials include individual products (such as fertiliser), basic elements (such as nitrogen, lead or carbon dioxide) and resources (such as energy, water and soil).[15] This approach is especially informative when examining the intensity of use of individual materials, but it is also helpful in assessing whether economies are "dematerialising", or whether the generation of waste caused by the processing of material inputs is simply being shifted abroad.

Another important aspect of environmental accounting is measuring the degradation of air and water. Accounting for these types of degradation is often less straightforward than for other environmental resources, given the importance of quality (rather than quantity) changes for air and water. The expenditures

paid to remedy or prevent pollution provide another perspective from which to assess the links between the economy and the environment. A further set of accounts considers links between the economy and the environment in specific industries. Of particular interest are agriculture, transport and energy. These sectoral accounts do not involve use of new measurement tools, but rather apply environmental accounting approaches at a more detailed level. Finally, since accounts are generally compiled at a national level, information on cross-border flows of environmental resources is also important.[16]

All aspects of environmental accounting are discussed in the manual *The System of Integrated Environmental and Economic Accounts* (UNSD, 1993) currently being revised.[17] The revised manual discusses resource accounting for all types of resources; valuation techniques; and options for reorganising the traditional economic accounts to highlight environmentally related flows. Further refinement of SEEA will assist in the development of a broader sustainable development framework.

Social accounting

Interactions between the social and economic spheres have received much attention, particularly in the area of income distribution. Accounting in this area involves developing alternative presentations of household income and consumption, which link aggregate data to household data. Work along these lines is being developed using social accounting matrices (SAMs), which apply national accounting principles at varying levels of aggregation. Research is also well established in the field of accounting for human capital and the investment in — and depreciation of — knowledge. Still, significant conceptual and information gaps remain in these areas.

Another element that might be integrated into the national accounting framework is an account for the links between employment and economic production. The industry structure of both production and employment, and their links with employee compensation, make issues such as labour intensity and productivity relatively easy to examine when data on employment and production are combined in a single framework. More generally, an expanded national accounting framework should aim to better integrate data from labour force surveys, to discuss types of employment, skills, age structures and demographic trends. Accounting for social capital, however, has only recently begun to be discussed. Probably one of the least developed areas of study, assessing social capital requires more work to better understand its linkages with other types of resources.

Overall, the largest gap in building a framework for measuring sustainable development is in links between social and environmental factors. A key issue in this respect is the health-effects of various forms of environmental degradation. Discussion of environmental issues from a social perspective, such as the employment effects of environmental policies, has also been limited to date. Better delineation of these links would help complete the sustainable development framework.

Analytical frameworks

Analytical frameworks are a useful complement to accounting frameworks. These frameworks employ a common underlying perspective, and can be readily adapted to different settings and policy questions. Two approaches are discussed here. The first is the use of the *Pressure-State-Response* (PSR) model. The second is the *Resource-Outcome* indicator approach, which is used to present indicators for economic, environmental and social variables in this Report.

The Pressure-State-Response model

The Pressure-State-Response (PSR) model was originally developed in the context of OECD work on environmental policies and reporting. It starts from the principle that human activities exert pressures on the environment that affect its quality and the quantity of natural resources. The PSR model provides a means of selecting and organising indicators in a way useful for decision-makers and the public. Depending on the specific purposes for which the PSR model is used, it can be easily adjusted to take account of greater

detail and specific issues. One such example is the adaptation proposed by the United States Interagency Working Group on Sustainable Development Indicators (the "capital maintenance framework"), which focuses on endowments and the driving forces that change them. Other examples of approaches based on the PSR model for environmental or sustainable development analysis include those proposed by the European Environment Agency, the Wüppertal Institute and the OECD work on sectoral environmental indicators.[18] This model has proven robust and useful, particularly in highlighting relationships between the environment and the economy. Making it suitable to cover the social dimension of sustainable development would however require further adaptation and extension.

Resource-Outcome Indicator Approach

The Resource-Outcome Indicator Approach builds on the view that sustainable development is development that satisfies current needs without compromising the ability of future generations to satisfy theirs (see Chapter 2). In essence, this approach identifies a necessary condition for sustainable development in the preservation of various assets, since these assets provide the foundation for the satisfaction of needs both today and in the future.

From a measurement perspective, the approach requires measures of both how well we are preserving our assets (resource indicators) and how well we are satisfying current needs (outcome indicators). An important element of this approach is its extension of the traditional economic balance sheet to consider a broader range of economic, environmental and social assets. Needs are also considered to encompass economic, social and environmental requirements.

The distinction between resource indicators and outcome indicators is not always clear-cut. In fact, there is continual feedback between resources and outcomes. This feedback is especially important when considering human and social capital, as the satisfaction of basic needs (e.g. food, health and shelter) will impact on the quality of human and social capital. Though it still requires further development, the resource-outcome indicator approach is used in this Report as a basis for selecting a set of indicators to measure overall sustainable development trends in OECD countries. Before describing this set of indicators, however, the following two sections consider a range of measurement issues associated with resource and outcome indicators.

Resource indicators

Resource indicators reflect the extent to which the asset base is being maintained. This includes indicators reflecting changes in the quantity and quality of assets. Also important are resource indicators which reflect the stock of assets at a particular point in time. Comparing these stocks to threshold levels provides an indication of major pressure points. Two broad types of resource indicators can be identified:

- Stocks of different assets at a given point in time, in either physical or monetary terms.

- Increases and decreases of these assets during a given period, due to changes in quantity, quality or value.

For some assets, these measures can be easily defined; this is the case, for example, of forests or produced assets. For others such as air and biodiversity, it may be necessary to rely on partial or proxy indicators, in particular to adjust for changes in quality. Resource indicators can be expressed both in physical and in monetary terms.

A number of other issues underlie the measurement of assets. First, a list of assets should be broad and include those that may become important only in the future. Both option and bequest values of assets should hence be included in valuation. Second, the degree of substitutability between different assets should be considered. While substitution among some types of assets may be compatible with sustainable

development (e.g. substitution between produced and financial assets or between different species of trees), this may not always be the case.

The following discussion concerning the measurement of different resource indicators (accompanied by a list of these indicators, Table 3.1) includes currently available indicators for various resources, along with other indicators that may be developed in the future. Some of these medium to long-term indicators may be already available for a few countries or may be in the process of development.

Environmental assets

Air and climate

Air is a fundamental asset. Changes in the quality of air have been the focus of much attention in discussions on long-range trans-boundary air pollution, climate change and ozone layer depletion. Atmospheric pollutants from energy transformation and consumption, and from industrial processes, contribute to global, regional and local air pollution. These pollutants affect global temperatures, human health, and ecosystems. Degraded air quality can have substantial economic and social consequences, from medical and insurance costs to reduced agricultural output, and forest damage. The numerous international agreements and protocols point to the significance of these issues, and confirm the importance of monitoring air quality.

Indicators that best reflect changes in air quality are, first, those describing concentrations of pollutants in the atmosphere and, second, those describing emissions of greenhouse gases and other air pollutants. To ensure links to policy, the indicators selected should be related to international and domestic standards and agreements. Another approach is to value the amount of air degradation, a difficult and controversial method whose measures are not yet well developed. Nonetheless, valuation of air degradation may provide useful insights into the nature of the problem, and give some sense of its magnitude in a comparative way. Expenditures on air pollution abatement and control also provide useful and complementary information.

Water

Freshwater resources are of major environmental and economic importance. Inefficient water use may lead to reduced river flows and water shortages, salinisation of freshwater bodies in coastal areas, human health problems, loss of wetlands, desertification and reduced food production (see also Chapter 10). Both over-exploitation and degradation of environmental quality exert pressures on water resources. Relating water abstraction to the renewal of stocks is central to sustainable water resource management. However, the distribution of water resources varies widely among and within countries, while water stress may be concentrated on particular types of water supplies, such as aquifers. Indicators of changes in water resources can be derived from water resource accounts.

Beyond quantity, water *quality* also has economic, environmental and social importance. Water quality can be defined in terms of a water body's suitability for various uses, such as drinking, swimming or capacity to host aquatic life. It is affected by water abstractions, by pollution loads from economic activities, and by climate and weather factors. When pressure from these sources lowers water quality to the point that drinking water requires ever more advanced and costly treatment, or that aquatic plant and animal species in rivers and lakes are greatly reduced, then the sustainability of water resource use is in question. Indicators of water quality fall into three broad categories: those measuring water quality in rivers and lakes[19]; those measuring pollution loads; and those measuring the effort required to return sewage water to an acceptable quality (e.g. connections to sewage networks and expenditure on waste water treatment).

Land and soil

Land and soil resources have close links to other environmental assets, and to associated economic activities. They are used for production purposes (mining, agriculture, forestry, manufacturing, etc.), transport,

human settlements, tourism, ecosystem development and wild life. Land use describes the functional aspects of land — in terms of its identifiable purpose or functions (such as agricultural, forestry or urban purposes) — which lead to tangible (food, industrial crops, biodiversity) or intangible (landscape) products or values. Unsustainable land use has consequences for soil quality, biodiversity, air and water quality, as well as for related human activities. Land use patterns often depend on competing economic, societal and environmental demands for land. They are in turn affected by economic and socio-demographic developments, and by climatic and environmental factors. Indicators that best reflect land resources are *land use patterns* and *related changes or conversions over time*. Changes in land use give important information about countries' endowments in biological resources both from an economic and an environmental perspective; these are also linked to issues of urbanisation.

Quality changes in soil resources include physical degradation (e.g. erosion, desertification), and biological or chemical degradation (e.g. toxic contamination, excess nutrients, salinisation, acidification). They have many implications for natural habitats and ecosystems, and also affect productivity in primary industries, especially agriculture and forestry. Indicators that best reflect soil quality are: the area of land affected by different levels of erosion risks; the degree of top soil losses due to erosion; and the area of land contaminated with heavy metals and organic compounds. Most of these indicators require further conceptual and measurement work, as well as analysis at sub-national and sectoral levels. To measure on-farm soil quality, the OECD has developed indicators of both the risk of water erosion and of wind erosion. These indicators are based on estimates of the share of agricultural land affected at different risk intervals (from low/tolerable to high/severe categories). While in most OECD countries the area of agricultural land at high/severe risk to water and wind erosion is not large, in some more than 10% of such land falls within this risk class.

Minerals and non-renewable energy sources

The important contribution of mineral and non-renewable energy sources to economic production has made these resources the subject of significant measurement efforts. Measures of their quantity and value are relatively advanced in some countries. In particular, OECD resource-rich countries such as Canada, Australia, the United Kingdom, Norway and the United States have all compiled estimates of their sub-soil assets, often in both physical and value terms. Results from these countries suggest that sub-soil assets contribute significantly to their overall net wealth.

The basic measurement technique used for mineral resources is to estimate the stock value (and therefore changes in the stock) using the net present value (NPV) of the future income stream from the resource. Both volume and value measures of the stock of resources are relevant for assessing sustainability, and such indicators are increasingly available for resource-rich countries. While this approach is widely accepted, a number of practical measurement problems remain. In particular, the physical size of resources and the discount rate used can have a significant impact on the measured values of these resources. More contentious is the issue of whether to adjust GDP for the use of these resources. Useful indicators in this area can also be derived from material flow accounting.

Biological resources

Biological resources as considered here include forests, fish stocks, livestock, crops and certain plants (e.g. vineyards, orchards, rubber plantations) which are a direct input into economic production. In terms of measurement, focus has been primarily on forests and fish stocks. At first glance, measuring fish and forests resources seems reasonably straightforward since market prices for the output exist and assets are observable. Because these resources are generally renewable, measuring their sustainability requires estimating the balance between the annual regeneration of the stock and the harvest or off-take (i.e. estimation of the maximum sustainable yield). Within the OECD at least 9 countries[20] have compiled accounts for forests. Measurement of fish stocks has also progressed but is not as well advanced.

However, there are some gaps and difficulties in measurement:

- Values of forests should include, beyond the commercial value of timber, valuation for their function as a sink for carbon dioxide emissions and as a place for recreation. Valuation of these benefits is often problematical (see Chapter 10).

- Valuing fish stocks is difficult in the case of straddling and migratory stocks. Whether to focus on key species or on the total stock is also an important question. Valuation from a perspective of ecosystems is also challenging.

Biodiversity

Biodiversity refers to the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and to the ecological complexes of which they are a part. It includes diversity within species, between species and ecosystems. Preserving biodiversity is one of the key policy targets in the OECD Environmental Strategy and it is of increasing importance for OECD and non-member countries, especially since the ratification of the Convention on Biological Diversity (CBD) in 1992. The Convention has shifted the policy focus in many countries toward more holistic national biodiversity action plans, rather than on the protection and conservation of endangered species and habitats — although the latter still remains an important objective.

Biodiversity indicators are still at an early stage of development, and systematic and comprehensive data sets are not available for most OECD countries. To date, work on this topic has focused mostly on a few core indicators and on agricultural biodiversity. Indicators currently available include the number of endangered or extinct species as a proportion of assessed species, and the size of protected areas as a proportion of total area. Other indicators refer to changes in the area of key ecosystems and to habitat alteration. Work is underway to further develop these indicators and to address genetic, species and ecosystem diversity, drawing on the CBD framework.

Economic assets

Produced assets

Produced assets include machines, factories, dwellings, office buildings, computers and oilrigs. Because they form the basis of much economic production, adequate investment in them is essential to long-term economic growth. The level of these assets is sustained if investment is as large as depreciation in a given period. The difference between gross investments and depreciation is the change in the "net capital stock" of produced assets. OECD countries have shown consistently positive net changes in the stock of produced assets since the 1970s, though this is not always the case in developing and transition countries.

Significant progress has been made in refining concepts and valuation techniques for measuring produced assets. Most OECD countries provide measures of consumption of fixed capital in the context of their national accounts. However, only about half of OECD countries release data on the *stock* of produced assets. This reflects the difficulty and cost of collecting data on the quantity and value of these stocks, and the need to estimate values using various models and assumptions.[21] In recent years a significant amount of work has been undertaken to address these issues, providing a much better understanding of the capital stock measurement. The OECD, in collaboration with several national statistical offices, is in the process of producing a manual to guide the estimation of the stock and depreciation of produced assets.

Technological change and financial assets

Improving the use of available resources might enable both their sustainable use and the continued provision of benefits. Unfortunately, in most efforts to measure sustainable development, technology is considered fixed. Many countries measure technological change through estimates of "multi-factor productivity" (MFP). However, measures of MFP are not always good indicators of technological change[22] and different approaches to the measurement of MFP can lead to different results (OECD, 2000*c* and 2000*d*).

Also, natural resources, which are either freely available or for which market prices do not reflect marginal costs of extraction, are not explicitly considered in MFP measures. Thus accelerated use of these resources could be misinterpreted as an increase in productivity or technical change. It is therefore important to examine independent measures of technological change such as research and development expenditures or the number of patent applications.[23]

The role of financial assets and liabilities in sustainable development has often been ignored. While individual countries can often maintain net debtor positions with the rest of the world — if there is confidence in the income generating capacity of the economy — the speed with which financial assets and liabilities can be transferred across borders can affect the economy. Monitoring the net financial position of both individual countries, and sectors within a country, is therefore important for sustainability.

Social assets

Human capital

Promoting economic prosperity and sustainable development requires investment in human capital. It is increasingly recognised that these objectives call for high levels of knowledge, skills and competence. (OECD, 1998*c*). While a number of relevant indicators exist, comprehensive measurement presents many conceptual and practical difficulties.

Traditionally, measures of human capital have been based on completed years of schooling or on formal educational qualifications. However, these measures do not take into account the quality or nature of the education, any education or training received outside the formal educational system, or the potential depreciation of this type of human capital over time. In recent years, the OECD has played a major role in developing direct measures of adult competencies based on surveys of skill assessments for its adult population (OECD, 2000). These surveys highlight the fact that differences in literacy skills for persons at the same level of educational attainment are often significant.

Attempts to place a market value on human capital have followed a number of different methods. Labour-income based approaches value each additional level of educational attainment on the basis of the additional earnings accruing to persons with that attainment. An alternative approach is based on the total cost of the inputs required to obtain education at a particular level. While these input costs cannot be considered a measure of market values, in practice they may be a reasonable first approximation.

Measures of changes in the stock of human capital are generally based on estimates of expenditure. While this is relatively straightforward in the case of formal education, estimates of investment in continuing education and training are more difficult to obtain.[24] Measuring the depreciation of human capital is even more problematic, as this generally depends on the use of individual competencies. For example, survey results suggest that people can lose some of their literacy skills if these are not maintained through regular practice at home and at work (OECD 1998*e*).

Both quantitative and qualitative changes are important in examining human capital. From a quantitative perspective, the sustainability of the stock of human capital will depend on overall demographic factors, since changes in population size and structure will affect the size of the working age population. Indicators of migration rates, fertility rates and employment to population ratios are therefore relevant. The quality of education and training is also very significant. Impacts of environmental and social factors on the health of the labour force also have a direct impact on the quality of human capital.

Social capital

Social capital refers to those societal relationships that are increasingly recognised as a determinant of economic growth and human welfare. Measuring social capital is probably the most challenging area of sustainable development measurement. In the first instance, definitions of social capital may range from

Table 3.1. **Resource indicators**

	Current indicator	Medium to long term indicator
Air and climate		
Air quality	Greenhouse gas emission index, CO2 emissions	Same
	NO_x and SO_x emissions, acidification index	Same, plus emissions of toxic compounds
	Global atmospheric concentrations of greenhouse gases	Same
	Air pollution abatement and control expenditure	Same
Water		
Water resources	Intensity of water resource use	Same
	Total abstractions	Same
Water quality	Connection rates to waste water treatment	Same for secondary and tertiary treatment, plus pollution loads
	Water pollution abatement and control expenditure	Same
Land and soil		
Land resources	Changes in land use	Same
Soil quality	Erosion risk (wind, water)	Soil contamination
		Soil erosion
Minerals and non-renewable energy		
Mineral resources	Volume / value of mineral deposits	Same
	Volume / value of mineral depletion	Intensity of use of mineral resources
Non-renewable energy resources	Volume / value of energy deposits	Same
	Lifetime of proven energy reserves	Same
	Consumption of energy resources	Energy intensity index
Biological resources		
	Intensity of use of forest resources	Same
	Volume / value of forest resources	Intensity of use of fish resources
		Volume / value of individual biological resources
Biodiversity		
	Size of protected areas as a proportion of total area	Same by type of ecosystem
		Change in area of key ecosystems
	Number of threatened or extinct species as a proportion of assessed species	Species and habitat indicators
Produced assets		
	Volume / value of net capital stock	Same
	Gross fixed capital formation (GFCF)	Same
	Consumption of fixed capital (COFC)	Same
Technological change		
	Multi-factor productivity growth rate	Same
	Expenditure on R&D	Same
	Number of patents	Same
Financial assets		
	Net foreign assets	Same
	Foreign direct investment	Same
	Current account balance	Same
Human capital		
	Proportion of the population with upper secondary/tertiary qualifications	Value of human capital
	Literacy and skill indicators	Same
	Fertility and net migration rates	Same
	Education expenditure	Value of investment in human capital
	Rate of unemployment	Value of depreciation of human capital

those covering only relationships between individuals and their community, to those encompassing institutional structures (see Chapter 2). They may even extend to include the full social and political environment (OECD, 2001). Depending on the definition used, different indicators are relevant: at a narrow level, indicators of membership levels in civic associations are useful, while indicators of political stability, civil liberty, corruption or social disintegration (e.g. crime rates) may be appropriate at a wider level (World Bank, 1997). Work in this area also focuses on defining the links between social capital and sustainable development so that a measurement target can be better identified.

Possible resource indicators

Many of the resource indicators discussed in this section are at the centre of work within the OECD on environmental, economic and social indicators. Table 3.1. presents a range of possible resource indicators, distinguishing those that are currently available for most OECD countries and those that may be developed in the future. Although work to develop new indicators is needed, it is also important to improve the statistical quality of existing indicators and to ensure that a broad range of indicators is available for Member countries. Finally, many of the indicators can be presented in a number of different ways — e.g. indicators of emissions of greenhouse gases may be measured in total, per capita or per unit of GDP.

Outcome indicators

Outcome indicators are aimed at measuring the satisfaction of human needs, in both quantitative and qualitative terms, where needs are defined broadly to cover social, economic and environmental factors. Because of the lack of agreement on a single definition of well-being, measurement will need to be based on a collection of partial and indirect indicators. Socio-economic outcomes such as income, consumption, employment, education, housing and health are all relevant aspects of well-being, and indicators for these exist. However, other factors — such as justice, exclusion and crime — are not easily measured.

As observed earlier, the boundary between resources and outcomes is especially difficult to draw in the case of environmental issues. In order to steer some practical course through this issue we can define several types of environmental outcome indicators. These are:

- the provision of, and access to, certain environmental services (e.g. safe drinking water, green space);

- environmentally relevant consumption (e.g. energy and water consumption, municipal waste generation, travel patterns); and

- issues linked to environmental health and justice (e.g. populations exposed to certain levels of pollution or risks, effects on human health). Public opinion about these issues could be considered as proxy indicators, but would require harmonised surveys that do not currently exist.

Issues linked to environmental democracy (i.e. availability of and access to environmental information, participation, etc.) are also important but more difficult to measure in the form of indicators.

A range of outcome indicators relevant to sustainable development is listed in Table 3.2. As for resource indicators, there is a need both to develop new indicators and to improve the statistical quality, country coverage and time series of existing ones. More work is needed in particular to identify other environmental indicators, and to develop indicators of the links between environmental and social issues.

Towards an OECD set of sustainable development indicators

Previous sections have described a range of measures and methodological issues, and have introduced the notion of measurement frameworks for organising available information. This section considers how to

Table 3.2. **Outcome indicators**

	Current indicator	Medium / long term indicator
Income level	Net national income (NNI) per capita	Same Unpaid household services
Income distribution	Gini coefficients D9/D1 decile ratio	Same Same
Consumption	Household final consumption expenditure Environmentally relevant consumption (municipal waste generation, water and energy consumption, transport modal split)	Actual individual final consumption Same
Health	Life expectancy at birth Urban air quality (concentration of selected air pollutants in urban areas)	Disability free / Quality adjusted life years Population exposure to air pollution Environment related health expenditure
Education	Participation rates	Same
Employment	Employment to population ratio	Same

combine the available indicators to provide an overall indication of the sustainability of development trends. Due to the difficulties in developing single indicators, the approach followed is that of constructing a limited set of indicators. Proposing a preliminary set of indicators along with its rationale provides a short-term tool for OECD work, and may contribute to fostering progress at international and national levels. Some of the key principles used for constructing such indicator sets are illustrated in Box 3.4. The Resource-Outcome indicator approach described earlier is used here to select and present indicators, and to allow interpretation of the indicator set.

Box 3.4. **Key principles in selecting sustainable development indicators**

A set of sustainable development indicators should:

- Have a clear policy relevance and in particular:
  - *provide balanced coverage of some of the key issues of common concern to OECD countries, and reflect changes over time;*
  - *be easy to interpret (*i.e. *movements in each indicator should have clear implications for overall sustainable development);*
  - *allow comparisons across countries;*
  - *lend itself to being adapted to different national contexts, analysed at different levels of aggregation and linked to more detailed indicator sets.*
- Be analytically sound and broadly accepted.
- Be based on data that are available, of known quality and regularly updated.

Previous sections of this Chapter have suggested a large number of indicators for the measurement of sustainable development. Some of these indicators may not yet be available, and other more relevant indicators for a particular theme may be available only in specific countries or regions. Consideration of such a broader list is important to give appropriate scope to the measurement effort, and to provide a basis for adapting the headline set in response to emerging issues.

Based on the broad set of indicators proposed above, Table 3.3 presents a smaller, headline set of indicators. The composition of the set reflects judgements on those issues deemed to be of primary importance at present, although this may change over time. Also, the selection consists of those indicators that are available for a large proportion of OECD countries. These indicators are grouped into two broad categories, so as to convey the importance of both maintaining assets and satisfying overall well-being.

Table 3.3. A preliminary set of sustainable development indicators

Theme	Current indicator
Resource indicators : Are we maintaining our asset base?	
Environmental assets	GHG emission index and CO2 emissions
Air quality	NO_x and SO_x emissions
	Intensity of water use (abstractions / renewable resources)
Water resources	Consumption of energy resources
Energy resources	Size of protected areas as a share of total area
Biodiversity	
Economic assets	Volume of net capital stock
Produced assets	Multi-factor productivity growth rate
Technological change	Net foreign assets & Current account balance
Financial assets	
Human capital	Proportion of the population with upper secondary/tertiary
Stock of human capital	qualifications
Investment in human capital	Education expenditure
Depreciation of human capital	Rate of unemployment
Outcome indicators: Are we satisfying current needs?	
Consumption	Household final consumption expenditure
	Municipal waste generation intensities
Income distribution	Gini coefficients
Health	Life expectancy at birth
	Urban air quality
Work status / Employment	Employment to population ratio
Education	Participation rates

The above set makes use of both monetary and physical indicators. Also, several indicators are sometimes proposed for the same theme, with the choice depending on the purpose of analysis. For example, in relation to climate change, trends in emissions of greenhouse gases relative to Kyoto targets may be appropriate for policy, while emissions per capita or per unit of GDP may be more useful for comparing trends across countries. For some indicators, it may be important to consider both changes in stocks over time, as well as at levels relative to some known threshold. The proposed set takes into account the fact that, in some cases, the indicators selected may need to be applied at more detailed sectoral or local level. The need for underlying data sets to support the construction and reporting of these indicators is an important consideration. It should be emphasised that this set is preliminary and will be further discussed with Member countries and others involved in sustainable development measurement. Discussion is also required on how this set might best be used in policy formulation and monitoring. Available estimates for OECD countries for each of these indicators are presented in an Annex to this chapter.

Conclusions

Measuring sustainable development is necessary for addressing the long-term future of our societies. Without an integrated information set on long-term sustainability problems, public awareness of these issues will be limited and the formulation and monitoring of policy responses will be difficult.

This chapter has portrayed measurement as operating at a number of different levels. At a broad level, measurement requires maintaining detailed data sets, as well as integrating these data either into a single indicator or into a limited set of indicators. This chapter has focused on the development of a set of indicators, where indicators are presented in terms of resources and outcomes. This approach stresses the importance of extending national balance sheets to a broad range of assets, and of maintaining these assets in order to provide for future well being. Use of an underlying framework to link these various indicators is essential to future measurement work.

OECD countries have developed a wide and growing body of experience in the measurement of sustainable development. The preliminary set of sustainable development indicators presented here is by no means final or definitive. Further development of frameworks and indicators in each of the three dimensions (economic, social, environmental) should allow this set to be refined over time, and to be productively linked with indicators in relevant sectors (e.g. agriculture, transport, energy). The OECD intends to discuss the preliminary set with Member countries and others, and to investigate the development of a database of sustainable development statistics. The OECD itself can play an important role in developing these measurement tools, but much work must also be done at a national level. Finally, and most importantly, there is today a sufficient body of knowledge to argue that measurement problems *should not* be seen as a barrier to the formulation and implementation of sustainable development policies.

NOTES

1. This does not imply that government policy is always adequate or effective in ensuring the needs of the entire population or in adapting to changing circumstances. But there seems little disputing that social protection systems in most OECD countries play a significant role in ensuring social sustainability.

2. At the very least, it provides no indication of how income is distributed.

3. The problem of maximising inter-temporal welfare was examined as far back as 1976 by Weitzman, with the optimal consumption path being that in which a maximum amount of output is consumed without reducing the original amount of capital.

4. This residual is measured as the difference between: *(i)* the wealth value of returns to both labour and capital; and *(ii)* the value of produced assets and urban land. The first term is measured as the present value of non-agriculture GNP and agricultural wages, minus rents on minerals and fossil fuels, and minus depreciation of produced assets; the present value is taken over the mean productive years of the population (World Bank, 1997).

5. The World Bank estimates of the wealth of nations, to the extent that they attempt to measure the value of all assets contributing to economic production, can be considered to incorporate implicitly the value of such intangibles for purposes of economic production.

6. In practice, the extension of balance sheets to incorporate even natural and human capital assets, let alone social capital, is in itself a major undertaking. However, interest in the reporting of human capital is growing and has been discussed in the context of enterprise reporting, where traditional balance sheets have proven ill-adapted to the expansion of certain types of firms (e.g. software producers) having substantial market value, limited conventional physical assets but significant capital assets embodied not only in intellectual property but also in the knowledge and experience of their workers (OECD 1997).

7. Additions to human capital are estimated by expenditures on formal education. They thus do not include the contribution due to immigration, enterprise training or informal learning in the workplace or other settings. Moreover, there is no accounting for depreciation or depletion in human capital attributable to such factors as ageing, unemployment, emigration or early death.

8. A number of these measurement efforts were discussed at two Expert Workshop on Sustainable Development Indicators held in the OECD (OECD, 1998*a*, and OECD, 2000*a*) and the 1999 OECD Conference "Towards Sustainable Development - Indicators to Measure Progress" hosted by the Italian government (OECD, 2000b).

9 . A number of OECD countries participated in the testing of the first set of indicators proposed by the UNCSD (Austria, Belgium, United Kingdom, Germany, Finland, France and the Czech Republic and Mexico).

10. For further details on the Ecological Footprint Index see WWF International, 1999; on the pilot Environmental Sustainability Index see www.ciesin.columbia.edu/indicators/ESI; and on Total Material Requirement see www.wri.org/.

11. For example, GDP measures do not include a wide range of non-market activities, may hide inequalities between population sub-groups, do not take account of differences between expenditure and utility, and fail to consider social outcomes such as enjoyment of civil liberties or absence of crime.

12. The approach was originally suggested in Nordhaus and Tobin, 1972. Details of the Genuine Progress Indicator can be found at www.rprogress.org/gpi/. OECD,1998*b* presents a short review and comparison of three ISEW which have been compiled in recent years.

13. Background on environmental accounting and its uses can be found in OECD, 1995 and National Research Council, 1999.

14. A detailed discussion of the issues is presented in two documents by the World Resources Institute, *Resource Flows: The Material Basis of Industrial Economies* and *The Wealth of Nations: Material Outflows from Industrial Economies*. Also see www.wri.org/.

15. OECD has completed a detailed accounting for flows of nitrogen and derived a soil surface nitrogen balance indicator from this approach. See OECD, 2001. The OECD nitrogen balances are available on the OECD website at: www.oecd.org/agr/env/indicators.htm.

16. National Accounts Matrices including Environmental Accounts (NAMEAs), developed originally by the Netherlands, have been used by a number of agencies for the analysis of particular environmental issues such as air emissions. The aim of NAMEA is to integrate environmental data with data on economic activity as recorded in the National Accounts framework.

17. Draft chapters can be viewed at ww2.statcan.ca/citygrp/london/london.htm. The final text will also be available on this site.

18. Regarding transport see OECD (1999*a*), regarding agriculture see OECD (2001).

19. France has developed water quality accounts which provide some indicators of water quality changes. For a summary of this work see OECD, 2000*b*.

20. Australia, Austria, Canada, Denmark, Finland, Germany, Norway, Sweden and the United Kingdom.

21. Most countries have adopted variants of the "perpetual inventory model (PIM)" to measure the value of the stock of produced assets. This model uses estimates of the flows of produced assets (net investment), price indices for different types of assets, and assumptions on depreciation, average asset lives and the pattern with which assets are retired.

22. The difference is largely due to the treatment of embodied technical change which is insufficiently captured in the MFP measure but which would ideally be included in a measure of technological change.

23. For guidance in the calculation, use and interpretation of productivity indicators, see the *OECD Productivity Manual: A Guide to the Measurement of Industry-Level and Aggregate Productivity Growth*. (Release date 30 March 2001 as PDF file on www.oecd.org/subject/growth/an_ec_gr.htm)

24. Evidence from a number of countries suggests that enterprises spend the equivalent of about 1 to 2% of payroll costs on training. Hours-based measures also show that, in some countries, an average of fifty hours of training per adult (25-64) per year is undertaken. Over the life cycle, this amounts to some 2000 hours of continuing education and training per adult which, by any measure, is a substantial investment.

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Annex 3.A.

INDICATORS FOR SUSTAINABLE DEVELOPMENT

This Annex is an illustration of the preliminary set of indicators for sustainable development described in Chapter 3. Its graphs show available estimates for OECD countries for most of the indicators selected. An effort was made to show changes over time whenever possible.

As stated in Chapter 3, the present set of indicators are a compromise between what is desirable and what is currently available for most or all of the OECD Member countries. There will be ongoing work, in consultation with Member countries and other international organisations concerned to further develop the indicators, to improve, extend and update them and to publish them on a regular basis in the future.

The data used to calculate the indicators have been compiled from existing OECD and other international sources.

A supplementary document giving the numeric values of the indicators here and more details on their technical characteristics is available from statistics.contact@oecd.org or via www.oecd.org

Sources:

OECD-MEI: *Main Economic Indicators,* Monthly publication.
OECD-ALFS: *Labour Force Statistics, 1979-1999*, released in 2000.
OECD-NA: *National Accounts of OECD Countries. Volume 1,1988-1999,* released in 2001.
IMF-IFS: *International Financial Statistics.*

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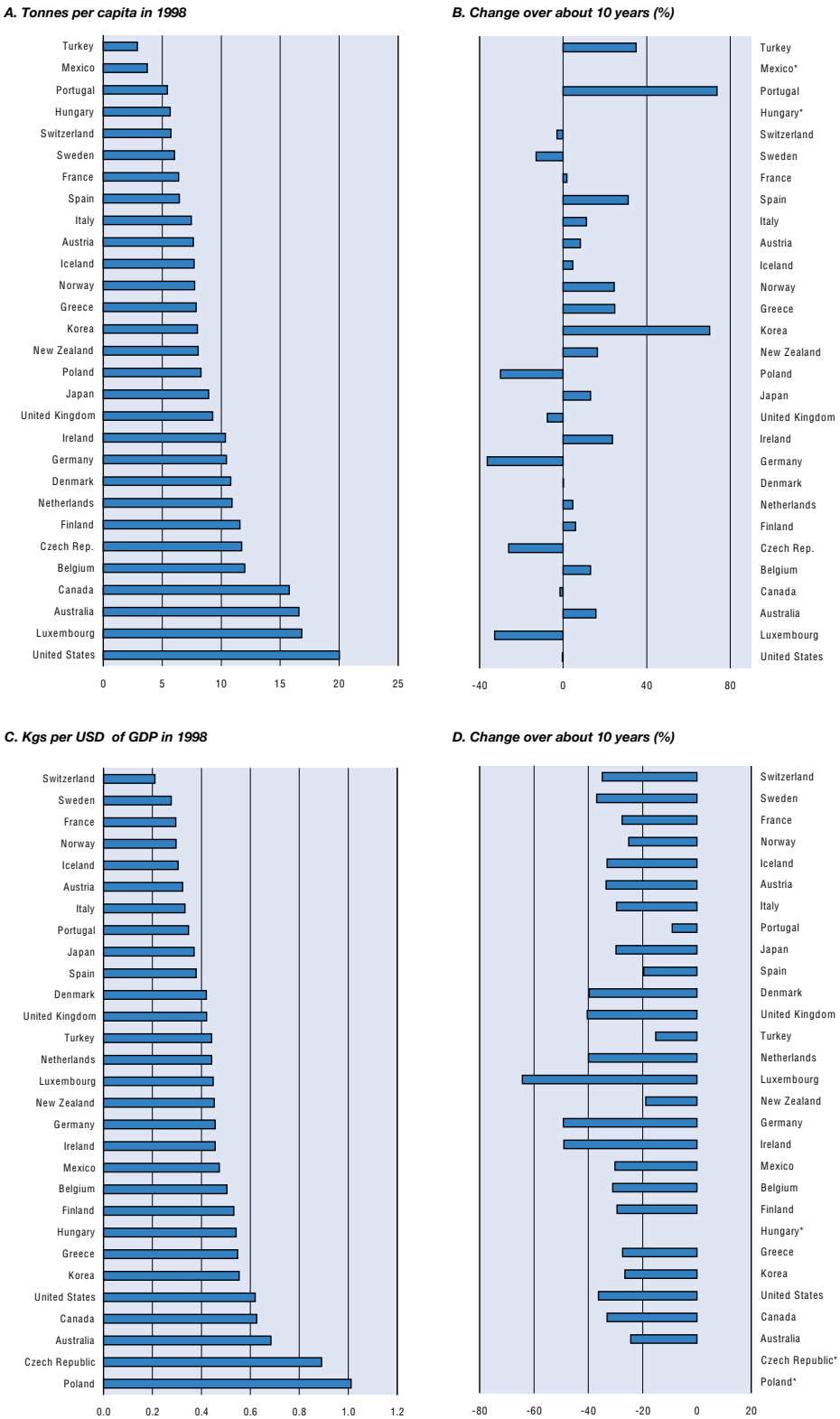
OECD-IEA, International Energy Agency
OECD-ELSA, Education, Labour and Social Affairs

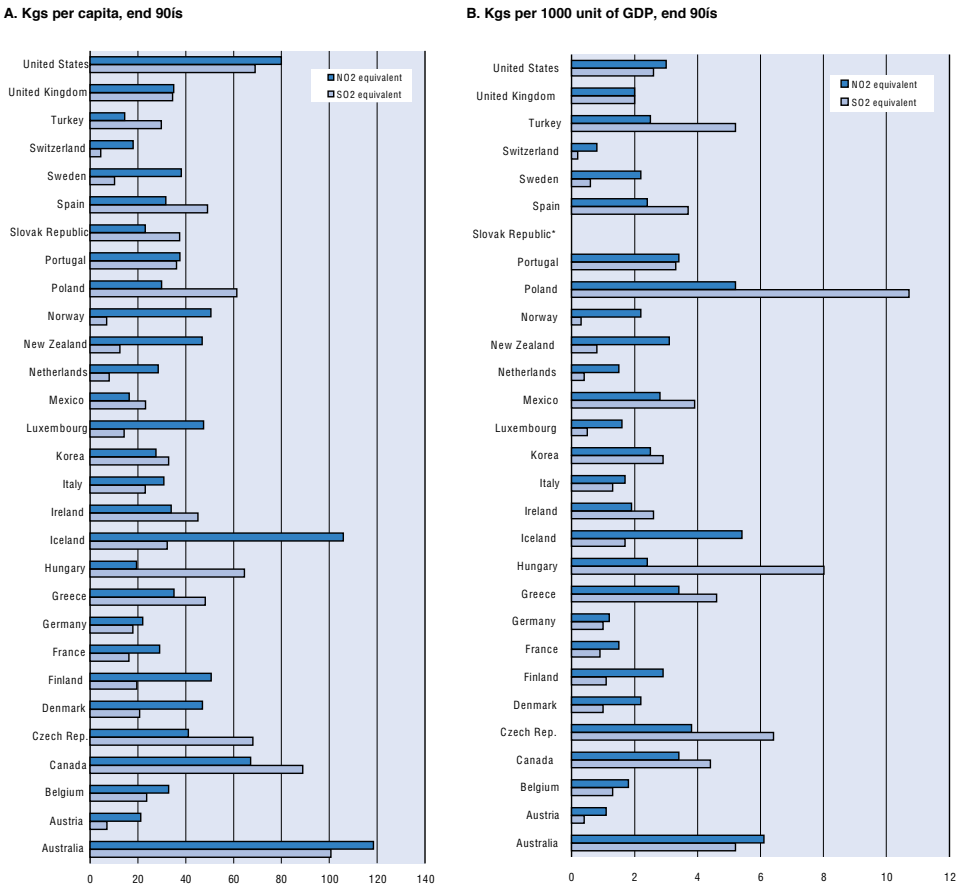
Notes:
(*) means no data is available for this measure.
No indicator is available yet for the volume of net capital stock.

Figure 3.A.1. **CO_2 emissions from energy use**



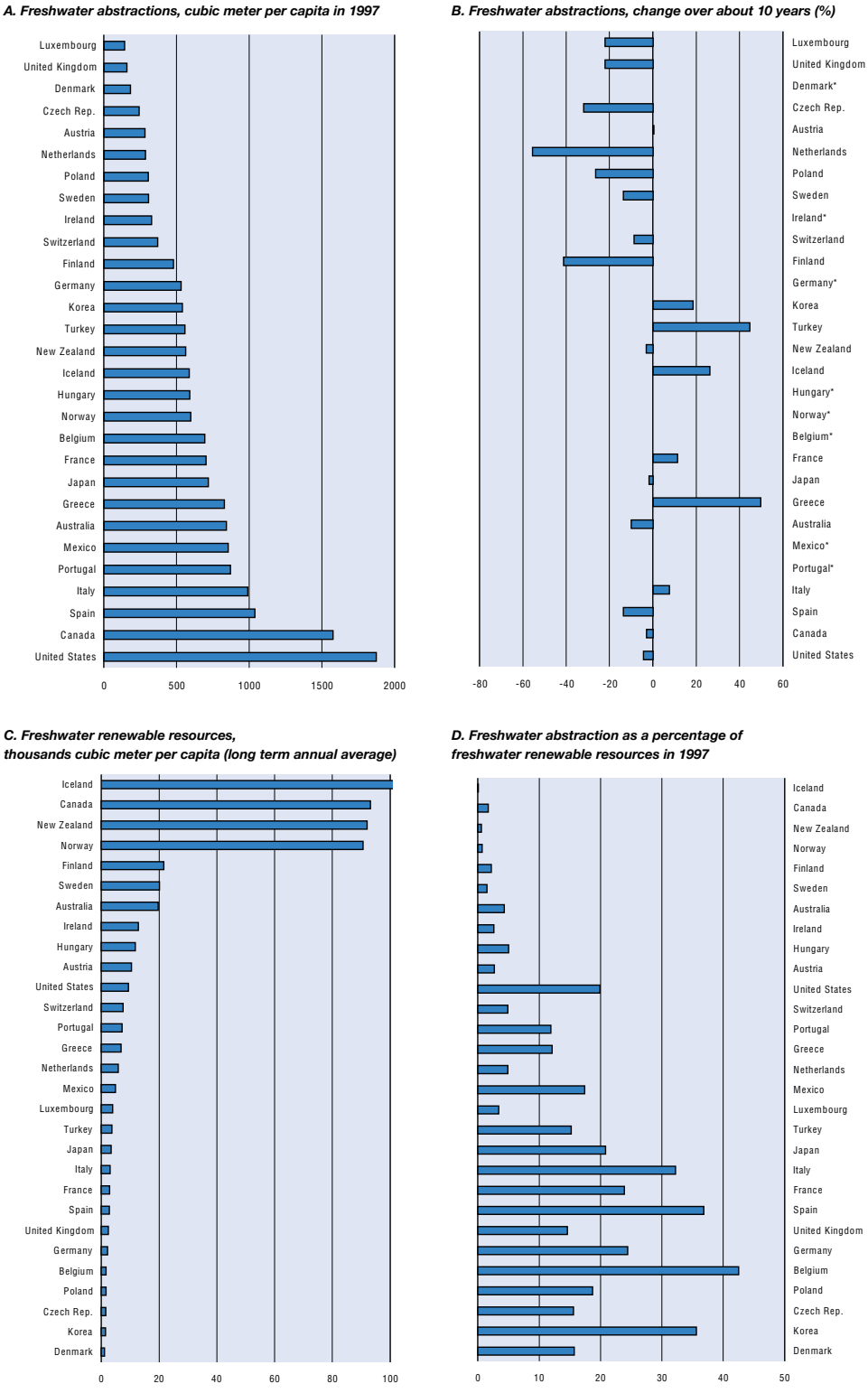
Notes: Anthropogenic CO_2 emissions from energy use only (Reference Approach). Oil held in international marine bunkers is excluded. Oil and gas for non-energy purposes, and the use of biomass fuels are excluded. Peat is included.
Source: OECD-IEA, OECD-ALFS, OECD-NA

Figure 3.A.2. **Total man-made NO_x and SO_x emissions**



Note: Data refer to sulphur oxides (SO_x) and nitrogen oxides (NO_x), expressed as the weighted sum of quantities of SO_2 and NO_2, carbon monoxide (CO), particulates and volatile organic compounds.
Source: OECD (1999), *OECD Environmental Data: Compendium 1999 edition* , Paris.

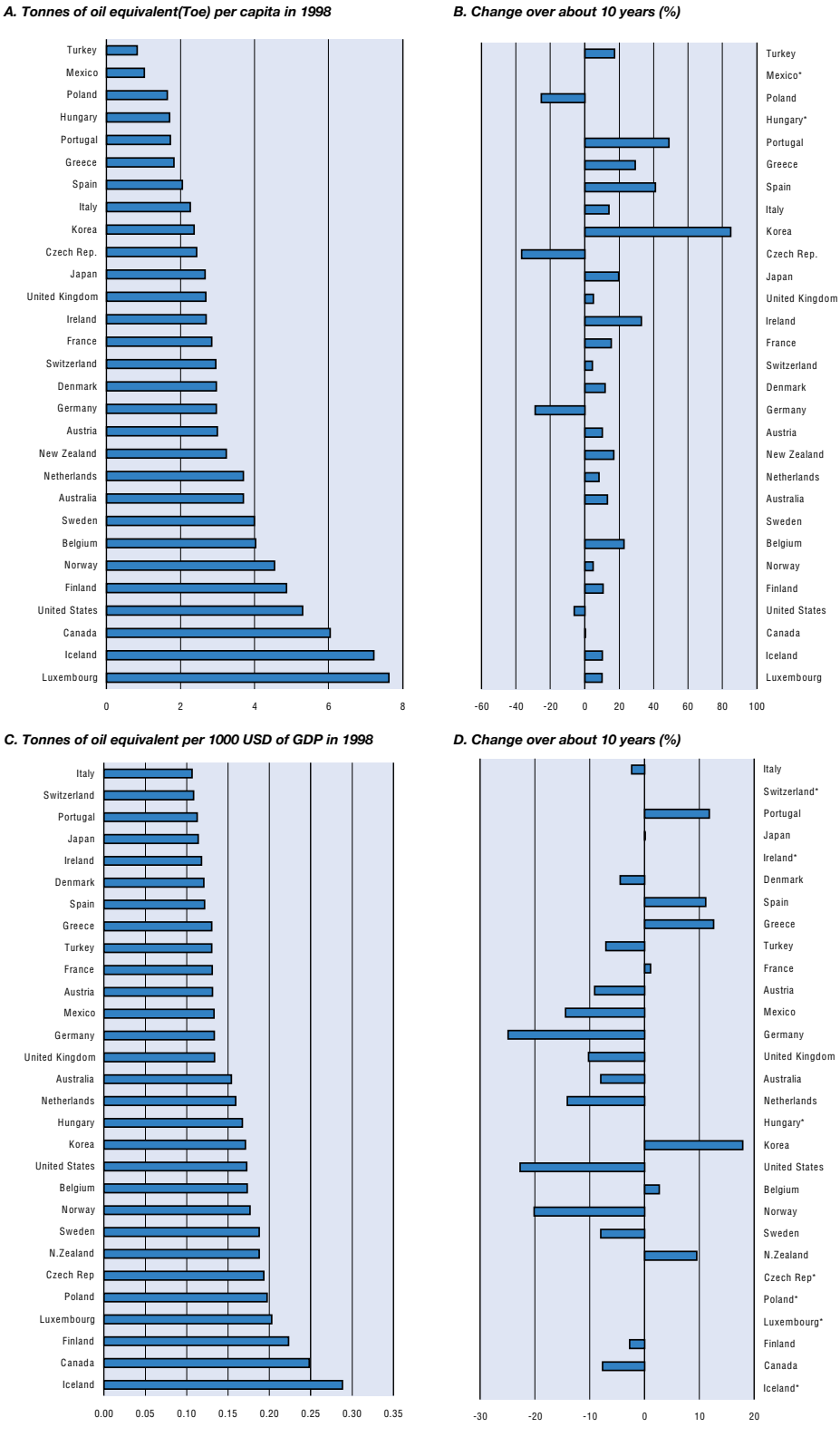
Figure 3.A.3. **Total freshwater abstraction and resources**



Notes: Water abstractions refer to water taken from ground or surface water sources and conveyed to place of use. Most recent data refer to years 1993 to 1997 according to the country ; the evolution is compared to 1985 measures and show increase as well as decease in demand. Renewable freshwater resources is net result of precipitation minus evapotranspiration (internal) plus inflow (total). This definition ignores differences in storage. The water stress is considered high when abstractions are reaching a level of 40% of resources

Source: OECD (1999), *OECD Environmental Data: Compendium 1999 edition*, Paris.

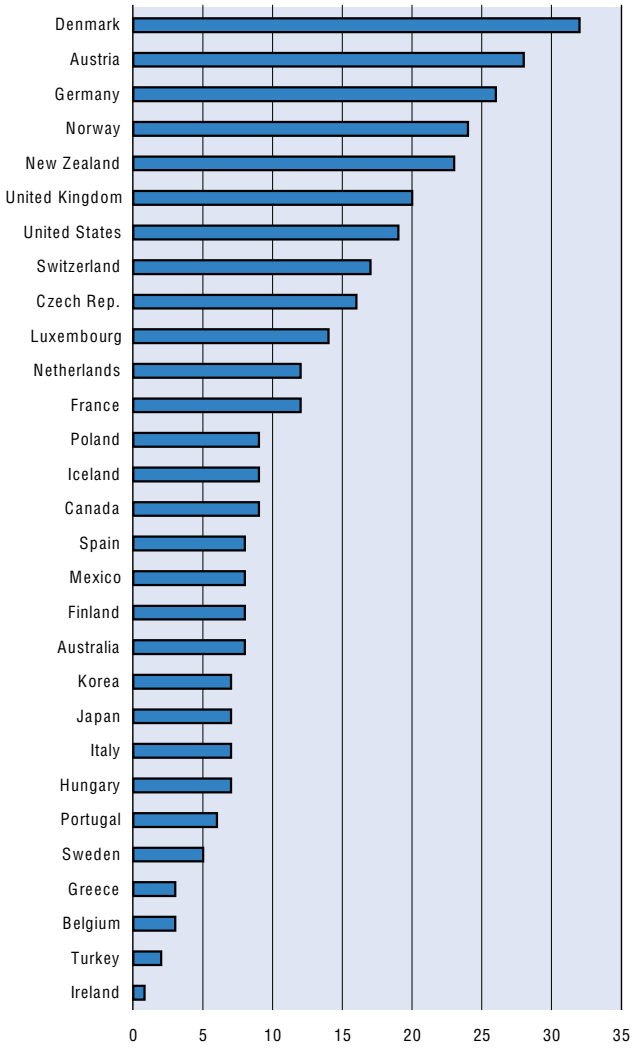
Figure 3.A.4. **Consumption of energy resources**



Notes: The total final consumption of energy refers to end-use of different sectors (industry, transport, agriculture, commerce, public services, and residential uses, as well as non energy uses of gas, coal, oil and oil products). It includes consumption of solid fuels (main coal), oil, gas, electricity and heat.

Source: OECD (1999), *OECD Environmental Data: Compendium 1999 edition* , Paris; OECD-ALFS; OECD-NA

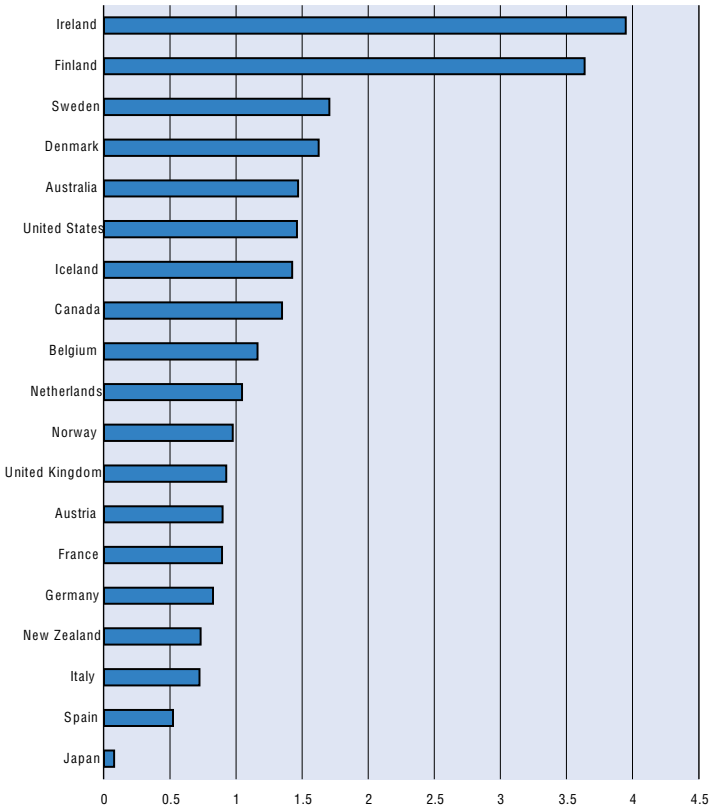
Figure 3.A.5. **Major protected area in per cent of territory in 1996**



Note: Actual protection levels and related trends are difficult to evaluate, as protected areas change over time : new areas are designated, boundaries are revised and some sites may be destroyed or changed by pressures form economic development or natural processes.
Source: OECD (1998), *Towards sustainable development - Environmental Indicators* , Paris.

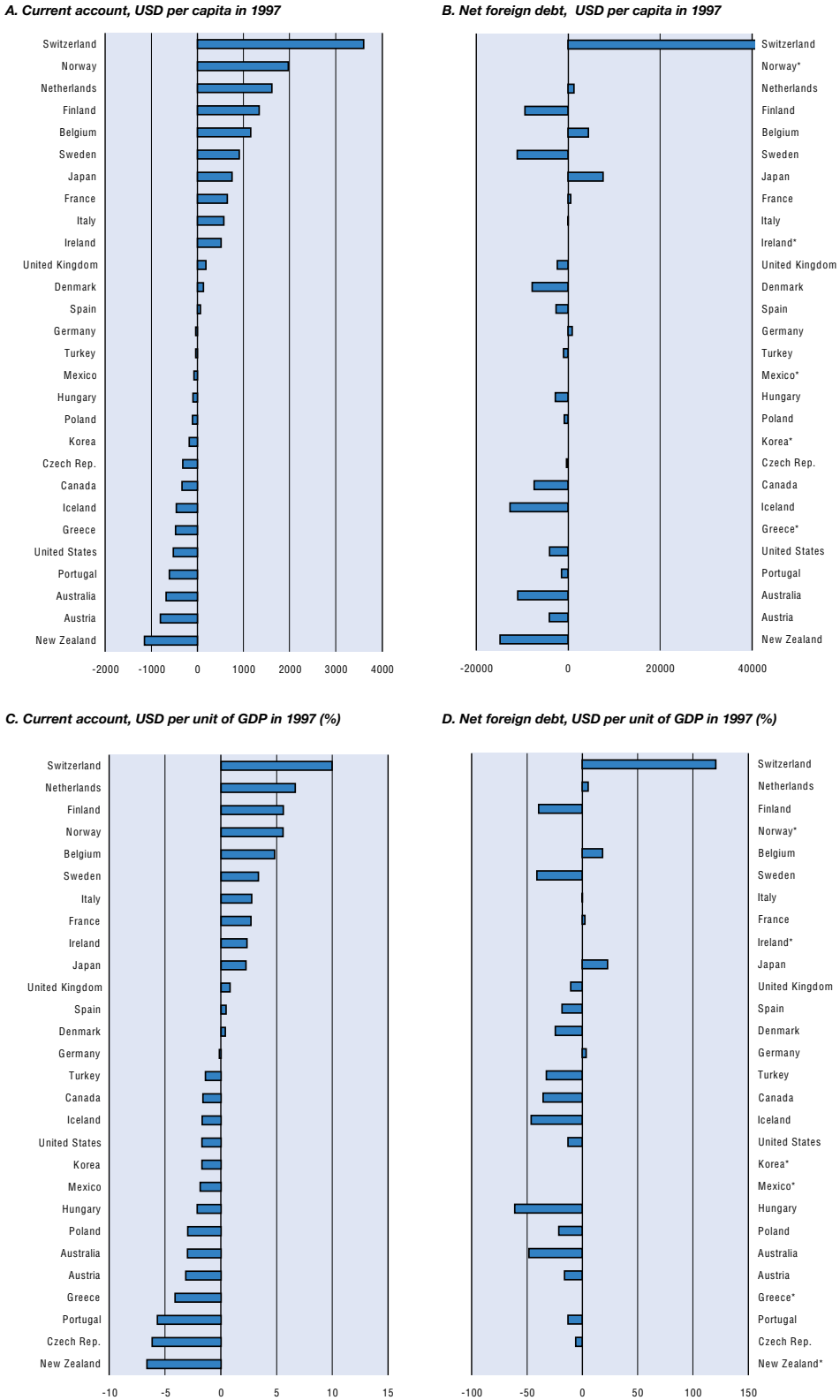
Figure 3.A.6. **Multi-factor productivity growth**

Average 1995-1999 growth rates (%)



Notes: Data based on trend series and time varying factor shares. 1997 for Austria, Belgium, Italy and New Zealand. 1998 for Australia, Denmark, Ireland, Japan, Netherlands and United Kingdom.
Rates of change of multi-factor productivity (MFP) reflect the rate of output growth per combined inputs. The combined inputs are labour and capital, each weighted with their share in total cost. MFP growth is calculated residually, as the part of the rate of output growth that is not explained by the rate of labour or capital input growth.
Source : OECD

Figure 3.A.7. **Net foreign assets and current account balance**

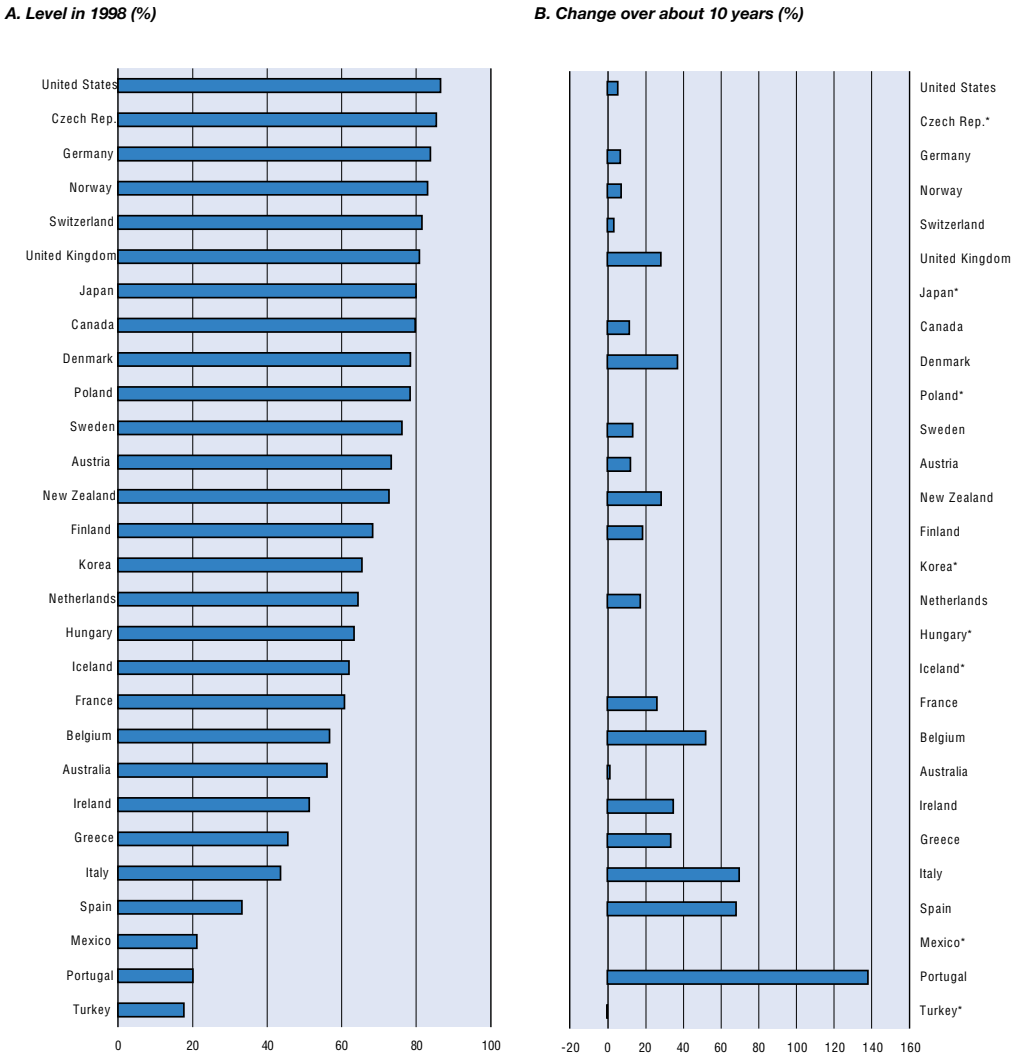


Sources: OECD MEI, ALFS, NA

Sources: IMF: IFS, OECD: ALFS, NA

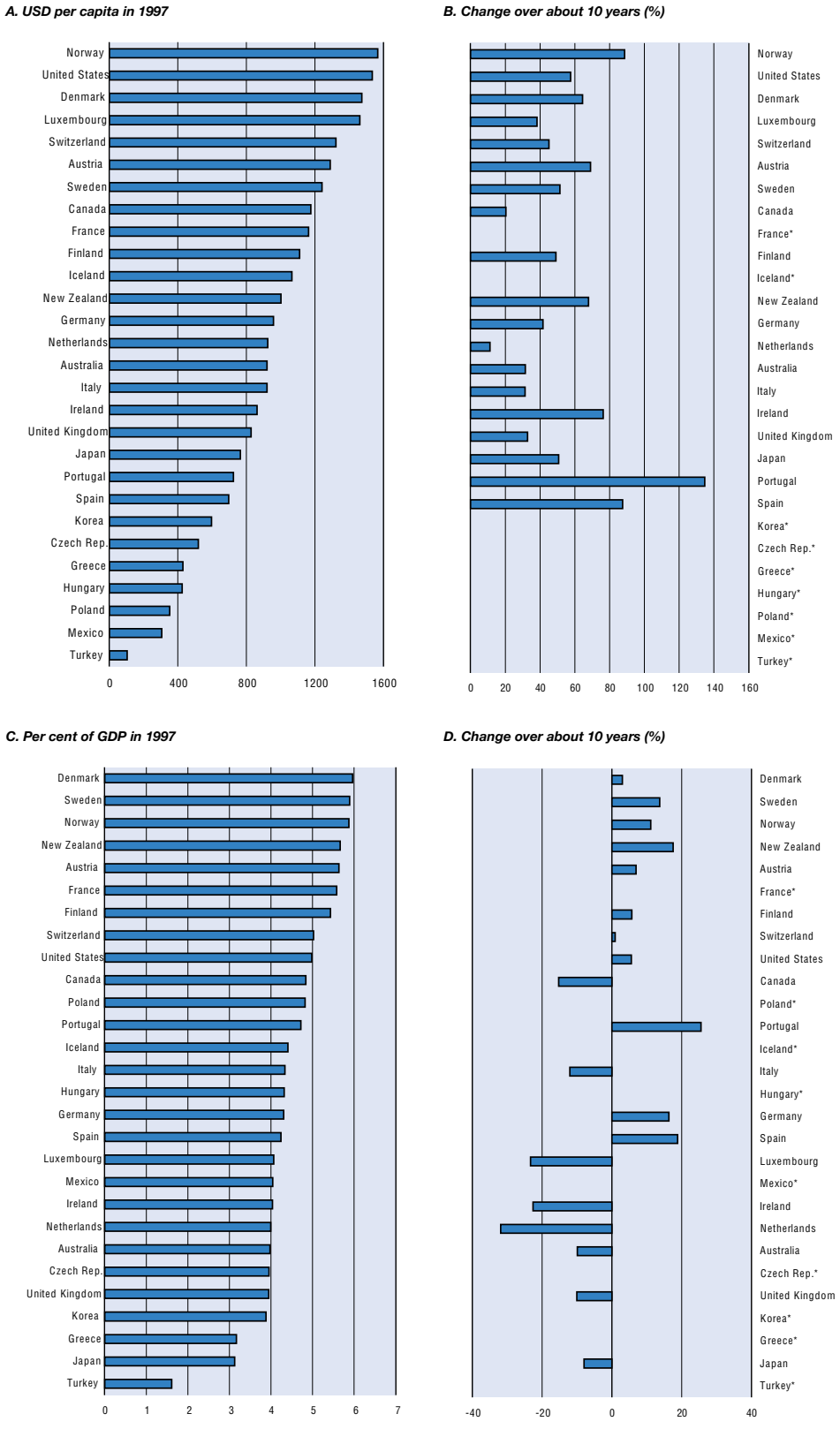
Note: Balance of payments data are compiled according to the Balance of Payments manual (BPM5) published by the IMF; Net foreign debt refers to the International Investment Position compiled by the IMF as external financial assets minus external financial liabilities.

Figure 3.A.8. **Proportion of the population (25-64 years) with upper secondary/tertiary qualifications**



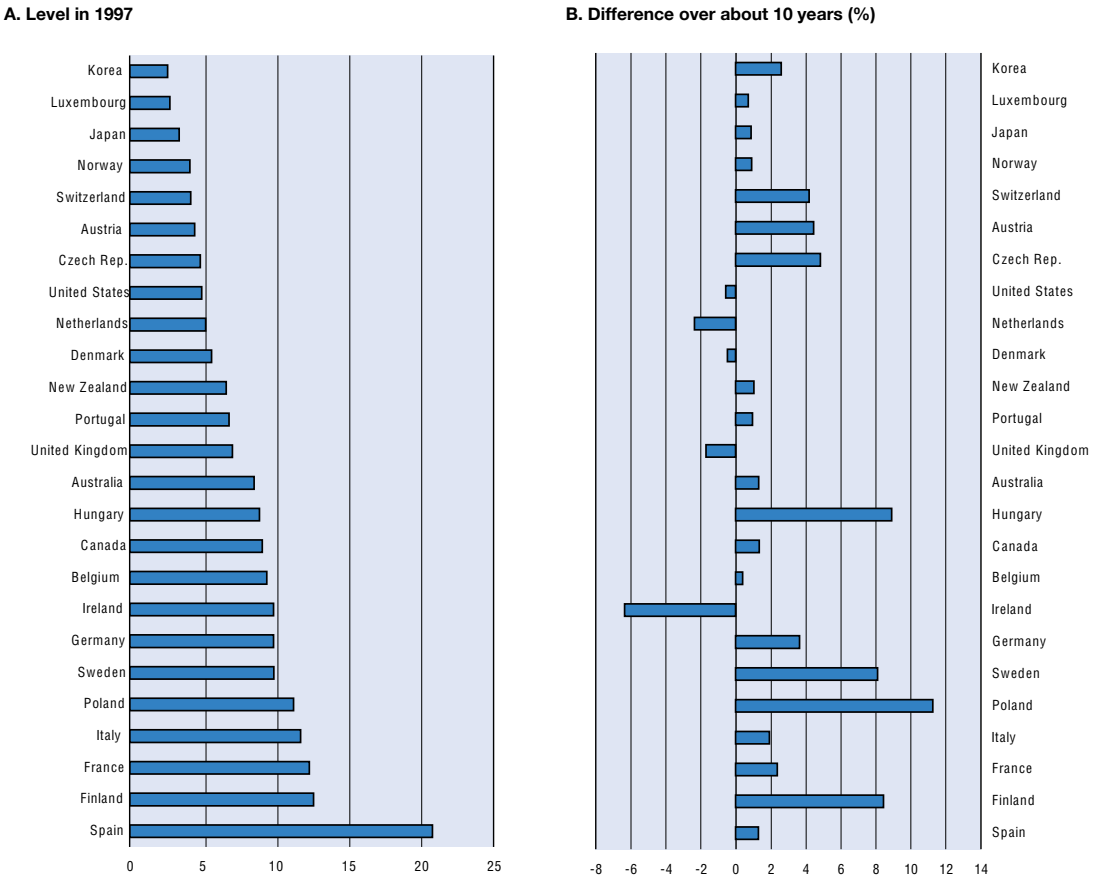
Source : OECD (2000), *Education at a glance : OECD indicators*, Paris.

Figure 3.A.9. **Public expenditure on education**



Note: Expenditure data on education refers to all levels of government direct expenditure for educational institutions converted to PPP-USD.
Source: OECD-ELSA,OECD-ALFS,OECD-NA

Figure 3.A.10. **Standardised unemployment rates**

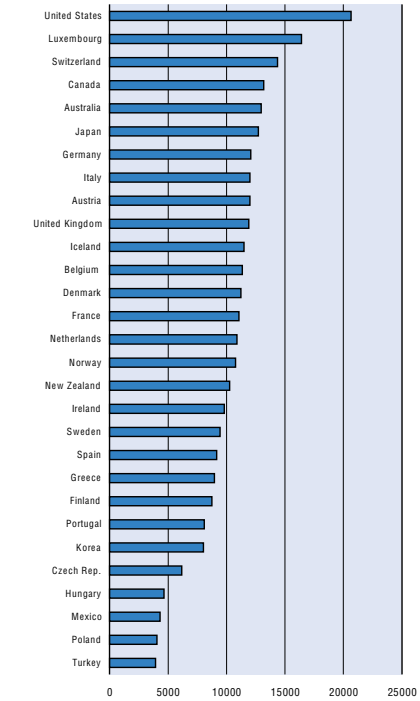


Note: The standardised unemployment rates give the numbers of unemployed persons as percentage of the civilian labour force. Definitions conforms to ILO guidelines.
Source: OECD-MEI

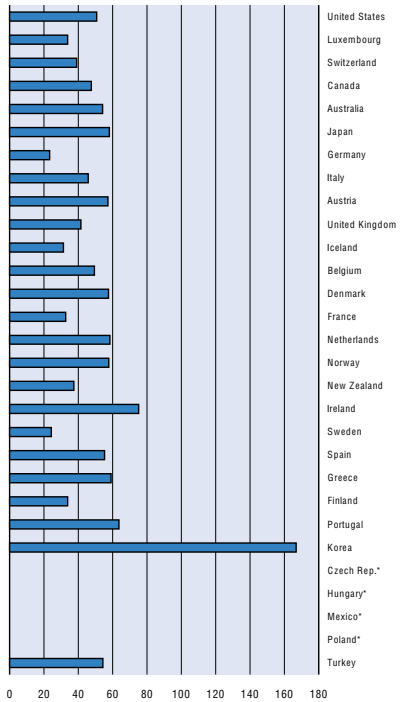
Figure 3.A.11. **Household consumption and waste generation**

I. Household final consumption expenditure

A. USD per capita in 1997

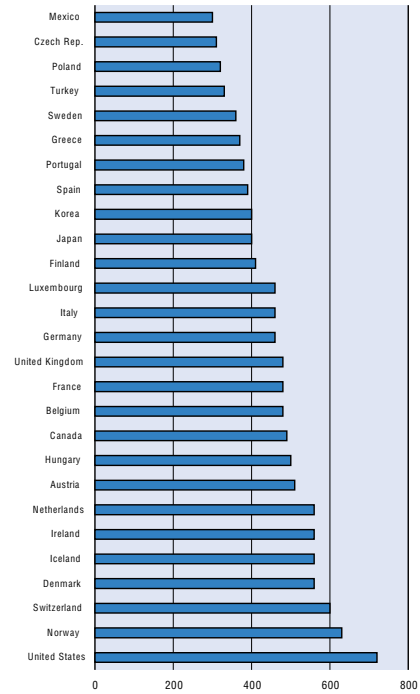


B. Change over about 10 years (%)

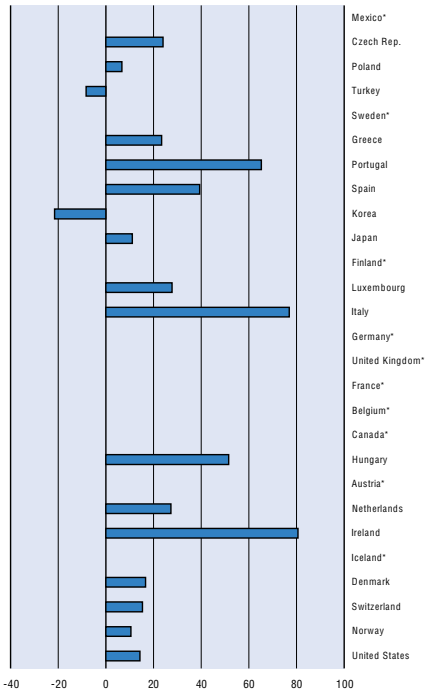


II. Municipal waste

C. Kgs per capita in 1997



D. Change over about 10 years (%)



Notes: I. Household final consumption expenditure consists of the expenditure, including imputed expenditures incurred by resident households on individual consumption goods and services, including those sold at prices that are not economically significant.

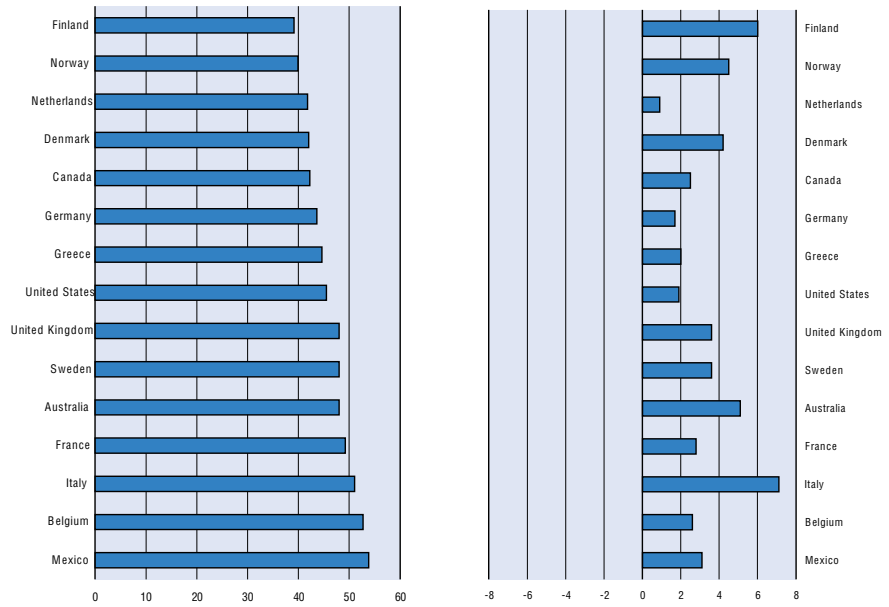
II. The amount and composition of municipal waste vary widely among OECD countries, being directly related to levels and patterns of consumption and also depending on national, waste management and minimisation practices. Data refer to 1997 or the most recent year.

Source: OECD (1999), *OECD Environmental Data: compendium 1999 edition* , Paris; OECD-NA

Figure 3.A.12. **Income inequality**

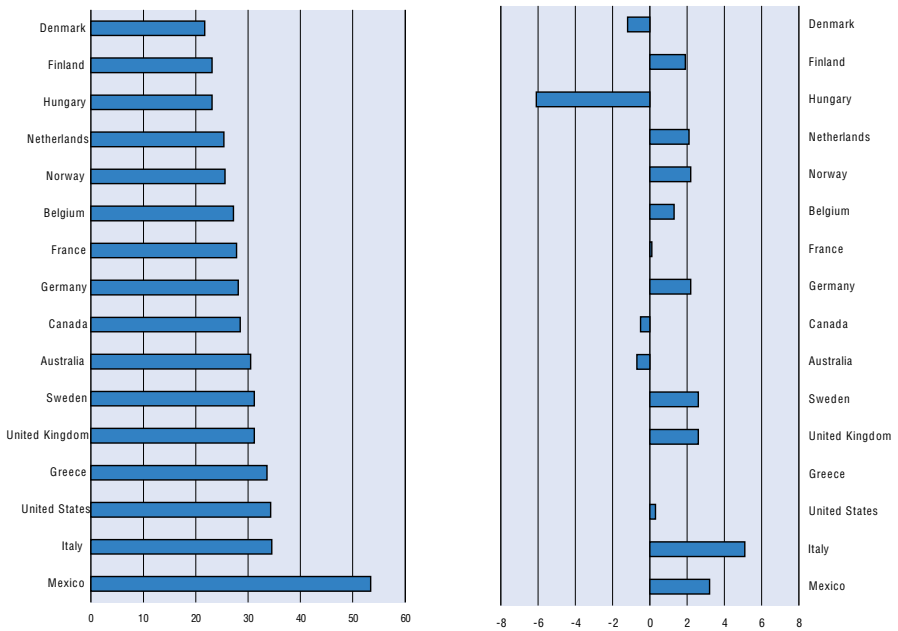
I. Gini coefficient for market income (before taxes and public transfers)

A. Gini coefficient multiplied by 100 ***B. Difference over about 10 years***



II. Gini coefficient for disposable income (after taxes and public transfers)

A. Gini coefficient multiplied by 100 ***B. Difference over about 10 years***

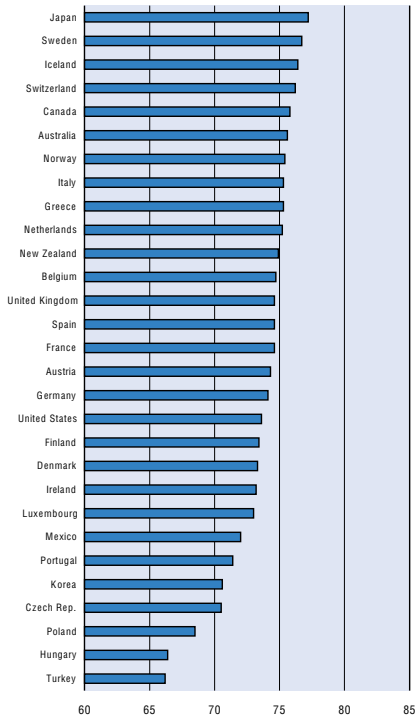


Note: Data refer to different years around end 90's. Gini coefficients of household income per individual, for the entire population (equivalence scale elasticity of 0.5).
Source: Förster *et al.* (2000), "Trends and Driving factors in Income Distribution and Poverty in the OECD Area", OECD Labour Market and Social Policy Occasional Paper No. 42.

Figure 3.A.13. **Life expectancy at birth**

I. Males

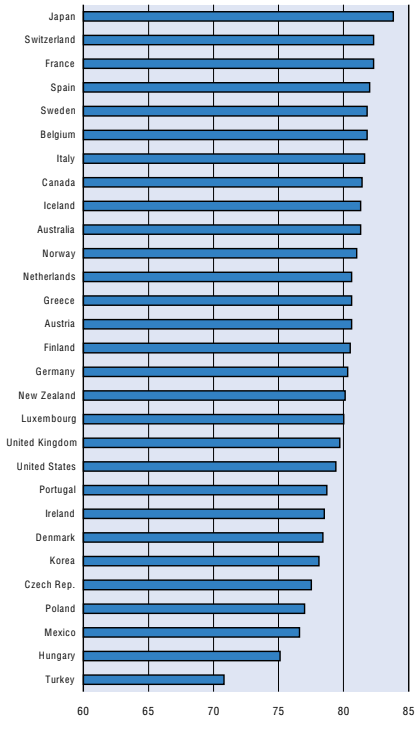
A. Numbers of years in 1997



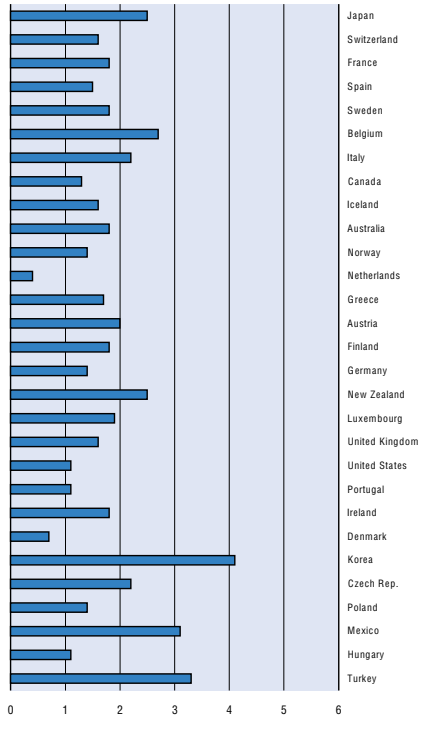
B. Numbers of years gained in 10 years

II. Females

A. Numbers of years in 1997



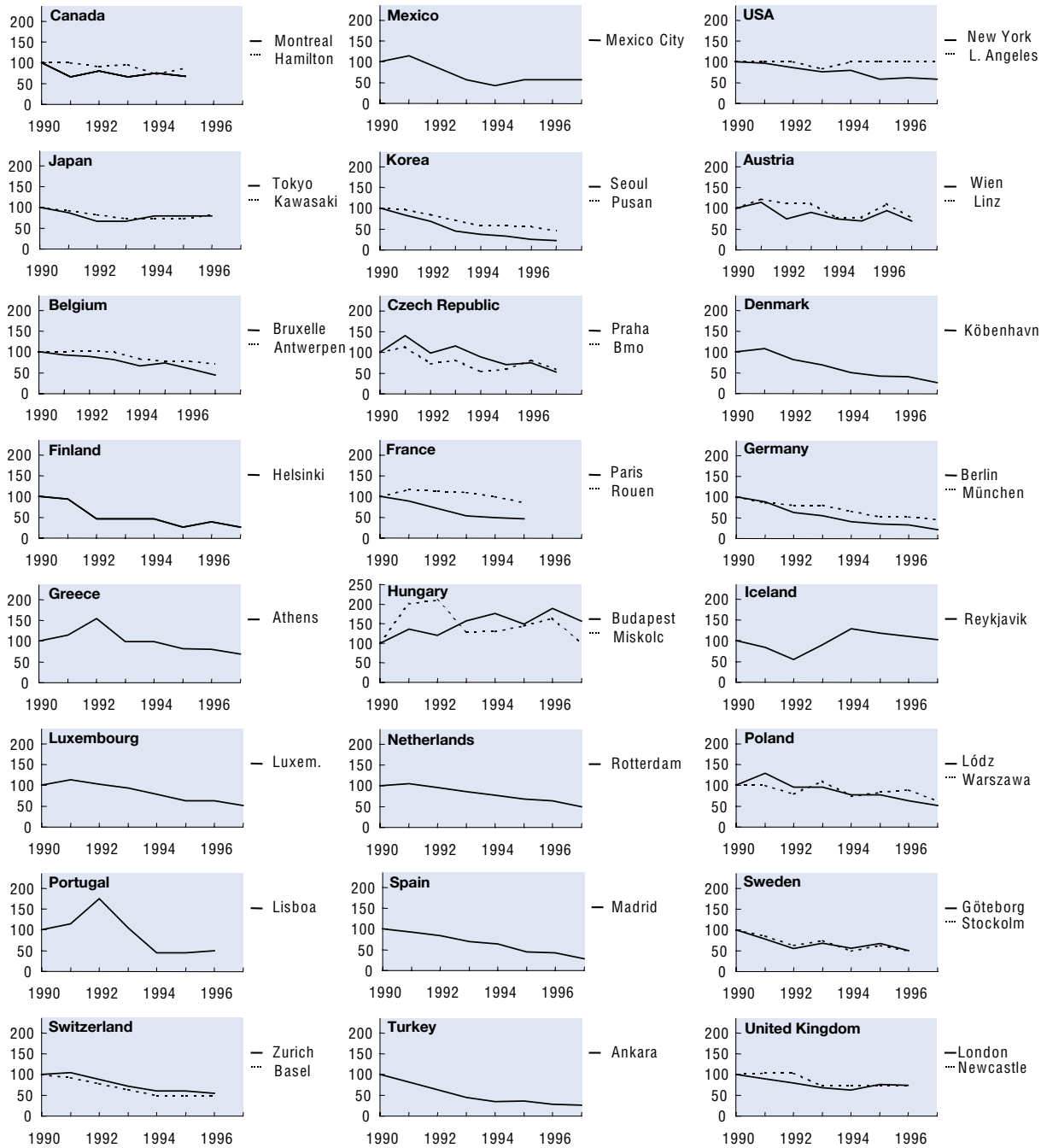
B. Numbers of years gained in 10 years



Source: OECD (2000), *OECD Health Data 2000: A comparative Analysis of 29 OECD Countries*, Paris

Figures 3.A.14. **Urban air quality**

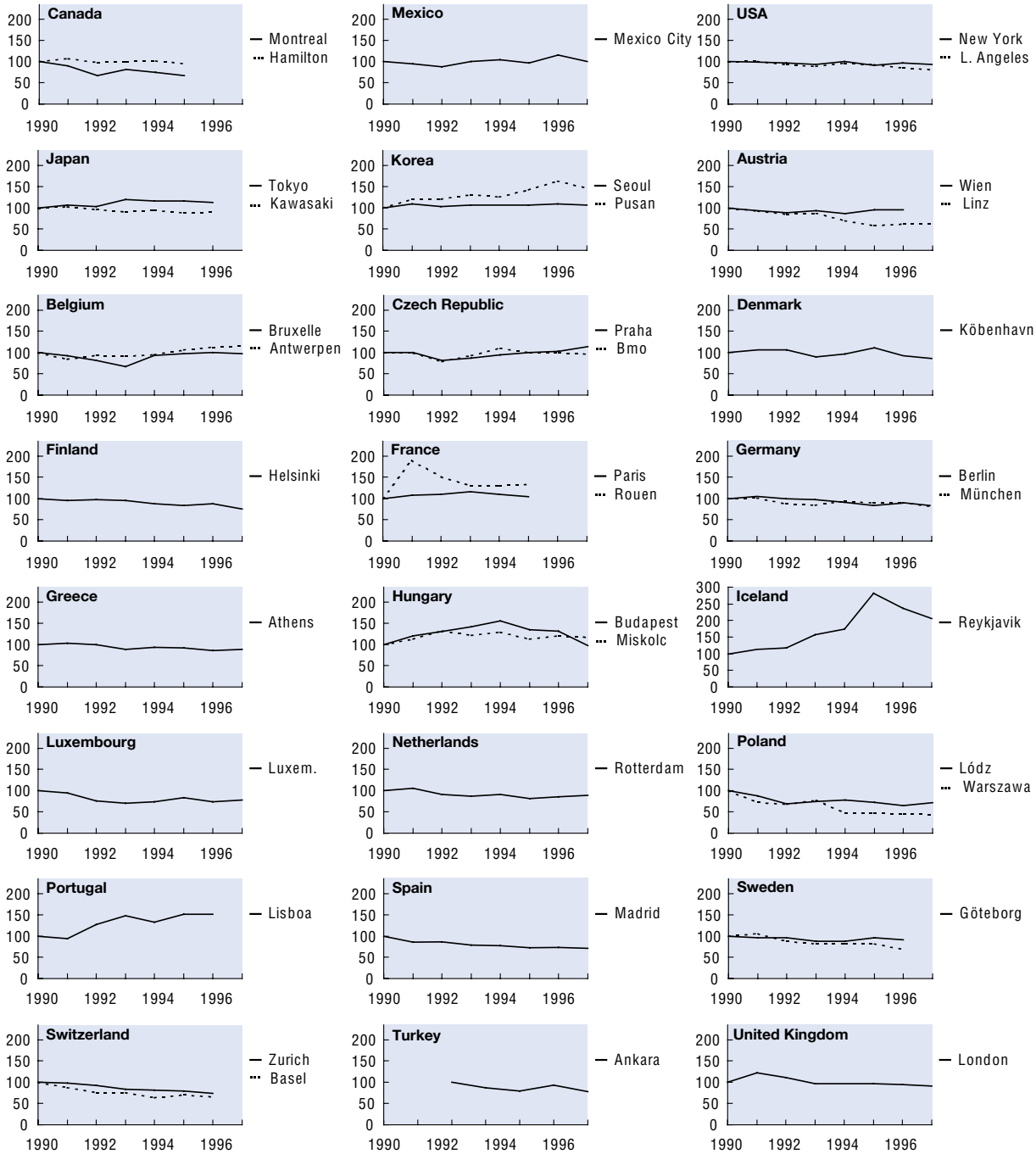
I. SO_2 concentrations in selected cities
Index 1990 = 100



Source: OECD (2001) *Environmental Indicators,* Paris.

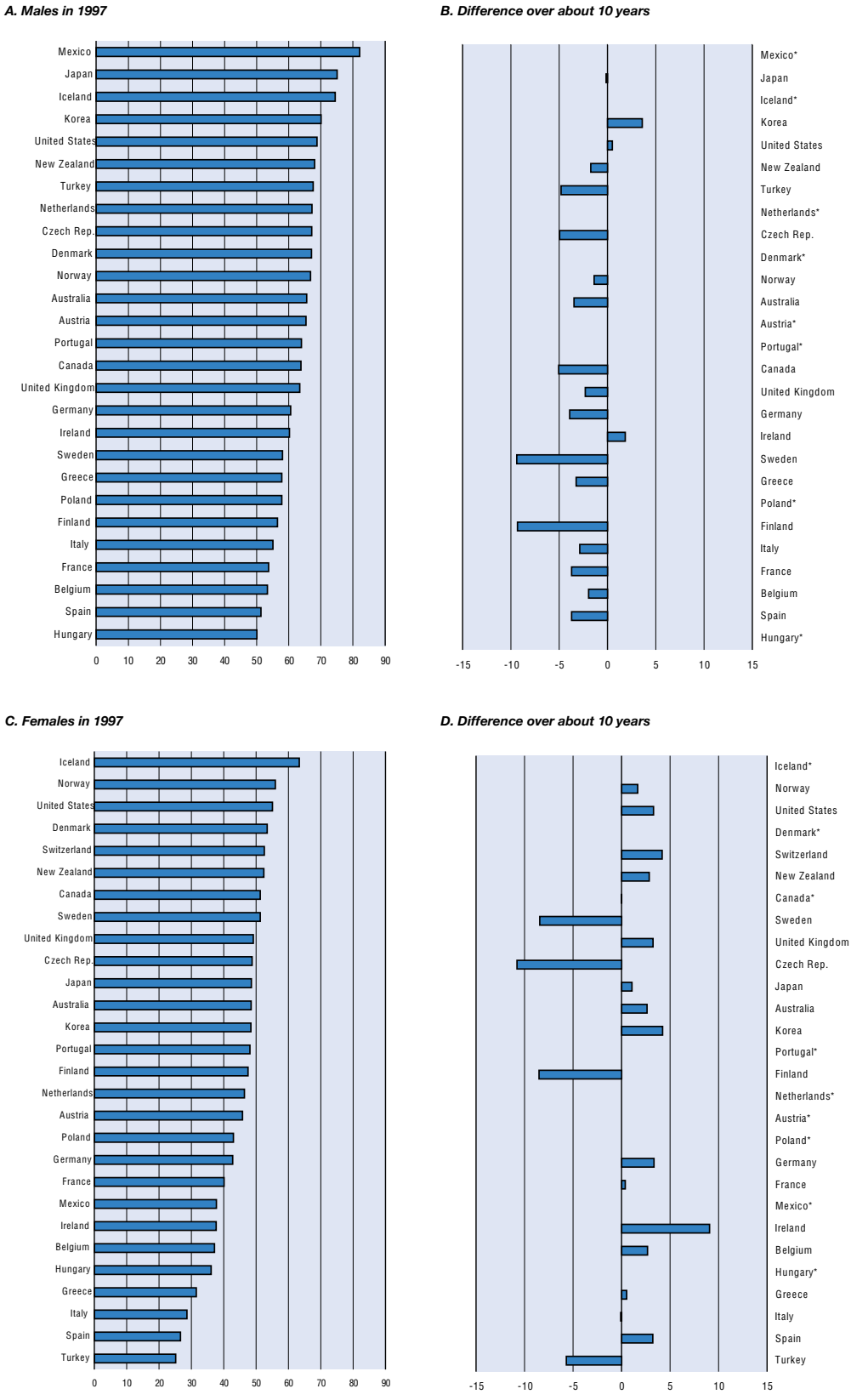
Figures 3.A.14. **Urban air quality**

II. NO_2 concentrations in selected cities
Index 1990 = 100



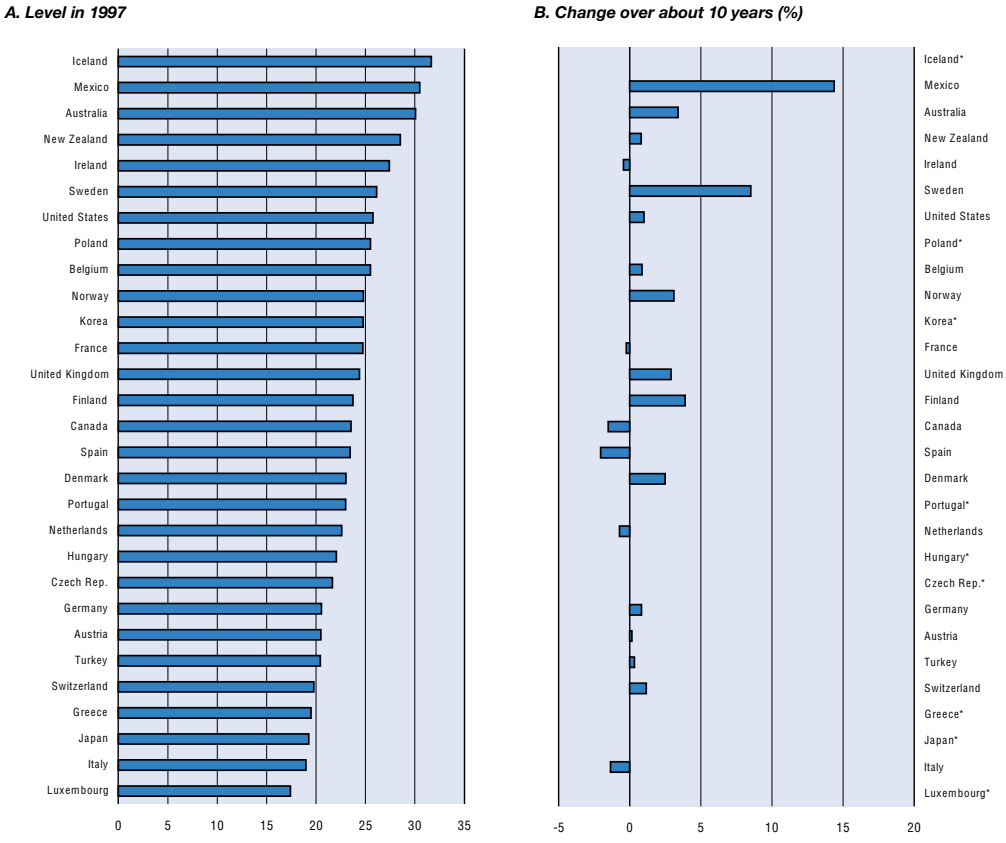
Source: OECD (2001) *Environmental Indicators,* Paris.

Figure 3.A.15. **Employment to population (over 15 years) ratio**



Source: OECD, ALFS

Figure 3.A.16. **Total enrolment as a proportion of total population**



Source: OECD - ELSA

Section II

ENHANCING SUSTAINABLE DEVELOPMENT IN OECD COUNTRIES

Chapter 4.

INSTITUTIONS AND DECISION MAKING

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Chapter 4.

INSTITUTIONS AND DECISION MAKING

Effective, well-functioning institutions are an essential foundation for sustainable development. As noted by the Brundtland report in 1987, the challenges presented by population growth, economic development and the need to improve agricultural, energy and industrial systems — though fundamentally interdependent — are managed by institutions that tend to be "independent, fragmented and working to relatively narrow mandates with closed decision-making processes." (WCED, 1987, p.310). The High-Level Advisory Group on the Environment (which reported to the OECD Secretary-General in November 1997) noted the importance of addressing this disconnect between environmental and economic systems, and the institutions which support them. And though institutional change has occurred in the decade and a half since the Brundtland report, reshaping international institutions to meet the needs of sustainable development continues to be one of the most significant goals facing government and society today.

This chapter addresses the institutional challenges for sustainable development from both a domestic and an international perspective. "Institutions", as used in this chapter, encompasses not only organisations (both national and international), but also the stakeholders who interact with them, the processes by which they reach decisions and which have an impact on progress towards sustainable development, and the activities they undertake to implement their goals (including multilateral agreements on economic, social and environmental issues, and domestic legislative instruments).

Key institutional issues

OECD countries, although with different cultural and historical backgrounds, share the essential features of democratic institutions that constitute the basic framework of democratic governance. This framework is characterised by the rule of law; respect and protection of basic human rights; checks and balances between the executive, legislative and judiciary branches; auditing and accountability mechanisms to review government action; a degree of autonomy for local government; and an independent civil society. This institutional framework also includes a capacity to take into account the global dimension of sustainable development challenges, and to deal with uncertainties in knowledge of the long- term impact of decisions. Decision-making mechanisms need to adapt to address sustainable development goals. This calls for a coherent integration of policies in the economic, social and environmental spheres; a wide-ranging participation of civil society in decision-making; and a long-term view of the challenges.

Integrated approaches to decision-making

While some OECD countries have started, following Rio, to develop public sector responses to the need for integration, there remains great potential for public sector institutions to find synergies between economic, environmental and social issues by considering them together. To date, much greater attention has been paid to the relationships between the economy and the environment, or between the economy and society, than to crafting a genuinely cross-cutting approach aimed at achieving multiple policy goals at the same time. This is not surprising, since a three-dimensional approach involves more complex analysis, interactions and trade-offs. Some countries have already made progress towards greater policy integration. The United Kingdom, for example, has adopted an approach which distinguishes between *(i)* strengthening the scientific basis and effectiveness of existing environmental institutions, and *(ii)* applying sustainable development in a horizontal way across organisations.

Economic and environmental policy integration has become a main institutional focus over the last decade or so, as the need to take environmental externalities into account in a wide range of sectoral economic policies has grown increasingly evident. This trend towards the integration of environmental and economic concerns at the domestic level has been mirrored to some degree at the international level, for instance in the Environment for Europe process, or in the Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC). To be truly effective, however, this integration will need more than just environmental add-ons to economic policy (and vice versa). It will increasingly mean a more fundamental integration of both sets of needs. One obvious need for such integration is in the international trading regime, but the principle is equally valid in other contexts as well, both within and between nations.

Moreover, there is now a growing awareness of the need to integrate environmental and economic policies with social policies in relation to such issues as health and environment, employment and environment, and environmental justice. For example, the Third Ministerial Conference on Environment and Health in London (June 1999) saw the signing of a Charter on Transport, Environment and Health. This charter emphasises the importance of integrating environment and health requirements with targets in transport and land use policies; as well as the need for health and environmental impact assessments of transport policies. There is also wide recognition of links between economic issues and social policy issues such as social cohesion and education.

The traditional segmentation of government decision-making impedes truly integrated policy making. In many cases, balanced and integrated decision-making will involve short-term trade-offs. In addition to adequate institutional integration at domestic and international levels, education and increasing public awareness of sustainable development will help make the necessary "cultural" shift toward greater policy integration. Schools, the media and advertisers are an important part of this education process. In addition, raising public officials' awareness and capacity — through combined education, training, staff mobility, new working methods, sharing of best practices and benchmarking — is critical.

Accountability mechanisms are an important step of any management process to ensure feedback on the effectiveness of policies. When it comes to sustainable development, efficient "inside" monitoring becomes critical to ensure that sustainable development implementation stays on track. Accountability and reporting mechanisms provide a framework for incremental review of institutional performance in achieving sustainable development goals.

Implementing integrated strategies effectively requires:

- Integrating sustainable development early in the policy-making process.

- Adopting measurable targets.

- Identifying clear responsibility for action and establishing responsibilities and accountability for sustainable development.

- Prioritising the sustainable development implications of specific policies, programmes and activities.

- Strengthening horizontal (across central government) and vertical (between levels of government) coherence.

- Developing practices, procedures and work instructions for the implementation of policies which can promote sustainable development.

- Monitoring and reporting publicly on progress or lack of progress with the oversight of a "focal point" in government.

- Identifying and assessing training requirements for government officials and others.

Participation of citizens

Well-designed consultation and participation processes are essential components of democratic governance.[1] They are especially important for the implementation of policies promoting sustainable development, because of the multiplicity and complexity of these goals. In this context, informed public debate contributes to the transparent discussion of the range of policy options, which impact society and specific sectors differently.

While OECD countries have different levels and traditions of civic involvement, most have initiated specific policies to improve consultation, public participation, and citizens' involvement. Some initiatives have been explicitly aimed at promoting sustainable development, while others have important but less direct implications. And though their objectives and means vary, they generally contribute to raising citizen awareness and enhancing the legitimacy of public policies. One essential shared objective is assuring adequate representation of those who do not have easy access to or sufficient representation in public debate, such as minorities, indigenous populations, and the unemployed.

The Aarhus Convention, a legal embodiment of principle 10 of the Rio Declaration and the concerns mentioned above, represents a recent institutional development of considerable significance for sustainable development. Its full title reveals its ambitious coverage of inter-linked issues: the "Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters". Primarily targeted at countries that are members of the UN Economic Commission for Europe (UN/ECE), the Convention (adopted in June 1998) reflects a growing acceptance for greater public involvement in decision-making across policy sectors and institutional levels. In this sense, the Aarhus Convention can be both a catalyst and a model for other policy areas and regions of the world (Box 4.1).

Citizens are not only key participants in the processes by which governments and public bodies take decisions. Citizen groups are also partners in implementation. With the privatisation of some former government activities, environmental and social policies are increasingly carried out by the voluntary sector. Business, labour unions and NGOs are key actors in sustainable development. Over the last decade, their participation in sustainable development initiatives, and their collaboration with each other has developed considerably.

At the international level, the UN Commission on Sustainable Development has pioneered the idea of multi-stakeholder dialogues on sustainable development themes, an innovation that reflects an accelerating trend in the "real world". Leading businesses have left behind the era when environmental responsibilities were accepted reluctantly (as was the case in the early 1970s). Many have even taken a pro-active approach to environmental, social and economic responsibilities towards the full range of their stakeholders (shareholders, customers, suppliers, investors, regulators, neighbours, and employees). Some businesses, especially certain multinational enterprises (Shell, for example), are arguably ahead of governments in the coherence of their approach to sustainable development. "Triple bottom line" thinking (economic, social and environmental) is echoed in the comprehensive public reports produced by these firms. This trend is being mirrored by the Global Reporting Initiative (GRI) convened by the United Nations Environmental Program (UNEP), the World Business Council for Sustainable Development, the Coalition for Environmentally Responsible Economies, and others.

The nature of NGO participation has also evolved considerably in the last decade, from being primarily one of campaigning against the action (or inaction) of government or business, to increasingly seeking ways to work in partnership with them in situations of common interest. This evolution is especially true of environmental NGOs, but also applies to those more involved in development or social/human rights issues. At the same time, many NGOs have become more outspoken in their demands for the reform of international institutions, which they see as undermining progress towards the goals of sustainable development — particularly those economic institutions (such as the WTO, IMF World Bank and OECD) which are closely associated with globalisation (see Chapter 8).

Box 4.1. The Aarhus Convention

The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters was signed by 35 countries, including eleven Central and Eastern European countries (CEEC) and four Newly Independent States (NIS), during the June 1998 "Environment for Europe" Conference in Aarhus, Denmark, and is expected to enter into force in 2001, once sixteen countries have ratified it. It is administered by the UN Economic Commission for Europe. NGOs (non-governmental or citizens' organisations) participated as equal partners in most phases of negotiation, to a degree beyond that allowed in previous international negotiations and in a way which establishes a precedent for future international environmental negotiations. The Convention's provisions include:

Access to information

- Environmental information held by public authorities should be accessible to the public through clear and transparent procedures. Exemptions should be limited and clearly defined. These can include the protection of intellectual property rights, confidentiality of personal data, and national security.
- Grounds for refusal should be narrowly interpreted. Public authorities should balance the protection of specific interests against the public interest in environmental protection, and information should almost always be disclosed.
- Public authorities must reply to requests within a specific period and justify refusals to provide information.
- Public authorities can apply reasonable charges for information and must publish the scale of charges.
- Public authorities must collect, update and disseminate environmental information.
- Public authorities should actively disseminate to the public documents on environmental legislation, policies and programmes as well as international conventions and other significant documents.

Participation in decision-making

- Public authorities must give notice that a decision will be made, in sufficient time for the public to prepare and participate in the process.
- Members of the public should have the opportunity to submit comments, information and analyses.
- Decisions should be in writing, and specify the reasons they were taken.
- Public input should be considered in the final decision.

Access to justice

The public should have access to judicial or administrative review when seeking the enforcement of environmental laws, or if procedural rights to access to information or participation have been infringed. Under the Convention, the public should have access to an independent and impartial review body that can provide adequate and effective remedy, including injunctive relief, and whose decisions are binding on the public authority. The process should be timely and inexpensive, with procedures established in law and final decisions in writing and publicly accessible.

Source: UN Economic Commission for Europe, internet site

Ultimately, though, the actual taking of decisions remains squarely in the hands of governments or other bodies vested with decision-making authority. Consultation and informal participation of stakeholders at early stages of the policy making process can thus make future implementation much more successful. For this to happen, governments must set clear rules about whom to include in the consultation processes, and what form participation should take. These measures should prevent the final outcome from being captured by sectoral interests.

Taking a longer-term view

Another central theme of the Brundtland Report, the Rio Declaration, and Agenda 21 was the need for policies to be sustainable over the long term, an idea closely linked that of inter-generational equity.[2] If the institutional framework does not promote a long-term perspective, future generations are likely to find that those things that are taken for granted by previous generations — such as natural resources, the capacity of the environment to absorb by-products, and the social fabric — have been seriously compromised. It is essential, then, that the environmental and social costs of economic activity be fully reflected in the prices paid by the present generation (see Chapter 5). Achieving the necessary long-term perspective will require: (*i*) more emphasis on efficient gathering of scientific information to better identify and manage risks, including long-term risks; and (*ii*) systematic collaboration and information sharing between and within ministries on horizontal issues.

The capacity of governments to address longer-term issues effectively depends on their ability to predict future trends and emerging issues. This requires greater efforts to strengthen research capacities in sectors where there is a lack of knowledge. Moreover, capacity building on longer-term issues is possible only if sufficient financial resources are provided, yet finding this additional funding is becoming particularly difficult in a context of government withdrawal. Canada is attempting to deal with this problem — and attenuate the need for considerable new financial resources — by reorienting and networking existing capacities through partnerships between government, the private sector and academia formed around a coherent national research strategy.

A closely related institutional requirement for long-term sustainability is the use of sound science (founded upon good empirical evidence) in decision-making. There is currently a strong development of research in fields connected to sustainable development but the quality of the information, the coherence of findings between different disciplines and the quality of advice to decision-makers remains uneven.

Indeed, the real impact of this knowledge on decision-makers is not always clear. Improving the connections between research and government is therefore crucial. Recent initiatives to fill this gap include the Canadian Policy Research Initiative designed to better connect government, society and research on a number of crosscutting issues, including sustainable development. The existence of a robust network of expertise in universities is equally important, although the relationship between government and academia may vary according to country. In France, for example, the "Institut des Hautes Etudes de Développement et d'Aménagement du Territoire" was established in early 2000 as a partnership between the government and the Fondation Nationale des Sciences Politiques. Its purpose is to implement a joint research programme called PROSES ("science, environment and society") which supports progress towards sustainable development.

Domestic institutional developments

The issues and challenges described above have three implications for sustainable development at the domestic level. First, initiatives to modernise government in many OECD countries can have significant consequences for sustainable development, and need to take these into account. Second, there have been a number of explicit measures to integrate sustainable development into the institutional framework. Third, government institutions should operate in an environment which is open to civil society involvement. This section analyses these developments, evaluating the adequacy of what has been put in place to date, and considering what further institutional changes are needed.

The changing role and function of government: consequences for sustainable development

Though sustainable development has emerged as a separate concept relatively recently, most OECD countries began to see the need for balancing environmental and social concerns with economic development by the end of the nineteenth century (OECD, 2000*b*), when legislation was established for nature conservation and basic social benefits. Even earlier, public health legislation had been enacted to deal with the health effects of air and water pollution resulting from the Industrial Revolution. In the twentieth century, the creation of the welfare state completed this legislative and regulatory framework, although only limited efforts were made to integrate the economic, environmental and social policies being developed.

In the final quarter of the last century, major shifts in the role of government have resulted from waves of reforms (initiated mainly in the 1980's and 1990's in most OECD countries) designed to improve efficiency, effectiveness and accountability, as well as modern partnership and consultation processes with citizens. In many OECD countries, budget constraints created a tendency for the state to withdraw from a direct role in a number of sectors and to reduce the resources available to the public sector. In the 1990's this was accompanied by a devolution of responsibilities to the local level. This change often placed a greater burden on local government as resources were squeezed in attempts to control expenditure. At the same time a prominent trend emerged in the privatisation of sectors that were previously in the hands of government, including sectors that greatly influence ecological and social sustainability, such as energy, water utilities, and transport. However, centralisation and high environment ministry budgets are not necessarily a precondition for sustainable development. If the necessary integration of thinking and action is taking place, focusing priorities should lead to a more efficient spending of resources.

Another important question concerns the degree of "steering capacity" of governments in sectors that have a significant impact on environmental outcomes and, more broadly, on sustainable development. Related to this issue is the question of how to balance competing priorities, particularly if cuts are made that endanger the "critical mass" needed to perform essential tasks.

Sub-national governments in most OECD countries are responsible for relatively comparable tasks, particularly at the municipal level: "classic local public services" include town planning, local transport, sewage systems, refuse collection and water supply. Most decentralisation reforms aim to give local authorities full responsibility for these matters, thereby increasing their potential impact — whether positive or negative — on the sustainability of outcomes at the local level. However, the implementation of social (health, education, social assistance) and environmental policies is often shared between levels of government. The complexity of the distribution of responsibilities in these policy fields leads to "grey areas" (OECD 1997), which can undermine progress towards sustainable development (for example, through reduced policy coherence, conflicts, and overlapping activities).

This raises important questions about the balance between greater decentralisation and maintaining sufficient steering capacity in the centre, a necessity for avoiding policy inconsistencies and implementing international agreements. Achieving coherence is particularly challenging in federal systems, where institutional complexity is traditionally high. At the metropolitan level, there is a need to identify the benchmarks against which the adequacy of systems of urban governance can be judged. To help identify these, the OECD has developed "Principles of Metropolitan Governance" (see Chapter 16), which include sustainability as one of the principles.

Supplementing the existing framework with new institutions and processes

The balance between the three powers in the state — legislature, executive, and judiciary —varies from country to country, as does the role of each in advancing the sustainable development agenda and in establishing dedicated bodies to deal with these issues. In Germany, federal initiatives come mainly from parliament, while in many other countries like the Netherlands, the United Kingdom or the United States, the executive has taken the lead. This section focuses on initiatives at the national level (for similar initiatives developed at sub-national levels, see Chapter 16, and OECD 2001*b*).

Parliaments have exercised a significant role in promoting the importance of policy coherence in support of sustainable development goals. This contribution has come through commissions or advisory bodies that report to parliament, the exercise of oversight (through control of the new bodies) and transparency mechanisms (i.e. informing citizens). Establishing specific bodies to deal with sustainable development allows institutions to evaluate how well the various parts of government are working together. The New Zealand Parliamentary Commissioner for the Environment has played this role (e.g. in examining issues such as urban sustainability), while in Germany, the work of the Committee on Sustainable Development resulted in 60 recommendations to government and concrete proposals for new strategic directions (OECD 2001*b*).

Parliaments also play an essential role in the ratification of international agreements related to sustainable development, through, in some countries, their extension of treaties and in translating these agreements into domestic legislative systems. The role of parliaments in implementing sustainable development

Box 4.2. **Organisational approaches to sustainable development within the executive: some examples**

Different approaches are being developed for the integration of sustainable development within the executive. These are not mutually exclusive, and a given country may use different approaches in parallel.

- "*Co-ordination approaches*" typically involve broad-based inter-ministerial working groups or cabinet-level committees, task forces, etc. to fully examine the interface between the economy and the environment (social aspects are typically dealt with less explicitly.) France established an inter-ministerial steering group in 1995 to guide the 'greening of government' initiatives. The United Kingdom created a Cabinet Committee of 'green' Ministers supported by civil servants in each Department. The co-ordination approach is particularly common in federal countries that need to ensure coherent action at the federal and state level. Australia, for instance, has established a wide range of co-ordination bodies.

- *"Structural approaches"* are characterised by attempts to better integrate policies through internal institutional innovation. This is sometimes achieved through "mega-departments" dealing with different aspects of sustainable development that have traditionally represented conflicting interests. In the United Kingdom, the creation in 1997 of the Department of the Environment, Transport and the Regions, under the Deputy Prime Minister, was explicitly intended to achieve greater integration of policy in the wide range of fields for which it is responsible. In the Netherlands, the environment and spatial planning Ministries have been combined into one "big" Ministry — as have agriculture/fisheries and nature management, and water supply and transport (though the primary motivation for the merge was not that of policy integration for sustainable development). Such structural reorganisation offers the potential for a progressive integration of environmental concerns into many aspects of government policies. However, the degree of integration of these portfolios within one Ministry is uneven and some degree of segmentation often remains. A complementary solution adopted by a number of countries such as the United Kingdom and Italy is to establish "environmental units" in sectoral and other Ministries.

- *"Strategic approaches"* involve fewer structural changes but focus on the necessity to develop a shared agenda in government with concrete plans for action. Attempts to formulate compatible ministerial strategies have been initiated in Canada and Belgium. In Canada, federal/national departments and agencies have to draw up sustainable development strategies and are being challenged to take environmental, economic and social considerations into account more systematically — in their policies, their programmes and their day-to-day operations. In Belgium, a Task Force in the Bureau Fédéral du Plan is responsible for developing a strategic federal approach to sustainable development including, notably, an evaluation of policies for their sustainable development implications. Also, a commission made up of officials from all federal departments is responsible for the elaboration of sustainable development plans every four years.

remains limited by the fact that many countries do not consider sustainable development as a discrete policy field requiring specific legislation. Indeed, it has frequently been parliamentary bodies dealing with the environment that have broadened their interests to include sustainable development. While this broadening represents a positive trend, it raises the question of how well such bodies can formulate comprehensive approaches to sustainable development issues.

Integrated efforts by parliaments to develop legislation consistent with sustainable development are nonetheless underway in a number of OECD countries. In Italy, law 36/1994 sets out a framework for the reorganisation of the entire Italian water industry. It provides both vertical and (partially) horizontal integration of the water cycle (abstraction, public water supply, sewerage, treatment and discharge) within "optimal management areas" that the 20 Regions are expected to delineate. Associations of local authorities must then take on the responsibility for organising water services on an integrated basis.

It is the executive, though, that is usually the main vehicle for developing sustainable development policies at the national level. Based on some notable examples, a short typology of existing approaches can be suggested (Box 4.2). This overview reveals that the integration of social issues with both environmental and economic issues is still in its infancy (OECD 2001*b*).

Considering the limited body of specific legislation on sustainable development, the role of the judiciary in reviewing compliance remains embryonic. However, from an environmental point of view, the judiciary has played a key role in changing the behaviour of polluters. Legal action and enforcement have achieved a number of milestones in environmental protection. In some OECD countries like the United States, citizens' demands (often expressed through environmental and consumer NGOs), have contributed to giving the courts a significant role in dealing with critical issues affecting sustainable development (namely, environmental assessment issues), especially at the local level. It is likely that the role of different stakeholders in bringing cases to court could continue to expand, and the greater degree of openness of the judicial system to third parties could help to achieve sustainable development goals by assuring equality of access to the judicial review of contentious issues.

The common perception that "a new issue calls for a new institution" has led to the establishment of a wide range of organisations dealing with sustainable development. Bodies such as round tables and commissions take on advisory, advocacy, awareness-raising and information-sharing roles. During the course of the 1990s, following the Rio Conference, all thirty OECD countries established such national-level bodies; in federal states, these often exist at the sub-national level as well. Around 150 such bodies now exist throughout the world. There is currently a second wave of institutional creations that seek to complement or increase the impact of those already in place. In Germany, the Council on Sustainable Development (Deutsches Rat für Nachhaltige Entwicklung) was created in June 2000; in Korea, the presidential commission on sustainable development (PCSD) was established in September 2000; and in the United Kingdom, a Sustainable Development Commission was set up in July 2000. A key challenge for such bodies is to address economic, social, and environmental issues together. Governments can help this process by appointing individuals with a broad range of experience, and encouraging these organisations to broaden their focus to non-environmental issues.

In addition to bodies with an advisory role, a few countries have established new "autonomous" institutions that exercise audit and reporting functions. For example, the United Kingdom has established a Parliamentary Environmental Audit Committee to scrutinise sustainable development policies and actions across government. Similarly, Canada has created the position of Commissioner of the Environment and Sustainable Development, held by an independent appointee who tables reports in Parliament. This is an interesting institutional feature of the Canadian system which fulfils a unique and valuable function. The Commissioner's reports play an important role in identifying the gap between "goals" and "action", providing and disseminating information, raising awareness, and making policy recommendations (OECD, 2000a). So far, the Commissioner's reports have been critical of the extent to which processes of public consultation, for instance on climate change, have not been followed by action. But this "implementation gap" is one which is by no means unique to Canada and which demands the attention of all governments.

Since the government budget process is a key mechanism for allocating resources and reaching policy coherence in all OECD governments(OECD 1996), integrating sustainable development principles across the whole range of accounting and budget procedures, along with adequate accountability mechanisms, is an important goal. Nordic countries have experimented with a number of "greening the budget" initiatives. In Norway, for example, the Ministry of Environment, in co-operation with the Ministry of Finance, has established a framework for an annual document annexed to the National Budget This document examines the "Environment Profile of the State Budget", identifying all expenditure items that are wholly or partly motivated by environmental policy objectives. For this purpose, the spending ministries have been asked to classify expenditure by "result areas", for instance, according to the environmental policy goals they should help achieve. In Denmark, the Economic Council has experimented with ways to represent the condition of the environment and natural resources in the national accounts. Since 1997, "An Environment Assessment of the Finance Bill", a report designed to explain how the draft Danish budget proposals will impact on a range of issues (principally at the economic/environmental interface), has been issued annually by the Ministry of Finance (OECD, 2000*b*).

Efforts to integrate social and environmental components simultaneously into the budget process are not yet evident, though the UK Government is committed to a full appraisal and evaluation of the environmental effects of the policies it introduces (including social policies). All budget measures are screened for environmental impact, and these effects are summarised in the appraisals tables contained in the pre-budget and budget reports.

The role of civil society

Arguably one of the most significant institutional phenomena of the last decade has been the increasing participation of civil society in public policy debates, including those on issues pertaining to sustainable development. An active civil society is an essential component of any institutional framework for sustainable development. A quarter of Agenda 21 is devoted to "strengthening the Role of Major Groups" (which are defined broadly to include women, youth, indigenous people, non-governmental organisations, local authorities, workers, businesses, scientists and farmers). Business, labour, and citizens' organisations in particular have taken the sustainable development agenda on board in ways which challenge governments to match commitment with action, and to work in partnership with them.

Business has usually approached sustainable development from an environmental perspective. The 1960s and 1970s were a time when business and industry by and large denied their role in creating environmental problems. But by the end of the 1990s, many businesses and industries across the OECD had moved toward an acceptance, or even a welcoming of dialogue with government and other stakeholders about their environmental and social responsibilities. This participation, when coupled with active internal systems of environmental and social accounting, auditing and reporting (to complement more traditional financial ones) represents the state of the art in corporate approaches to sustainable development. However, such practices are found in relatively few large multinational corporations. In most cases, domestic companies have yet to embrace the sustainable development agenda in such a comprehensive way, and some have not yet fully addressed the more straightforward need for good systems of environmental management (see Chapter 15).

This evolution reflects a number of trends. Public opinion — whether expressed through legislative requirements, NGO campaigns, labour unions, employees, or the views of shareholders and investors — is increasingly demanding the highest environmental, social and financial standards from companies, wherever they operate. In the Internet-age, companies feel under constant scrutiny. This has led to an increasing number of domestic and international corporate codes of conduct (e.g. OECD Guidelines for Multinational Enterprises, OECD 2000*c*). At the same time, firms recognise that their own long-term survival depends on how they manage the linked issues that make up sustainable development.

Early corporate responses focused mostly on environmental arrangements, either through sectoral codes of conduct — such as the chemical industry's "Responsible Care" programme — or environmental

management standards that provide external recognition of internal efforts — such as ISO 14001 or the European Union's Environmental Management and Audit (EMAS) scheme. However, such voluntary initiatives have sometimes been criticised as being little more than exercises in public relations. This criticism underscores the need for voluntary approaches to operate within a framework of clear and consistent market and regulatory signals, and to be accompanied by a range of safeguards to ensure their effectiveness. These can include: clearly defined targets; benchmarking against a "business as usual" scenario; reliable monitoring; and effective stakeholder participation (OECD 1999*a*, and Chapter 5).

A growing, but still limited number of company-level initiatives aim to combine the three components of sustainable development. For example, the Royal Dutch/Shell group of companies has established a Sustainable Development Management Framework, which is included in the "business principles" of the Shell group (see Royal Dutch/Shell group internet site). As part of this, Shell is also beginning to develop a set of Key Performance Indicators to measure its progress towards sustainability, involving measures of economic/financial, social and environmental factors.

The importance of consultation and participation in creating an inclusive democracy and good community feedback to governments is a key requirement for sustainable development. With this in mind, a number of OECD countries have developed specific initiatives to advance their sustainable development agenda through better interaction with civil society. In Belgium, the early draft federal plan for sustainable development was submitted to a two-month public consultation that received 16,000 contributions from the public, including citizens' organisations. The draft project was modified accordingly and the draft plan made from it transmitted to government for debate.

One priority for many countries has been to raise awareness of sustainable development among citizens. In most OECD countries, sustainable development is a concept still unknown to the majority of the citizens. For example, a recent study showed that in Germany only 15% of former West Germans and 11% of former East Germans knew about the concept of sustainable development.[3]

Public consultation and participation is also used for designing strategies and for implementing current strategies and action plans. In Canada, departmental strategies for sustainable development are required by law, and were established after detailed *ex ante* consultation of the different categories of stakeholders concerned. According to the Commissioner of the Environment and Sustainable Development, high levels of satisfaction were reported amongst the citizens consulted. The United Kingdom has frequently used survey techniques for gathering quality of life perceptions of residents, and in the Welsh Assembly a detailed local consultation helped to identify citizens' priorities. Such consultation provides important information for governments on the likely effectiveness of policies. Other consultation mechanisms include reporting mechanisms, dealing with citizen complaints, and improving mechanisms for transparency. Each of these principles is embodied in the Aarhus Convention which, although focused on environmental issues, offers important general principles on handling public participation relevant to the other components of sustainable development.

Some concerns have been raised about the cost of extensive consultation. If not well designed and managed, consultation may be seen as a drain on both time and energy and could ultimately hinder progress towards sustainable development through lengthy and unproductive processes that delay action. In certain sensitive areas such as energy, the potential for conflicts between stakeholders may also be perceived as an "excuse" by government for not reaching a decision in the face of polarised opinions.

Although traditionally receptive to business interests, governments have generally been much less comfortable about providing "independent" NGOs with significant influence over public policies. However, since the 1960's, NGOs have been increasingly involved in a wide range of policy issues, particularly in environmental and social ones. One of the first results of the democratisation process in transition countries like the Czech Republic and Poland has been the growing importance of NGOs in public debate (Sutherlin, 1999). This presence has led governments to set up institutional processes for NGO participation.

In the Netherlands, the capacity to reach consensus after bargaining and pressure is often presented as a traditional feature of the so-called "polder model".[4] The number of "influential" stakeholders was traditionally limited by the tripartite system of Government, Business and Trade Unions, but social changes within Dutch society, such as the emergence of consumer and environmental concerns, has led to a broadening of this system. As Dutch society has become more pluralist, systems that favoured a limited range of interests have lost legitimacy (Bastmeijer K., 1997 and OECD 1999*a*).

One major obstacle to improving the engagement between an "active civil society" and government is the absence of a long tradition of openness. The number and level of involvement of NGOs varies substantially among OECD countries. In most continental European countries, as well as in Japan and Korea, NGO involvement is often limited by the argument that the state should safeguard the broad public interest by avoiding too close an engagement with specific lobbies or interest groups. But this is changing, partly in response to citizens' demands for a greater say in the decision-making process. Hence the importance of clarifying the criteria for NGO involvement in the policy-making process, and the need to give them access equal to that enjoyed by the traditional social partners — employers and trade unions.

International institutional developments

Progress towards sustainable development at the international level, particularly in global and regional inter-governmental organisations, needs to be underpinned by the same key institutional requirements that apply at the national level discussed above. However, some additional requirements are specific to international institutions, reflecting the *scale* of the problems being addressed and the need for an *equitable* sharing of responsibility for action amongst the countries concerned.

The magnitude of global problems demands coherent multilateral action by governments, international organisations and other actors. Climate change, global biodiversity loss, desertification, water access, and threats to forests and fisheries are some of the critical concerns at an international scale (UNEP, 1999). Each is linked inextricably with economic and social causes and effects. This implies that decision-making which does not integrate these components is likely to have only a marginal impact. The advance of economic globalisation has thrown into much sharper relief the need for new institutional arrangements to ensure that social and environmental goals are not undermined by global economic progress. The need for good governance, hand in hand with policy integration, is particularly marked in such areas as trade and investment[5] (see Chapter 8).

In light of these challenges, this section examines the central pillars of the international architecture for sustainable development; the principles on which they are founded; and how various types of international institutions have responded. It then draws some broader lessons, and suggests some of the institutional changes which may be needed to accelerate progress. Table 4.1 below provides a selective overview of the way in which a number of key international organisations have approached some of the fundamental principles of sustainable development, in particular integration, participation, and accountability. The last of these principles is closely linked to the issue of transparency, and to the need to ensure that objective, verifiable information about the decisions affecting sustainable development of these organisations is readily available to citizens

Foundations of the international institutional architecture

The 1992 UN Conference on Environment and Development (UNCED, or the Rio Earth Summit) marked a watershed in international policy through its approach to environment and development as equal, interdependent components of sustainable development. Negotiations on climate change and biological diversity, taking place through separate processes, resulted in the UN Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), which were concluded in Rio. The Conference participants also agreed to the Rio Declaration on Environment and Development (a statement of general but fundamental principles on sustainable development), to the Forest Principles, and to

Agenda 21, a vast non-binding action plan.[6] The Rio Conference was followed by a series of other global conferences, such as the 1995 World Summit for Social Development (Copenhagen), and the negotiation of other international agreements. The Rio Declaration was seminal and includes important principles that help to underpin the international institutional and legal framework for sustainable development. These include the principle of integration of environmental protection into the development process (Principle 4); the internalisation of environmental costs (Principle 16); participation and access to information and justice (Principle 10); inter-generational equity (Principle 3); and the principle of common but differentiated responsibilities (Principle 7). These principles also form part of the UN Framework Convention on Climate Change (UNFCCC) and a number of other agreements, such as the Convention to Combat Desertification (CCD).

The major document adopted at the Rio Conference was the comprehensive action plan "Agenda 21". Its forty chapters cover issues ranging from "Combating Poverty" and "Changing Consumption Patterns" to "Conservation of Biological Diversity" and "Children and Youth in Sustainable Development".[7] Agenda 21 is not a legally binding document, and some of its chapters have a broad and generalised sweep. Other chapters, however, such as those on Chemicals and Waste, have provided a practical framework for implementation. Agenda 21 has been an important mechanism for strengthening the role of civil society, both at the national and international levels. Section III on "Strengthening the Role of Major Groups" addresses women, children and youth, indigenous people, non-governmental organisations, local authorities, workers and trade unions, business and industry, the scientific and technological community, and farmers. The major groups categories are not always clear cut, but the concept has helped advance involvement by a wide variety of groups in UN and other processes.

Implementation of key sustainable development principles

"Sustainable Development" Institutions

Just as Sustainable Development Commissions and Round Tables of various kinds have been created at the national level, new organisations explicitly designed to address sustainable development have emerged at the international level. These include the United Nations Commission on Sustainable Development (CSD), and the various institutions connected to the Climate Change and the Biodiversity Conventions (IPCC, INCs, COPs). The business community also responded, for example by creating the World Business Council for Sustainable Development.

The *Commission on Sustainable Development* (CSD) is the central UN body charged with promoting the concept of sustainable development. The CSD's challenges come from its broad mandate and its role as a functional commission of the UN Economic and Social Council (ECOSOC), a council occupying a low place in the UN hierarchy and considered somewhat ineffective (UN 1997). Furthermore, the CSD's mandate addresses a wide range of issues, many of which are being dealt with in other fora, posing the problem of overlapping efforts. On the positive side, the CSD has succeeded in promoting greater involvement of civil society in the UN and national-level policy-making through Agenda 21 implementation and national reporting to the CSD. For this it has been sometimes presented as a "model" (Table 4.1).

At the international level, business is taking problems concerning sustainable development more and more seriously. For example, the *World Business Council for Sustainable Development* (WBCSD), has provided a progressive business voice since the mid-1990s, promoting the concept of "Eco-efficiency". The development of voluntary codes of conduct for enterprises often starts at the level of large multinational firms, then spreads to small and domestic firms over time. As noted above, a number of safeguards are needed to reassure the public of the effectiveness of such voluntary approaches, including effective regulatory mechanisms. (see also Chapter 5).

Table 4.1. Overview of some key international and regional organisations and sustainable development

	World Bank	EBRD	WTO	UNEP	CSD	WHO	European Commission	OECD
INTEGRATION								
Incorporation of Economic, Social and Environmental Dimensions of Sustainable Development in: Mandate Strategy	Incorporated in strategy and operational activities through various approaches e.g. CDF, safeguard policies, draft environmental strategy.	EBRD Agreement Article 2.1vii. Incorporation of environmental appraisal in investment and technical cooperation activities.	WTO Agreement (Preamble). Committee on Trade & Environment, Committee on Trade & Development.	Mission Statement focused on environment but refers to quality of life and inter-generational equity.	Main focus, based on Agenda 21. Poverty reduction and changing consumption and production patterns are overarching themes of current work programme. Work topics change annually	Incorporated in mandate of cluster of "Sustainable Development and Healthy Environments", Department of Health in Sustainable Development (HSD) and various activities.	Treaty of Amsterdam reinforced sustain able development as guiding EU objective. Sustainable Development Strategy under development.	"Sustainable economic growth" goal of 1961 Convention re-interpreted in 1998 to include social and environmental concerns.
Activities	Increasing integration of environment, social and rural development priorities.	Main focus on environment, though social issues not ignored.	Broad Preambular definition could be read to encompass all three components.			As applied at WHO, concept includes all three dimensions.	Integration process, launched in 1998, aims to achieve integration of environmental considerations in other sectors. Social component not yet well-developed.	Sustainable development one of eight strategic objectives in 2001-2002.
Extent to which work of organisation reflects successful integration of all dimensions of sustainable development	Changes in response to past criticisms. New CDF and draft environmental strategy aim for deep integration.	(Not clear)	(Not clear)	Current activities, based on priorities defined in Nairobi Declaration, seem to reflect relatively high degree of successful integration, particularly of economic issues (eg. Work on trade and environment, Banking and Insurance Initiatives), but social component less well developed	Main focus, but still a predominance of Environment Ministers and officials at CSD meetings and in ongoing work; however, some participation by Development, Finance, and sectoral economic Ministers and officials.	Some promising indications of a fully integrated approach to new issues, . proposed Framework Convention on Tobacco Control (FCTC).	Ambitious process, seems to be facing a number of challenges. But progress uneven between economic sectors. Social aspects may not yet be on an equal footing with environmental.	3-year sustainable development Initiative brings together wide range of policy interests, from economic, social and environmental areas of the Organisation.
Internal structure: Senior individual responsible for sustainable development; supporting mechanisms	Vice-President for Environmentally and Socially Sustainable Development.	Head of Environmental Appraisal Unit (EAU).	Director of Trade & Environment Division and DDG.	(Not clear)	Under Secretary-General and Director of Division for Sustainable Development (DSD).	Executive Director of Sustainable Develop-ment and Healthy Environments, and Director of Health in Sustainable Development, plus designated focal point for Agenda 21.	Group of Commissioners on Growth, Competiti-veness, Employment and SD, Chaired by Commis-sion President supported by inter-Directorate Forward Studies Unit and Commission Services Group on SD.	Secretary General chairs sustainable development Steering Group of Directors; Deputy SG oversees work supported by Task Force.

Table 4.1. Overview of some key international and regional organisations and sustainable development *(cont.)*

	World Bank	EBRD	WTO	UNEP	CSD	WHO	European Commission	OECD
PARTICIPATION								
Civil society involvement	Changes underway in response to past criticisms. CDF new key mechanism.	Environmental Procedures cover public consultation, where appropriate. Revised Public Information Policy.	NGOs have attended Ministerial Conferences. Informal consultative processes between Secretariat and NGOs. Symposia. Civil society input at national level, but criticism continues from civil society.	Procedures and practices currently being examined, with focus on private sector and civil society. Active partnership with business via Trade, Industry and Environment Office (TIE).	Extensive: eg large number of NGOs accredited to CSD, innovative activities such as Multi-stakeholder Dialogues, on-going contacts with DSD, and a Non-Governmental Liaison Service.	Stakeholders involved in variety of ways, eg in World Health Assembly and Executive Board meetings. Individual departments have variety of arrangements.	Various arrangements, eg European Consultative Forum (see below), European Climate Change Programme, many informal contacts.	Greater access to meetings, documents and Secretariat for business and labour than for NGOs. Efforts at greater transparency and visibility now underway, OECD Forum 2000.
Internal/external advisory boards	(Not clear)	Environmental Advisory Council (ENVAC).	No	Different Divisions have own arrangements, . annual consultative meeting between business and TIE Office, Paris.	Various internal UN mechanisms, eg Interagency Committee on Sustainable Development (IACSD); no single external advisory body.	Some external advisory committees exist. Others being put in place as part of new WHO structure.	European Consultative Forum on the Environment and Sustainable Development.	BIAC and TUAC have had formal consultative status since 1962. OECD Round Table on SD provides a high-level multi-stakeholder policy input.
ACCOUNTABILITY Communication of decisions	Information disclosure policy based on presumption in favour of disclosure. Sophisticated web site. InfoShop in Washington DC and Public Information Centers in other locations.	Annual Report, various publications. Aim is to make web site key mechanism for information dissemination.	Web site updated in June 2000 to make it more user friendly.	Information and awareness-raising key function for UNEP. Broad range of publications and website info.	Wide range of activities, including "CSD Update" circulated to several thousand individuals and organisations; UN web site.	Variety of mechanisms, including WHA resolutions, papers, fact sheets, newsletters etc.	Variety of mechanisms, eg Communications, papers, fact sheets, "Europa" web site.	Range of mechanisms, . Website, Publications, "OECD Observer", Policy Briefs.
Mechanisms for external verification of reports	Inspection Panel, various evaluation processes.	Board of Directors. Internal Audit. Project Evaluation Department.	Through Member States.	Governing Council, Committee of Permanent Representatives, various evaluation processes.	Internal oversight, external auditors.	World Health Assembly, Executive Board, auditors.	Various mechanisms, . Council bodies, European Parliament, evaluation processes.	Through Member States, including range of "peer review" processes, for country surveys.

Other international institutions

One of the major trends in sustainable development over the last decade has been the shift in decision-making from the national to the international level. This has included the development and negotiation of new international agreements, the adoption of non-binding instruments at global conferences, and the establishment of new international fora. This trend is also reflected in a striking growth in multilateral environmental agreements (MEAs) dealing with endangered species, ozone protection, the management of regional seas, climate change, acid rain, etc. Many of these MEAs establish formal secretariats with a relatively specific mandate, focused on a single environmental problem, though they are increasingly required to consider the linkages between their activities and other policy fields, especially the economy. For example the OECD recently completed a review of trade measures in three multilateral environmental agreements — the Convention on International Trade in Endangered Species (CITES); the Basel Convention; and the Montreal Protocol on Ozone (OECD, 1999*b*). In the future, it is likely that this integration will deepen even further, shifting the focus to include all dimensions of sustainable development.

The broader, more integrated context for policy-making provided by sustainable development is today creating something of a dilemma for international environmental and economic institutions alike. Environmental institutions are finding that scarce resources must be applied to the broader goal of "sustainable development", while economic institutions are experiencing the same problem with respect to "the environment".

In the case of the environmental institutions, in particular MEAs, five essential elements can be identified (Waller-Hunter J., 1999):

- Solid grounding in science as the basis for their authority. Without this underpinning, the legitimacy of the institution will ultimately be eroded.

- Use of quantitative environmental norms and standards. MEAs that are confined to dealing with procedural issues are often questioned about their actual contribution to improving environmental performance.

- Financial incentives and mechanisms for developing countries to participate actively in MEAs. This will require consideration of competitiveness along with environmental issues in the formulation of new MEAs.

- Involvement of the private sector and civil society to contribute to the goals of new MEAs.

- Use of compliance and monitoring systems and dispute settlement mechanisms.

Assessed against these functions, the current system of international environmental institutions can be characterised as somewhat incoherent and incomplete (OECD 2001*a*). The scientific element is in some cases inadequate (e.g. the Convention on Biodiversity lacks strong scientific support of the type offered to the Framework Convention on Climate Change by the Intergovernmental Panel on Climate Change). Also, the Global Environment Facility has been created as a financial mechanism to facilitate the implementation of global conventions, but deals only with a limited number of issues.

MEAs lack effective compliance and dispute settlement mechanisms. Substantive synergies and gains in the efficiency of implementation are not brought to bear due to unconnected decision-making processes. These weaknesses have led to calls for a more coherent system of environmental institutions, involving the major MEAs and organisations like UNEP, the CSD and other parts of the UN system dealing with environmental issues (UNESCO, WMO, WHO, etc.). This could take the form of a World Environmental Organisation. To be effective, the creation of such an organisation would need to overcome technical difficulties concerning co-operation, co-ordination financing and legality.

MEA-based institutions will also have to learn to accommodate efficiency and cost-effectiveness concerns in their activities. The Kyoto Protocol is a good example of this, inasmuch as it contains three "flexibility mechanisms" aimed at increasing the economic efficiency of greenhouse gas emission abatement. The UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol reflect major steps forward in the *integration* of the different components of sustainable development. Through their "hard" targets they act as a driver in "forcing" sustainable development initiatives to be operational.

Measures to address climate change affect virtually all areas of economic activity. Climate change has had a considerable impact in encouraging recognition of sustainable development concerns among a wide range of business and industry actors, including those from the financial sector. The reinsurance industry has played a pioneering role in this area, encouraged by UNEP and non-governmental organisations.[8]

The United Nations Environment Programme (UNEP), established after the Stockholm Conference in 1972, is the primary environmental pillar of the UN system. The Nairobi Declaration, adopted in 1997, provides the current foundation for focusing UNEP's work on five priority areas: environmental monitoring, assessment, information and research, including early warning; enhanced co-ordination of environmental conventions and development of environment policy instruments; freshwater; technology transfer and industry; and support to Africa. UNEP's mission statement confirms the aim of integrating sustainable development in all aspects of its activities[9] (Table 4.1).

International economic institutions have traditionally perceived environmental and social concerns either as a "brake" on economic growth, or as being primarily the responsibility of others. Yet these perceptions are changing. The sophistication of the way in which environmental considerations, in particular, are taken into account by international *economic* institutions seems set to deepen in the future, especially if political momentum within OECD countries to further liberalise global trade and investment is to be maintained.

These institutions have begun to recognise that strong environmental policies promote, rather than hinder, economic opportunity. There has already been some progress in this direction, as witnessed by the WTO's Trade and Environment Committee, established in 1994. The OECD has had a similar Group since 1991. The preamble to the World Trade Organization (WTO) Agreement links economic development with the goal of sustainable development.[10] The aims expressed in the Preamble place the WTO at the centre of the challenges of globalisation (Brack D., 1997). However, as the collapse of the Seattle Ministerial Conference in late 1999 showed, there are fundamentally different views concerning the WTO's approach to trade and sustainable development.

Critics have long argued for greater transparency and participation in relation to both developing country members and civil society actors (Oxfam, 2000). The WTO has sought to enhance the transparency of its activities through making documents available, making its website into a forum for informal consultative processes between the Secretariat and NGOs, and inviting NGOs to attend Ministerial Conferences[11] (see Table 4.1). Dialogue is also maintained through symposia involving NGOs and Member governments. Transparency has also been the subject of continuing discussions in the General Council. As shown by the demonstrations in Seattle, the WTO is seen by its critics as lacking legitimacy. This is in part due to the fact that access by civil society actors is restricted in comparison with, for example, the UN Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), where NGOs participate as observers in many meetings and working groups.

The *World Bank* has, for some time, been active in trying to reconcile the simultaneous need for economic growth and environmental protection (and, more recently, social development.). In 1999, it launched the new Comprehensive Development Framework (CDF), a holistic approach to the development process. The CDF recognises the *linkages* between all elements of the development process (i.e. economic, structural and social policies)[12] as well as the need to involve all development partners. Consultation with civil society, including the private sector, local authorities and bilateral donors plays an important role.

At the World Bank, activities in the areas of environmental, social, and rural development are increasingly brought together to achieve an integrated approach to sustainable development. The Bank's environmental assessment procedures cover its "safeguard policies", which deal with environmental, human health and socio-cultural issues (including habitat protection, involuntary resettlement and indigenous peoples). Another key aspect of the Bank's policy is the application of "environmental conditionality" in its lending policies. In May 2000, the Bank issued a draft version of its new environment strategy for consultation. The central challenge of this strategy will be to balance, in operational terms, environmental and developmental concerns that contributes in a measurable way to poverty reduction.

Social institutions have also raised awareness of sustainable development. As early as 1990, the Director-General of the International Labour Organisation (ILO), in his report to the 1990 International Labour Conference, made a clear link between environmental, economic and social issues, stating that "the main difficulties in dealing with the environment are not technical, but political, economic and social." Since then the ILO has developed a project on "Workers' Education and the Environment" (published in 1993), which aimed to raise the environmental awareness of trade unionists. This initiative was followed by a series of booklets on "Trade Unions and Environmentally Sustainable Development" (1996) that included "indicators" of sustainable development to help trade unions define their own action.

The World Health Organization (WHO) provides some good indications of how international organisations need to approach sustainable development. It has continued to play an active role in the field since its participation in the Rio Conference, through the Department of Health in Sustainable Development (HSD) (see Table 4.1), which encompasses all components of sustainable development. It also has both an Executive Director of Sustainable Development and Healthy Environments and a Director of Health in Sustainable Development. In addition, there is a designated focal point for Agenda 21, with responsibility for promoting sustainable development issues across the Organization. Various processes are being put in place in the new structure of WHO to provide advisory support in different areas of sustainable development and health (in some areas, external advisory committees already exist). Examples of integrated approaches range from the major Roll Back Malaria and Tobacco Free initiatives launched by the Director-General, to numerous task forces and committees that involve different departments and other UN or development agencies.

Indicators for reporting on progress play a key role in WHO activities (WHO 2000). Each department maintains a range of contacts with civil society stakeholders, which also have official relationships with WHO.[13] Further arrangements could be envisaged to ensure adequate integration of input from different governments into the work of the Organization on matters such as air quality, water quality, soil quality and contamination.

Regional institutions

The European Commission presents some interesting lessons about how regional institutions have approached sustainable development (see Table 4.1). For example, the Amsterdam Treaty reinforced the role of sustainable development as a guiding aim for the EU, while the Cardiff European Council in 1998 launched a process of integration, inviting sectoral Councils (initially, Transport, Energy and Agriculture) to develop specific integration strategies. The integration process — in which development of indicators plays an important role — encompasses the external dimension of EU policy, including relationships with developing countries (European Commission 1999). This effort is extremely challenging, as it requires the EU to consider activities in virtually all policy areas. Clearly, successful implementation of such initiatives requires political commitment at a high level.

In addition to integration strategies, a new EU sustainable development strategy is being prepared for the ten-year review of the Rio Conference in 2002 (Rio + 10). The "Group of Commissioners on Growth, Competitiveness, Employment and Sustainable Development" has asked the Commission's Forward Studies Unit to co-ordinate the work of a Cabinet and Commission Services group with the task of identifying sustainable development objectives. The results will provide the basis for development of the strategy, to be presented in June 2001. The completed sectoral integration strategies (also to be produced for the Summit by June 2001) and the sustainable development strategy are intended to dovetail.

NAFTA contains an environmental sub-agreement. The debate on the Multilateral Agreement on Investment (MAI) reinforced the point that sustainability questions also have an important *investment* dimension — *trade* is not the only concern. The OECD Guidelines for Multinational Enterprises (see below) contained a chapter on environmental protection since 1991 — a core element of the June 2000 review.

Debate about the *effectiveness* of international institutions has tended to focus on institutional proposals and on internal matters, such as staffing and budgets. Less attention has been paid to the effects of national government approaches. "Integration begins at home" is a critical lesson, though one that has yet to be fully internalised by the international community. Part of strengthening the international decision-making architecture therefore needs to address the way national governments approach their engagement in international policy-making processes, in addition to addressing national-level co-ordination in implementation. An assessment of national approaches might include the following elements:

- A prioritisation exercise to identify major issues and the appropriate fora to deal with them, with the key goal of minimising overlap and duplication.

- Advance consideration of the outcomes likely to emerge from negotiation meetings and how agreements will contribute to sustainable development.

- Ways to avoid routine exhortations to support outcomes already agreed to, and general calls to adhere to existing agreements.

- Improved co-ordination among agencies at the national level to address linkages.

- Re-assessment at a high political level, making it possible to look beyond narrow sectoral interests.

The growing complexity of the sustainable development problem will also make it increasingly difficult for traditional single-issue institutions (whether economic, social or environmental) to deliver credible results. This seems likely to result in the expanded use of an institutional approach that has been used by the NGO community for some time with considerable success – the idea of "networking". Networking is a "bottom up" approach to institution-building, based on the premise that individuals and groups — not formal institutions — drive innovation. Its use has been greatly facilitated by the global information age. Moreover, networking can help policy-makers deal with three key aspects of complex problems: *(i)* managing knowledge flows; *(ii)* focusing on particular market and intergovernmental failures; and *(iii)* broadening participation in decisions. Recent examples of "networking in action" include the World Commission on Dams[14], and the Global Reporting Initiative co-ordinated by UNEP and CERES, which has developed a comprehensive framework within which companies can report on their economic, social and environmental performance. It is likely that the composition of these networks will expand and change — from the current situation in which networks tend to be dominated by businesses, NGOs, and governments in the OECD countries, to greater involvement of groups in developing countries.

However, the prevailing perception in developing countries — that the institutional framework for sustainable development has been inadequate — cannot be ignored. There is a persistent disappointment among many developing countries concerning the implementation of the "Rio partnership", reflecting the feeling that developed countries have failed to make the critical linkages between their policy commitments in the Rio accords (and subsequent agreements), and separate policies developed to address issues such as trade, aid and finance. Bringing these together at the international level is thus a priority.

The OECD's processes of dialogue with a wide range of developing countries, and in particular the work undertaken with economies in transition, could provide a solid foundation for such efforts. However, a more active process of sharing knowledge, experience and policy solutions between OECD countries (and the OECD itself), and developing and transition countries, may now be needed to help accelerate a global transition to sustainable development.

The OECD

The economic weight of OECD countries, including lifestyles and consumption patterns, makes their global impact on sustainable development extremely significant. The OECD's role in relation to globalisation and issues such as foreign investment and market liberalisation is particularly important. The OECD's founding Convention of 1961 calls upon the Organisation to develop policies for "sustainable economic growth and employment" and "sound economic expansion". Partly in response to a report to the Secretary-General in 1997 from a High-Level Advisory Group on the Environment, the Meeting of the OECD Council at Ministerial level in April 1998 confirmed that "Ministers agreed to interpret the term sustainable as including social and environmental, as well as economic, concerns."[15] This marked the start of sustainable development becoming a strategic priority for the Organisation, and of a major three-year project leading up to the 2001 Ministerial Meeting.

The priority attributed to sustainable development has also led to the establishment of the OECD Round Table on Sustainable Development, whose aim is to enhance international co-operation on sustainable development work by providing intellectual stimulus to the work of the OECD, and fostering informal high-level dialogue between environmental and economic communities. Its membership comprises high level officials from environment and economic ministries, representatives of the World Bank, the WTO, the EU, agencies of the UN system and members from the business community and non-governmental organisations.

Two main stakeholder groups — business and trade unions — have traditionally had a special consultative status at the OECD, through the Business and Industry Advisory Committee (BIAC) and the Trade Union Advisory Committee (TUAC). Recently, both Advisory Committees have been granted routine access to non-confidential documents (the majority) of all the inter-governmental Committees that manage the bulk of the OECD's policy. Non-governmental organisations, especially but not only environmental ones, have until recent years had much less access to both documents and meetings of the OECD — with the exception of expert workshops — which has been a source of considerable criticism. The OECD has become increasingly aware of the need to address this issue and has taken a number of steps in the direction of greater openness, including holding an "OECD Forum" in 2000 and 2001, at which sustainable development was one of the principal topics, and at which stakeholders, ministers, and international experts were equally represented.

An important example of substantive contribution to sustainable development is the revised set of Guidelines for Multinational Enterprises, developed under the auspices of the Committee on International Investment and Multinational Enterprises (CIME), and adopted by OECD governments in June 2000. The new Guidelines aim to create a framework which encourages international investment and addresses some of the potential negative impacts of the globalisation process. The comprehensive approach of the updated Guidelines includes recommendations on combating corruption and safeguarding consumer rights, disclosure and transparency, core labour and environmental standards and human rights.

The Guidelines were updated in dialogue with business, labour and non-governmental organisations, and one of their interesting features is how the process of preparation, in particular the consultation with stakeholders, succeeded in addressing concerns related to globalisation, a potentially difficult and contentious policy area. In light of the civil society campaign against the Multilateral Agreement on Investment (MAI) a few years ago — highly critical of the OECD's approach to involvement of developing countries and stakeholders — this indicates a change of approach at the OECD. Recommendations made by the High-Level Advisory Group on the Environment in 1997 that the OECD "should, as a matter of urgency, develop into the key intergovernmental organisation providing the industrialised nations with the analytic and comparative framework necessary for their economies to make the transition to sustainable development" remain valid. The Group also urged that "sustainable development not be seen as one among many important items on the OECD agenda… it should become a way of ordering and approaching all other issues". As confirmed in the June 2000 Ministerial Level Meeting, "Achieving sustainable development remains a major overarching goal of OECD governments."[16]

The decision of Member countries in 1998 to make sustainable development a strategic priority for the Organisation has already been fruitful. But a tension persists between, on the one side, treating sustainable development as one of a number of strategic issues for the Organisation and, on the other, viewing it as a more coherent way to approach the inter-relationship between all economic, social and environmental issues. Given this realisation, it could be useful to articulate these goals more firmly in the objectives of the Organisation, for instance by amending its founding Convention or by formally clarifying its interpretation. Such a change would provide a powerful signal to Member countries of the long-term importance of the issue.

Conclusions

A strong political commitment is crucial to achieve the policy integration needed to underpin sustainable development. This must come from the highest levels of government, and be embraced by prime ministers, as well as ministers of the economic/finance, social welfare, and the environment. OECD countries agreed to the "Programme for the Further Implementation of Agenda 21" adopted by UN General Assembly in its special session in June 1997, which implies completion of national strategies for sustainable development by 2002. The next step is for the active implementation of the strategies.

Successful sustainable development strategies will combine the integration of economic, social and environmental objectives, at all levels of policy development and decision-making; wide participation; effective, credible and independent mechanisms for reporting and accountability; and flexibility to adapt to changing circumstances. Collective responsibility within government for implementation of decisions which support a sustainable development strategy needs to be clearly established, and include explicit procedures and an assessment of training needs. Coherence across government departments and among different levels of government is vital. Current decisions and future policies should be founded upon sound science and based on empirical evidence.

The increased transparency brought about by greater NGO involvement increases the likelihood that decision-making will promote sustainable development. An inclusive approach is essential to confronting conflicting interests and points of view, and to providing an institutional framework for addressing trade-offs. It also contributes to enhancing the legitimacy of government actions. Access to information should be provided by governments to both public and private sector entities. In addition, well-managed consultation and participation processes should lead to concrete outcomes.

The role of national government approaches to international fora has received less attention than it deserves. Nation-states are the decision-makers in international institutions, which means that co-ordination and coherence ultimately rests with them. They also have an explicit obligation to implement at the national level what they have agreed to internationally. In view of the limited analysis of this issue, a strategic reassessment of national engagements in international policy-making processes is timely.

An immediate priority for OECD countries is to build confidence in their relations with developing countries in relation to sustainable development. This could include addressing aspects of the implementation of existing commitments, helping to strengthen the capacity of developing countries, as well as fostering a more active process of sharing information, experience, and policy solutions.

Sustainable development presents enormous challenges for both domestic and international institutional frameworks. In particular, sustainable development challenges governments, organisations and other actors to consider development from a multidimensional perspective. Progress on integrating economic with environmental goals, or economic with social goals, often seems more manageable than bringing all three together at once. Yet if knowledge, experience and technology are shared, within and between countries, the practical problems may be easier to overcome. Among international organisations, the OECD, with its economic expertise and diverse skills across the entire policy arena, is uniquely placed to contribute to this process.

NOTES

1. See OECD Survey on Government-Citizens Connections www.oecd.org/puma/citizens/index.htm.

2. Principle 3 of the 1992 Rio Declaration on Environment and Development states that "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations".

3. The results presented by Werner Schulz, University of Witten/Herdecke, at " North Germany Sustainable Economics" (Nachaltiges Wirtschaften im Norden), Bremen, 30 June 2000

4. See Dutch Ministry of Foreign Affairs internet site www.minbuza.nl

5. In the Millennium Report, the UN Secretary-General highlights the impact of globalisation. The report notes "…a new connectivity among economic actors and activities…", and recognises the benefits of globalisation as "…faster economic growth, higher living standards, accelerated innovation and diffusion of technology and management skills, new economic opportunities for individuals and countries alike". However, the report notes that the benefits are shared unevenly: ".. in recent decades an imbalance has emerged between successful efforts to craft strong and well-enforced rules facilitating the expansion of global markets, while support for equally valid social objectives, be they labour standards, the environment, human rights or poverty reduction, has lagged behind". These issues are further discussed Chapter 8

6. See United Nations internet site www.un.org/

7. Its four sections cover: Social and Economic Dimensions (I), Conservation and Management of Resources for Development (II), Strengthening the Role of Major Groups (III) and Means of Implementation (IV). Agenda 21 can be accessed through www.un.org/es

8. See Swiss Re internet site www.swissre.com/e/issues

9. "To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations", UNEP Corporate Profile, p 2.

10. "… relations in the field of trade and economic endeavour should be conducted with a view to raising standards of living, ensuring full employment and a large and steadily growing volume of real income and effective demand, and expanding the production of and trade in goods and services, while allowing for the optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment and to enhance the means for doing so in a manner consistent with their respective needs and concerns at different levels of economic development". This and other documents can be accessed at the official WTO Internet site.

11. See also Decision adopted by the General Council on 18 July 1996

12. Development of social principles, in response to the Development Committee in 1998, is also evolving. See for example World Bank, 1999*b*

13. See WHO internet site www.who.int/ina-ngo/ngo/princ-e.htm.

14. The World Commission on Dams was established in 1998 to assess which, how, where and why the earth's 45,000 large dams have worked or failed to deliver. Chaired by Kader Asmal, South Africa's Minister of Water Affairs

and Forestry under Nelson Mandela, and now education minister, the Commission consists of 12 people - civil engineers and NGOs, chief executives, academics and government officials - who represent all sectors of development. As a group, the Commission has listened carefully to both sides the water and energy resource debate in cities like Colombo, Sri Lanka; Sao Paulo, Brazil; Cairo, Egypt and Hanoi, Vietnam. It analysed seven dams in the context of their basins under a microscope; studied national experience with dams in China and India; evaluated trends through 17 themes and a cross- check survey of 150 dams world-wide; and absorbed 900 submissions from afield

15. Communiqué of the OECD Council Meeting at Ministerial Level, Paris, 27-28 April 1998 [SGE/COM/NEWS(98)51

16. OECD News Release, Shaping Globalisation, Paris, 27th June 2000, para 5.

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Chapter 5.

POLICY INSTRUMENTS

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POLICY INSTRUMENTS

Introduction

In the late 1960s and early 1970s, environmental policies in OECD countries were conceived and implemented as a separate, self-standing policy area, largely independent from policies in other sectors and areas (such as taxation or international trade). In fact, environmental policies were often considered as an "add-on", disturbing rather than reinforcing other types of interventions. Furthermore, environmental protection was often perceived as incompatible with economic growth and social goals.

This changed during the 1980s, when the concept of *policy integration* emerged. This concept was progressively extended from the sectoral level (e.g. integrating environmental policies with energy, transport agriculture policies, etc.) to integration across policy areas such as taxation, international trade and investment. In 1991, OECD Environment Ministers stressed that the integration of economic and environmental decision-making was one of the main challenges facing OECD governments, and adopted several principles to guide them in their quest for this integration. These principles recognised the link between economic growth and the environment. Further, Ministers stressed that economic and environmental policies cannot be made and implemented in isolation, and that environmental considerations should be brought to bear systematically on economic policy-making (OECD, 1999*f*). A further step was achieved with the emergence of the concept of *sustainable development*, which stresses that economic, environmental, and social policies should be mutually reinforcing.

Defining the numerous framework conditions for sustainable development is challenging. Some are treated separately in other chapters, like adapted and performing institutions (see Chapter 4), the role of globalisation (see Chapter 8) and the promotion and diffusion of technical innovation (see Chapter 6). This chapter reviews, in *policy-oriented* terms, a selection of key framework conditions and the practical policy instruments needed to implement them. It will focus on two main points:

- Improving the policy framework through a more effective, transparent and efficient regulatory framework (using an effective economic appraisal of regulatory impacts and externalities; and a coherent set of market-oriented policy instruments.)

- Correcting market and intervention failures by removing distortionary subsidies, introducing green tax reforms, and creating markets for pollution control and resources management.

Improving the policy framework

The need for a more effective and efficient regulatory framework

Governments have long used regulations to better align public and private interests. Regulations have helped governments to make impressive gains in reaching important public goals such as macro-economic stability, higher employment, improved education and training, equality of opportunity, and high standards of environmental quality, health and safety.

Historically, regulations have been introduced over a long time period and in an uncoordinated manner in an effort to cope with emerging issues on a case-by-case basis. Many of these regulations are now obsolete, while new problems like global warming demand the rapid deployment of new measures in a complex economic and social context. Regulations will continue to be important tools for preserving and advancing public interests. However, regulations often suffer from a number of drawbacks, such as excessive rigidity, high costs (especially administrative and compliance costs) and weak enforcement. There is a real risk, then, particularly at times of rapid change in economic and social conditions, that regulations become an obstacle to achieving the very objectives for which they are intended — and that their costs exceed their benefits.[1]

Regulatory reform

Over the last decade or more, most of OECD countries have engaged in processes of regulatory reform. Regulatory reform relates to most, if not all, areas of public intervention: economic (market entry, competition, pricing); social (health, safety, environment); and administrative (red tape). Reforms have aimed at both reducing the extent of regulations ("deregulation") *and* improving their quality. In general, deregulation strategies have been applied to liberalise product markets, while improvements of regulatory quality have affected social, environmental and administrative regulations (OECD, 1997*c*). Regulatory reform aim developing and applying the most efficient and effective means to achieve policy goals.

Successful regulatory reform enhances the capacity of governments to promote sustainable development. A fundamental objective of regulatory reform is to improve the efficiency of economies and their ability to adapt to change and to remain competitive. Another objective is to improve government credibility and effectiveness through the use of more effective and less costly regulations, or through alternative policy tools.

Harnessing market forces while integrating policy goals

One major goal of regulatory reform is to stimulate market forces by phasing out those regulations that restrict national and international competition, such as barriers to entry and exit, pricing controls, and restrictions on normal commercial practices. Inappropriate or excessive regulations can exacerbate market failures and result in substantial inefficiencies due to high compliance costs, regulatory capture and lack of innovation and competition (OECD, 1997*c* and 1997*b*). OECD simulations suggest that gains from market liberalisation in five sectors (retail distribution, telecommunications, electricity, air transport and road haulage) could raise GDP between 3% and 5.7% according to country[2] (OECD, 1997*c*). Three of these sectors (electricity, air transport and road haulage) are environmentally sensitive. For instance, increased electricity production, driven by price declines, could range from 3% to 7%. Similarly, substantial reductions in airline prices could boost air traffic by 14% in Germany and France, and by 20% in Japan (OECD, 1997f). However, the higher level of economic activity associated with lower prices could also lead to higher environmental pressures if environmental externalities are not factored in, or *internalised*.

If sustainable development is to succeed, its concerns must be fully integrated in regulatory reforms aimed at fostering competition and market openness. In other words, policies designed to promote market liberalisation should take into account potential social and environmental impact; and, conversely, environmental and social regulations should be cost-effective. Crafting the regulatory reform crucial to sustainable development involves four principal tasks:

- *Identifying the linkages* between various policy objectives. Failure to identify conflicts or synergies between market liberalisation, on one side, and environment, health and social protection, on the other, could undermine regulatory reform and damage other policies.

- *Managing the transition* to liberal markets. Not only must the reform provide for the effective development of a competitive market, but also find the most efficient way of integrating other objectives, such as environmental quality, safety, social goals and consumer protection. For example, in open markets, consumers will need more information about the environmental properties of different products.

- *Harnessing the full range of market forces*, by fostering competition in specific sectors, while correcting policy failures. This should include the removal of perverse subsidies that cause environmental degradation and the use of economic instruments such as environmental taxes and tradable permits where appropriate.

- *Reviewing and streamlining existing "command and control" instruments* that still dominate environmental policies (e.g. prohibitions, emission limits, technical standards). As policies evolved and new issues emerged, these regulations increased considerably in number and complexity. In turn, with the proliferation of environmental (and other) regulations, their implementation and enforcement became more difficult and costly.

Increasing economic rationale in regulations

Regulations are often introduced in response to political pressure to tackle urgent issues. Unfortunately, these regulations too often come without adequate understanding of their cost, benefits and long-term economic impact. In fact, regulatory bodies sometimes lack the analytical skills, resources, and data to take up a longer-term perspective. To remedy these weaknesses, many countries have introduced *regulatory impact analysis* (RIA), which includes both regulatory appraisal and regulatory evaluation. Regulatory appraisal is used to describe the *ex ante* assessment of proposed regulations, whereas regulatory evaluation refers to the *ex post* assessment of existing regulations. Evaluations may be undertaken either for the environmental regulatory system as a whole, or for individual regulatory instruments.[3] Their aim is to (OECD, 1997*c*):

- Evaluate the direct and indirect costs and benefits, and the long-term impact of regulations.

- Evaluate the cost and effectiveness of regulations.

- Increase the transparency of the regulatory process, with cost and benefits clearly defined, assessed and communicated to the public and stakeholders.

- Better inform choices to be made between competing or conflicting policy options.

- Enable an integration of multiple objectives, and a clear assessment of policy linkages.

- Improve the quality of regulations through a feedback mechanism whereby *ex post* assessments allow for the adjustment of current regulations.

Several, often complementary methods are used for RIAs: multi-criteria analysis; subjective scoring methods; risk-benefit analysis; impact evaluation; cost-effectiveness analysis; and cost-benefit analysis. A distributive criterion can be added, focussing on the effects of reform for one group within a country — for example, regulatory compliance costs for the business sector, fiscal implications for the government sector, or trade and competitiveness implications. A broad-based approach to RIA, applying complementary analytical tools is to be encouraged.

While several analytical tools can be used, cost-benefit analysis — the comparison of cost and benefits (to the extent possible in monetary terms) — is the tool of choice in an economic framework. Cost-benefit analysis relies on being able to assign values to the factors being analysed (though governments face the problem of valuing externalities whether or not they use benefit-cost analysis).

Valuing externalities in practice

The valuation of externalities and non-priced resources is a key requirement for sustainable development: *(i)* it is a prerequisite for a consistent correction of market and government failures; *(ii)* it provides a sound basis for the design of cost-effective policies[4]; *(iii)* it enables an effective integration of economic and

environmental policies; *(iv)* it provides a consistent framework to assess the costs and benefits of alternative actions; and *(v)* it improves the transparency of government options and decisions for stakeholders.

In general, the capital and operating cost of a given action (e.g. pollution abatement) can be easily assessed. However, as externalities are not priced in markets, most environmental benefits will remain without market value. For instance, benefits of air pollution abatement (reduced morbidity and mortality, reduced damage to crops and materials, improved visibility, etc.) will remain economically "intangible" if not translated into monetary terms. Economists have identified a series of values associated with environmental assets and uses, ranging from "direct use" values (the direct use of environmental resources such as clean water) to "existence values" (the value attached to the mere existence of a resource such as natural species or habitats). These values constitute the "total value" of environmental goods and services (see Chapter 2).

In cost-benefit analysis (CBA), both sides of the equation have to be expressed in the same unit, i.e. in monetary terms. In the absence of markets, this requires attributing a money value to the various components of the total value. Techniques for monetary valuation of environmental benefits and damages have made considerable progress over the last decade and are now more widely and consistently used by governments (Table 5.1).

Table 5.1. **Scope and applicability of main valuation techniques**

	Main areas of application	Conditions of application
Hedonic prices	Local air and water quality changes. Noise nuisance (mainly road traffic and aircraft). Choice of location of environmentally hazardous facilities (sewerage, power stations, new roads, etc.). Evaluating impacts of neighbourhood improvement programmes. Amenities (forest, open land etc.).	Active and competitive property markets. Environmental quality perceived by populations as relevant factor in property values. Local variations of environmental quality, are clearly perceptible.
Travel cost	Recreational sites, e.g. nature reserves, national parks, forests and wetlands for recreation, water-based sites. Fuel-wood supply. Collection of drinking water.	The site is accessible. People expend significant time or other costs to travel to the site.
Contingent valuation	Can be applied to virtually any case, but in particular to air and water quality; recreation (including natural resorts), conservation of un-priced natural assets such as forests and wilderness; option and existence values for biodiversity; and risks to life and health.	Representative sample of population. Sufficient information is available to the population sample.
Avertive behaviour	Noise nuisance, safety (risk).	Market in abatement/avoidance equipment must exist.

Several difficulties and obstacles still hamper the practice of evaluation (Barde and Pearce, 1991; Pearce and Barbier, 2000). First, there are *technical and informational obstacles to evaluation.* The different evaluation techniques are not applicable to every type of issue. Nor are they without limitations and difficulties due to complexity, cost, and the need for large volumes of data. To complicate matters, the degree to which individuals genuinely know their own preferences, and understand, in a quantifiable manner, the risk reduction delivered by environmental programmes is unclear. Finally, while the practice of benefits estimation evolves regularly, those preparing and making decisions are unlikely to be at the cutting edge of this evolution. *Better* use of benefit estimation techniques can come from (Barde and Pearce, 1991):

- The development of *practical guidelines* and manuals for CBA.[5]

- The creation of *databases* as a support to evaluation techniques, e.g. data on dose-response relationships (exposure to pollution and related effects), information on other physical data and compendia of existing estimates of damages and benefits.

- *Training* to educate both those who have to interpret benefit appraisals (decision-makers and their teams) and those with the responsibility to carry out benefit studies. Practitioners should also be trained to adapt their methodologies to the specific environmental issues at stake, to the needs of their clients and last, but not least, to present their results in an accessible form.

Ethical and philosophical obstacles also complicate evaluation. The welfare foundations of cost-benefit analysis are criticised in certain circles. In particular, "monetary reductionism", illustrated by the "willingness-to-pay" criterion, is strongly rejected on the ground that natural resources (air, water, fauna, flora, etc.), human life and health cannot be measured in monetary terms. As a one-dimensional concept based exclusively on individual preferences, the principle of maximising expected utility is judged inadequate for making decisions involving natural resources and future generations.

Finally, there are *political obstacles*. Policy makers may face opposition due to the philosophical and ethical concerns mentioned above. Moreover, the very objective and virtue of valuation is to make the actual benefits and costs of a given course of action explicit; an informed debate on such issues may not be attractive to decision-makers who want to retain a certain level of flexibility. Further, the scope of cost-benefit analysis is often too narrow: wider economic and social implications such as employment, distributive and competitiveness implications are not always accounted for and should be included. Also, doubts about the reliability of CBA often remain, both in official circles and in the general public. Transparency (i.e. clear exposition of methodology, sensitivity analysis, public communication, etc.) is therefore of utmost importance. When cost-benefit analysis is not feasible or likely to produce reliable results, cost-effectiveness analysis can be a useful tool.

Integrating the social dimension

Neither the impact of environmental degradation (e.g. air pollution) nor access to environmental services (e.g. city parks) are uniform across different social groups and households. Several recent studies in OECD countries have examined the relationship between the spatial distribution of toxic releases from industrial plants and the socio-economic and demographic characteristics of surrounding neighbourhoods (Johnstone, 2001). Research has also focused on the siting of hazardous waste facilities. In general, these studies find that the lowest income groups have the highest exposure to environmental hazards. Similarly, poorer households often have the lowest access to environment-related public services, such as public parks and water supply.

These results are hardly surprising. Firms that generate local pollution have an incentive to locate in poorer neighbourhoods, where the financial costs of environmental damages are lowest. Poorer families often end up in more polluted areas because environmental quality also affects the housing market; residential housing close to city parks, and far from polluting plants tends to be more expensive than housing in alternative locations (Johnstone, 2001).

The distribution of the cost of environmental policies across households is also important, albeit little explored. Such distribution generally reflects two main factors. First, because of higher demand at higher income levels, richer people are often willing to pay more for environmental quality than poorer groups.[6] However, if the cost of environmental protection is passed onto prices (in particular if prices of necessities like food or energy increase due to environmental measures) poorer households would be more affected than richer ones.

This issue is particularly sensitive in the case of environmental taxes (see below). The distributive effects of environmental taxes, especially those related to energy, may occur through three channels (Smith, 1998). First is the direct distributive impact related to the structure of household expenditure (e.g. heating and

transport) for different income groups; the larger the proportion of expenditure by low-income household devoted to energy, the more regressive the impact of the tax[7]. Next, indirect effects will originate from the taxation of production inputs; the more energy intensive the processes, the higher the taxes on the goods produced. Finally, structural factors may affect the point of *final* incidence of the tax.[8] For example, an energy tax may affect final consumers, energy producers or production factors (e.g. through a fall in wages or lower return on capital); also, part of the tax may be borne by energy consuming countries, and another part by energy exporting countries, according to the elasticities of supply and demand.

Environmental taxes applied to mass consumption products, such as motor vehicles and energy, may have a higher effect on lower-income households. The level of the tax also matters. Relatively low environmental taxes on products such as detergents, fertilisers, batteries and pesticides are likely to have a limited distributive impact, while large-scale environmental taxes, such as those on energy, can have more profound implications. Measures must be deployed to minimise the unintended regressive effects of environmental instruments, while maintaining their environmental effectiveness.

The need for a coherent set of policy instruments

Preserving a healthy environment is a multidimensional task. Environmental protection covers a wide range of issues related to pollution control and natural resource management. These issues occur at local, regional, national and global levels, cutting across both urban and rural environments. Since most environmental problems have their immediate cause in the economic activities of specific sectors, namely energy, transport, agriculture, and industry addressing them requires the effective integration of sectoral and environmental policies (see Chapters 12, 13, 14 and 15). Pollution control alone involves a complex set of factors: different pollution sources (fixed, mobile, diffuse) and different angles of attack (e.g. emission sources, production inputs, products, extended producer responsibility, entry controls and fees for infrastructures). Embracing all these dimension in an effective, economically efficient and equitable way requires a coherent set of policy instruments.

Policy mixes

To cope with this complexity, an increasing variety of instruments have been implemented in the context of "policy mixes". These instruments can be classified under six main categories (Table 5.2).

Table 5.2. The array of environmental policy instruments

Category	Examples
Command and control	Licenses/permits; Ambient quality standards; Emissions standards; Process standards; Product standards; Prohibition bans.
Economic instruments	Charges; Taxes; Tradable emission permits; Tradable quotas; Environmental subsidies; Deposit-refund systems; Performance bonds; Non-compliance fees; Resource pricing.
Liability, damage compensation	Strict liability rules; Compensation funds; Compulsory pollution insurance; Extended producers responsibility.
Education and information	Education campaign for the general public; Diffusion of technical information; Publicity of sanctions for non-compliance; Eco-labelling.
Voluntary approaches	Unilateral commitments; Public voluntary programmes; Negotiated agreements.
Management and planning	Environmental management systems; Zoning; Land use.

Such a diverse list allows governments to tailor each instrument or combination of instruments to the specific environmental problem at hand, thereby avoiding policies that are too costly or difficult to enforce. Controlling emissions of motor vehicles, for example, requires complementary measures such as technical standards specifying vehicle equipment and emission characteristics (e.g. catalytic converter); standards specifying fuel quality (e.g. lead-free gasoline); economic incentives to influence behaviour (taxes on fuels and vehicle usage, pricing of infrastructure); land use planning; education and information. In some instances, one single, or a limited set of policy instrument(s) might do the job (e.g. a ban on toxic substances). Devising the right policy mix is a matter of careful analysis, design, fine-tuning and adaptation, as well as coherence between different ministries (such as finance, agriculture and environment) and levels of government. Regulations continue to play a prominent role in policy mixes for environmental protection, but are increasingly applied in combination with two types of policy instruments: voluntary approaches and economic instruments.

Enhancing private sector involvement: voluntary approaches

Command and control regulations can show excessive rigidity and result in adversarial relations between the private and public sectors. As a result, many OECD countries have moved towards deploying more co-operative approaches with the private sector, in particular through *voluntary approaches* (VAs). Several reasons explain this evolution. VAs can increase flexibility both for business and government (which use VAs when regulatory structures are not adapted to specific issues, or as a tool to promote non-regulatory initiatives). They can also promote dialogue between stakeholders, including environmental NGOs and trade unions, who can use them as an opportunity to play a more active role in environmental policy. The business community sees VAs as a means to prevent new laws, regulations or environmental taxes. Finally, VAs are also believed to reduce administrative cost both for government and the private sector. Recent surveys (1998-1999) cite over 300 negotiated agreements in the European Union, about 30 000 local pollution control agreements in Japan and over 40 voluntary programmes in the United States managed by the federal government (Box 5.1).

Box 5.1. **Main types of voluntary approaches in OECD countries.**

Public voluntary programmes involve commitments devised by the environmental agency in which individual firms are invited to participate. Since participation is left to individual companies, these programmes can be described as "optional regulations". Some examples are the US programme 33/50 and the Eco-Management and Auditing Scheme (EMAS) implemented in the European Union since 1993.

Negotiated agreements are commitments for environmental protection developed through bargaining between a public authority and industry. They are frequently signed at the national level between an industry sector and a public authority, although agreements with individual firms are also possible.

Unilateral commitments are initiated by the private sector without any involvement of a public authority. The Responsible Care programme is an example of a unilateral commitment by the chemical industry in many countries.

Source: OECD (1999), *Voluntary approaches for Environmental Policy - Assessment*, Paris.

Voluntary approaches have proved to be effective in a number of instances. However, a recent assessment indicates that, if not properly designed, implemented and monitored, VAs can be subject to a number of problems (OECD, 1999*f*). These include: *(i) weak control,* either because industry does not provide adequate control mechanisms or because of a lack of sanctions; *(ii) free riding,* when, in the absence of monitoring and sanction provisions, parties have few incentives to comply with the agreement (i.e. "free riders" will bear no pollution abatement cost while possibly reaping the benefits of the agreement); *(iii) high transaction costs,*

as the cost of the agreement (e.g. cost associated with negotiations, the organisation of parties, monitoring, provision of informationm etc.) may be high when the number of stakeholders is large; *(iv) regulatory capture,* when powerful and well-organised industry organisations exert undue influence in the policy and regulatory process; and *(v) unambitious "business-as-usual" scenarios,* when the goals of an agreement imply little additional effort by participating firms (i.e. the environmental measures taken are those which would have occurred anyway). Finally, there is little evidence to support the notion that the flexibility of VAs increases their cost-effectiveness.

Eight key conditions for an effective and balanced implementation of VAs have been identified (OECD, 1999*f*).

- *Clearly-defined targets:* targets should be transparent, quantitative and clearly-defined.

- *Characterisation of a business-as-usual scenario:* before setting targets, estimates of a business-as-usual scenario should be established – e.g. what emission levels or other target variables are likely to be, given natural technical progress within the industry in question.

- *Credible regulatory threats:* at the negotiation stage, a threat of regulation by public authorities provides companies with incentives to go beyond the business-as-usual trend.

- *Credible and reliable monitoring:* these are essential for keeping track of performance improvements at both the company and sector level (in the case of collective VAs). In some cases monitoring by independent organisations may be necessary.

- *Third-party participation* in setting objectives and monitoring performance: firms' environmental performance should be public and transparent so as to provide industry with additional incentives to respect its commitments.

- *Penalties for non-compliance:* sanctions for non-complying firms can be based on either binding commitments or by establishing linkages between VA commitments and regulatory requirements (e.g. the integration of negotiated agreements requirements into operating permits).

- *Information and education:* to maximise their informational effects, support for technical assistance, technical workshops, edition of best practice guides, etc., should be promoted.

- *Provisions reducing the risk for competition distortions:* in the case of collective VAs, notification to anti-trust authorities can help guard against adverse effects on competition.

Economic instruments

Faced with the need to deploy more effective and efficient policies, OECD governments have increased their reliance on economic (or "market-based") instruments. Five main factors lie behind this evolution. First, regulations often turn out to be difficult and costly to enforce and do not always perform satisfactorily. Second, taxes, charges and transferable permits offer the potential for both *static efficiency* (overall costs for pollution abatement are minimised) and *dynamic efficiency* (permanent incentives for abatement and technical innovation are provided). Third, economic instruments provide *increased flexibility*, both for regulators and regulated, through the operation of the price system (polluters are free to choose the best mix of measures and are not trapped in rigid standards or prescriptive measures). Fourth, most economic instruments provide *government revenue* (in particular taxes and charges) that can be earmarked for a variety of purposes, including environmental protection. Fifth, as economic instruments work through the price system, they allow an effective integration between economic and environmental goals (for instance, there will be a close relationship between transport pricing and environmental protection).[9] A distinctive feature of emission taxes and charges is that they ensure full internalisation of environmental costs since payments are made on residual emissions.

Despite significant progress, OECD countries are still faced with serious environmental challenges, as outlined in OECD (2001*a*). The *OECD Environmental Strategy for the First Decade of the Next Century* calls for a forceful and more systematic use of market-based mechanisms to foster environmental sustainability. Box 5.2 defines the economic instruments most commonly used in OECD countries.

Box 5.2. **Economic instruments for environmental protection**

Emission charges and taxes: direct payments based on the quantity and quality of a pollutant.

Product charges and taxes: payments applied to products that create pollution when manufactured, consumed or discarded (e.g. sulphur and carbon content of fuels, fertilisers, pesticides, or batteries).

User charges: payments for the cost of collective services; primarily used for the financing of local authorities as in the collection and treatment of solid waste and sewage water. In the case of natural resource management, user fees are payments for the use of a natural resource (e.g. park, fishing, or hunting facility).

Marketable permits: these consist of environmental quotas, permits, maximum rights allocated to economic agents by a competent authority. Once the initial allocation is made, these permits can be transferred (or traded) between sources, geographical areas or time periods.

Deposit-refund systems: payments made when purchasing a product (e.g. packaging). Payment is fully or partially reimbursed when the product is returned to the dealer or a specialised treatment facility.

Non-compliance fees: payments imposed under civil law on polluters who do not comply with environmental or natural resource management requirements and regulations. They can be proportional to selected variables such as damage due to non-compliance, profits linked to reduced compliance, etc.

Performance bonds: payment of a deposit in the form of a "bond" imposed on polluters or users of natural resources. The bond is refunded when compliance is achieved.

Liability payments: payments made under civil law to compensate for the damage caused by a polluting activity. Such payments can be made to affected parties (e.g. in cases of chronic or accidental pollution) or to the government. They can operate in the context of specific liability rules, compensation programmes, or compensation funds financed by contributions from potential polluters (e.g. funds for oil spills).

Environmental subsidies: all forms of explicit financial assistance to polluters or users of natural resources (e.g. grants, soft loans, tax breaks, accelerated depreciation, etc.) for environmental protection. Environmental subsidies are in contradiction with the polluter-pays principle, except in certain circumstances as defined in OECD Recommendations (OECD 1972, 1974).

Source: OECD (1998), "Economic Instruments for Pollution Control and Natural Resources Management", in "OECD Countries: A Survey", Document No. ENV/EPOC/GEEI(98)35/REV1/FINAL, Paris.

Choosing a policy instrument

Choosing a policy instrument is complex, particularly in situations where options are limited. Priorities, objectives, time frames and institutional constraints should be clearly determined in order to select the most suitable options. While there is no rule to define an "optimum" policy mix, the following series of criteria can guide the choice of instruments (Barde, 2000).

- *Environmental effectiveness*: the most important criterion is the extent to which instruments will achieve their specific environmental objectives. For instance, it may be more effective to impose a ban on

hazardous substances rather than a tax; taxes may be more appropriate for mobile sources (such as motor vehicles) or polluting inputs (such as energy).

- *Static efficiency*: policy instruments should achieve goals at a minimum cost to society.

- *Dynamic efficiency*: there should be a continuous incentive to reduce pollution and to foster technical innovation.

- *Flexibility*: polluters should have maximum flexibility on ways to comply with environmental requirements, for example in the choice of abatement and adaptation strategies.

- *Simplicity of operation*: complex instruments can result in poor compliance, fraud, and excessive administrative and compliance costs.

- *Reduced transaction costs*: all components of implementation costs (monitoring, licensing, enforcement, etc.) should be minimised.

- *Integration of sectoral policies*: environmental policies must be integrated with other sectoral policies having an environmental impact (e.g. transport, energy and agricultural policies). For instance, control of pesticides and fertilisers may imply removal of related agricultural subsidies.

- *Minimisation of regressive distributive effects*: policy instruments may have unintended regressive impacts, for example by increasing the price of certain commodities.

- *International competitiveness*: policy instruments will encounter resistance if perceived as a threat to international competitiveness.

- *Conformity with international agreements and trade rules*: environmental policies operate within the framework of many international conventions, protocols and agreed principles, and must comply with WTO rules when they have trade implications.

- *Political acceptability:* this depends on factors such as cost, simplicity, transparency, public participation, etc. Concordance with the existing institutional framework is essential.

- *Economic impacts*: the wider economic effects of policy instruments must be carefully assessed and controlled (e.g. effects on prices, employment, economic growth).

Correcting market and intervention failures

The correction of market and intervention failures is the cornerstone for the implementation of a framework for sustainable development. Three key sets of measures contribute to this process: *(i)* reforming distortionary subsidies; *(ii)* greening tax systems; *(iii)* creating markets for pollution control and natural resource management. Measures in each of these areas are discussed below.

Subsidy reform

Background

The most widespread types of intervention failures in OECD countries come from subsidy programmes. Governments have historically influenced market prices through regulations, taxation, government ownership, subsidised loans, purchase commitments, budgetary transfers, trade barriers, set prices, etc.[10] Most support measures are either paid for through government budgets, or reduce the receipts to these budgets. However, there are also off-budget support measures, including market price support,[11] low rate of return requirements,

and exemptions from environmental standards. The non-internalisation of externalities can also be conceived as an implicit subsidy, in that it allows insufficient provision for future environmental liabilities. Furthermore, while most regulations are not obvious support measures, they can serve the same purpose (as in restrictions on third party access to electricity distribution networks).

Some support measures are pursued in order to enhance the competitiveness of certain products, processes, industries, social groups, or regions (Box 5.3). In other cases, support measures are used to address equity or social concerns. Often, though, the full economic, environmental and social costs of these measures are not considered. When costs outweigh direct benefits, these programmes lead to a policy failure. Recent experiences in OECD countries indicate that the reform of many of these subsidies may increase economic efficiency, reduce the burden on government budgets and consumers, alleviate environmental pressures and improve equity — resulting in "win-win-win" benefits. Compensation or transition measures (for the original beneficiaries of a subsidy) can smooth the reform process.[12]

Box 5.3. **Environmental support measures**

A distinction must be drawn between support measures for environmental protection and other support measures with potential detrimental environmental consequences. A number of support measures are designed to promote environmental protection, such as direct support for pollution control equipment (grants, soft loans, accelerated depreciation), the development of clean technologies, or energy efficiency. While such measures are clearly beneficial for the environment, they may distort markets and hamper rather than help sustainable development. Furthermore, such support measures may be in direct contradiction with the "Polluter-pays principle", basically defined as a non-subsidy principle.

Source: OECD (1972), "Recommendation of the Council on Guiding Principles Concerning International Exonomic Aspects of Environmental Policies", Document No. C(72)128, Paris.

The economic, environmental, and social effects of subsidies

Many support measures have unintended economic, environmental and social effects. In many circumstances, lowering support levels may end up increasing economic efficiency (Box 5.4). Furthermore, where subsidies are on-budget, their removal can improve government budgets and release funds for other uses. Off-budget subsidies may have second order effects on the budget as well. By setting high guaranteed prices for products, these subsidies encourage higher production and input use. As a result, much of the support may "leak away" from the intended recipient to input providers and others.[13]

Box 5.4. **Effects of energy support removal**

A number of studies have simulated the effects of removing coal and other energy subsidies, either at the world or country level. All of these studies found significant *environmental* benefits from subsidy removal in terms of reductions in CO_2 emissions, which decline in the sectors concerned by 1-8% in 2010 from their base level (OECD, 1997*b*). Where *economic* effects were analysed, most studies suggested real GDP gains. However, some of these studies also point to significant reductions in *employment* in the coal sector (associated with lower coal production). For example, according to DRI (1997), these subsidy reforms could lead to a loss of 104 000 mining jobs in Europe and Japan.

Support measures may also restrict dynamic efficiency. Support measures tied to the production of specific products or to the use of specific inputs or processes tend to "lock-in" the use of these inputs, processes or products, thereby reducing incentives for the development of new, more efficient or less environmentally

damaging alternatives. Furthermore, the higher prices at which products of supported industries are sold will generally put downstream industries at a competitive disadvantage. To limit this effect, support is often extended to these downstream industries, leading to so-called "subsidy clusters".

Many of the subsidies in place in OECD countries are used to support specific sectors — particularly agriculture, fisheries, energy and large industries, by either reducing costs (e.g. support to infrastructure, research and development, material inputs, etc.) or enhancing revenues (e.g. market price support). These support measures often lead to the increased use of inputs and increased production levels (OECD, 1998*a*). If not properly designed, support measures risk increasing total levels of environmental damage from production.[14]

Most support measures in OECD countries have been introduced to protect the employment and incomes of workers and farmers against foreign competition, especially in poorer regions. Often, however, the majority of the support accrues to large producers, thus leading to a regressive distribution.[15] The fact that this support is paid for by taxpayers, consumers, or both, raises equity concerns: either consumers pay artificially high prices for supported goods, as with minimum price support policies used in agriculture; or the government supports a given industry through direct payments or tax exemptions and reductions. When the consumer carries the burden of support, the high prices they pay for goods may have regressive distributive impacts, where lower income groups spend a larger portion of their income on the supported good than higher income groups. Furthermore, because of inefficiencies in support programmes, the amount of support given often far exceeds the amount received by the intended recipients (the so-called "low transfer efficiency" or "leakage effect"). In some cases, support levels surpass the average incomes of the supported workers.

Policy trends: reforming subsidies

The limited data available on support levels in OECD countries indicates that these levels have fluctuated for most sectors in recent years, with some declines for coal production and fisheries (Table 5.3.). For some sectors there have also been substantial changes in the form of support measures, with a shift from support tied to particular processes and products towards support that is de-coupled from levels of production or input use, or tied to environmental achievements.

Table 5.3. **Trends in support levels in OECD countries**

	1987	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture	326	-	-	-	394	-	-	-	-	336p	362p
Marine capture fisheries	-	-	-	-	-	-	-	-	6.8	6.3	-
Coal production	13.2	-	-	10.8	11.9	9.0	10.3	11.0	9.3	7.7	6.1p
Industry	-	36.9	41.6	45.7	44.1	43.7	-	-	-	-	-

Notes: p = preliminary. Data in USD billions. Agriculture: total support estimate for agriculture; data for 1987 represents an average for 1986-88; data for 1992 are an average of 1991-1993. Fisheries: government financial transfers to marine capture fisheries does not include market price support. Coal production: producer support equivalent in selected OECD countries (Germany, Japan, Spain, Turkey, United Kingdom). Industry: reported net government expenditures to industry; note that the support to industry overlaps with other support estimates, e.g. to energy.

Sources: OECD (1999), *Implementing Domestic Tradable Permits for Environmental Policy*, Paris; OECD (2000) *Transition to Responsible Fisheries - Economic and Policy Implications*, Paris; IEA (1999) *Energy Policies of IEA Countires, OECD/IEA*, Paris; OECD (1998), *Spotlight on Public Support to Industry*, Paris.

Agriculture is the sector that receives the largest levels of support in OECD countries. In 1998, total support to agriculture in OECD countries was estimated at USD362 billion, or 1.4% of OECD GDP. Although the aggregate support level remains high, it has tended to shift away from support to market prices and towards direct payments, sometimes combined with increases in budgetary-financed general services, such as research and training. Where market price support continues, many OECD countries use quantitative restrictions on production to reduce excess supply. Countries often attach environmental performance conditions to support as well, using agri-environmental programmes that reward farmers for complying with environmentally-friendly farming practices. Such support programmes should be devised so as to avoid compensation for measures that would have been taken anyway.

Government financial transfers to the *marine capture fishery sectors* in OECD countries amounted to USD 6.3 billion in 1997, representing 17% of the total value of landings (OECD, 2000). Over the years, transfers to capital and labour have contributed to creating over-capacity in fishing fleets, and to over-fishing of some fisheries. Though these transfers still persist, in recent years OECD countries have directed transfers more towards removing capacity, spending USD350 million in 1997 on the decommissioning of vessels and license retirement (OECD, 2000). In the absence of adequate harvest controls, payments aimed at reducing fishing effort have had little effect on improving resource sustainability, as remaining vessels may fish more efficiently or longer.

Over the last two decades, many OECD countries have reduced or eliminated direct *energy subsidies* and lifted price controls, as part of a general move towards market deregulation. As a result, support to coal producers in selected OECD countries has been declining, sometimes significantly, with a number of OECD countries fully removing their support in the last decade (IEA, 1999*a*). Support reductions have been accompanied by decreases in coal production in these countries, often with a substitution of less polluting fuels, such as gas. Subsidies have also been introduced to promote more benign energy sources and technologies, and subsidies to traditional fuel sources are being geared towards developing cleaner processes,[16] greater energy efficiency, and reducing emissions (IEA, 1999*a*).

Direct subsidies to *transport* activities are rare, although support is provided through a variety of other means — such as only partially recovering the costs of providing transport infrastructure and related services. Studies comparing the costs of road transport in three OECD countries with related expenditures found that only one of the three had road-related revenues which exceeded expenditures (OECD, 1998*a*; ECMT, 1998). When the social and environmental external costs (from air pollution, accident costs not covered by insurance, etc.) were considered, all three appear to significantly subsidise transport use, by over 50% in some cases. Cross-subsidies are also common between different road users, for example from cars and light trucks to heavy trucks, and from rural to urban road users. The liberalisation of transport activities has increased competition within and between transport modes, leading to a general increase in efficiency and innovative practices.

Support to *water services* provision is common in OECD countries. While most OECD countries now subscribe to the principle of "full cost recovery" in the provision of water services, few have actually achieved it in practice. Significant cross-subsidies between different water users also exist. Industrial water use comes closest to recovering the full costs of provision in OECD countries, while agricultural water prices remain particularly low. While many countries have been reluctant to raise water prices because of social concerns (Box 5.5), several OECD countries have reduced or eliminated water supply and treatment subsidies, and realised significant increases in water charges in recent years (OECD, 1999*e*).

Box 5.5. **Social concerns and water subsidies**

Some water subsidies aim to ensure minimum levels of water to all individuals. In this way, however, all consumers — not just those with lower incomes — are encouraged to over-consume water. Experience indicates that there are often better ways of achieving social objectives (such as general income support, or targeting water tariffs to those in need) than subsidising general water consumption.

Source: OECD (1999), *The Price of Water: Trends in OECD Countries*, Paris.

Implementing subsidy reform

OECD countries are moving towards reforming support measures, although this process has been slow in most countries. While the costs of financing subsidies are spread widely (i.e. to taxpayers or consumers in general), their benefits are highly concentrated. Often, the relatively small but homogenous groups that

benefit from subsidies have a stronger voice than the larger, more diverse group that pays for them. Despite these difficulties, experience has shown that reforming inefficient or environmentally damaging support programmes is possible, provided that reforms consider their social and economic implications, and employ targeted policies to smooth the transition. The following steps can smooth the process of subsidy reform.

Identify distortionary and damaging subsidies and increase their transparency. Subsidies are often difficult to identify, particularly in cases where adequate data on their nature and magnitude are not collected, or their impacts are poorly understood. Transparency and a clear understanding of the costs of subsidies are preconditions to achieving agreement on subsidy reform and allowing all stakeholders to comprehend the magnitude of support and its effects.

Gradual reform of existing subsidies. Giving priority to those subsidies whose removal will improve economic efficiency, reduce budgetary outlays and environmental damage, and lead to desirable social effects can minimise opposition to reform. In general, the least effective and most environmentally damaging subsidies are those tied to the use of certain production processes or inputs, or to the level of production. Where subsidy removal is politically unacceptable, a first step may be reform. While it will not eliminate budgetary outlays or other transfers to support certain groups or regions, reform can reduce negative economic and environmental effects. Reforms aimed at de-coupling subsidies from inputs, products or processes, and coupling them to the achievement of specific environmental aims have been introduced in many sectors.

Addressing equity and employment effects. In order to ensure that support removal does not lead to unemployment or lower economic development in affected regions, transitional measures may be necessary to ameliorate employment and social conditions. To do so, support funds may be redirected towards temporary compensatory payments, de-coupled from output levels and paid on a temporary basis (e.g. job retraining); or towards adjustments to existing social security and fiscal systems, to counter potentially inequitable effects of support removal.[17] In general, measures to ease the transition of workers in previously supported industries should be temporary, fixed-term, targeted to the intended workers, and only renewable under special circumstances. Longer-term measures risk creating budgetary drain and economic distortion, or compromising the environmental purpose of the reform.

Resolving international competitiveness concerns. For many support measures, unilateral reductions in support can improve efficiency in the allocation of resources — and a country's overall welfare — even if other countries maintain their subsidies (OECD, 1998*a*). However, countries that reduce support to industries producing internationally traded commodities may risk reducing the competitiveness of the affected sector, particularly if other countries also support that industry. A prisoners' dilemma may arise whereby all countries will benefit by removing their support together, but any single country will lose if it removes its support unilaterally. Under such conditions, co-ordinated action may be required.

Securing the effectiveness of support removal or reform. The effectiveness of support reform or removal also depends on the comprehensiveness of reforms. Support removal is most effective when combined with market liberalisation and with strong and targeted environmental policies. Furthermore, support reform will only occur if it is politically acceptable. Bringing the full benefits and costs of removing support measures to the attention of both policy makers and relevant stakeholders is essential to this process.

Environmental taxes

Background

In OECD countries total tax revenue averages 37.2% of GDP, approaching 50% in some countries. Tax systems can work *for* sustainable development, for instance by encouraging a sustainable use of energy and natural resources, or *against* it, by giving the wrong economic signals.[18] Most OECD countries have undertaken significant tax reforms since the end of the 1980s. These reforms have generally combined lower tax rates for higher income groups (which fell on average by more than ten points between 1986 and 1997) and firms (down 10 points over the same period); a broadening of the tax base; and a shift towards general consumption

taxes such as value added tax (VAT). In some cases, the overhaul of tax systems has also provided an opportunity to introduce environmentally-related taxes (Box 5.6), often in the context of more comprehensive "green tax reform".

Box 5.6. **Defining environmentally related taxes**

Taxes are defined as *compulsory, unrequited* payments to *general government.* Taxes are unrequited in the sense that benefits provided by government to taxpayers are not normally in proportion to their payments. The OECD classification also uses the terms *fees and charges* (as opposed to *taxes*) and *levies* to refer *to compulsory requited payments* to either general government or other bodies (e.g. environmental funds or water management agencies).

A large number of environmental taxes and charges have been introduced in OECD countries with the explicit purpose of environmental protection. Examples are taxes on polluting emissions in the atmosphere and water, or on specific polluting products (sulphur, carbon, chemicals, lubricants, packaging, pesticides, fertilisers, etc.). But the environmental relevance of a tax comes primarily through its impact on the relative prices of goods and services (and relevant price elasticities), *regardless of the purpose or name of the tax.* For example, a tax on fuel oil introduced for purely fiscal reasons will have the same environmental impact as a fuel tax introduced to combat CO_2 emissions, as they will both lead to similar changes in relative prices. In the context of sustainable development, what matters is the extent to which these taxes have a bearing, positive or negative, on environmental protection. In co-operation with the European Commission and IEA, the OECD has set up a comprehensive database[19] of "Environmentally Related Taxes", which includes all energy and transport taxes that are of major relevance to environmental protection.

Source: OECD Data base on environmentally related taxes

Revenues from (pollution-oriented) environmentally related *taxes* amounted to 2.5% of OECD GDP and 7% of total tax revenues in 1997 (Figure 5.1.). These figures show that some "greening" of tax systems is already in place. Note that revenue is *not* an indicator of the environmental effectiveness of these taxes.

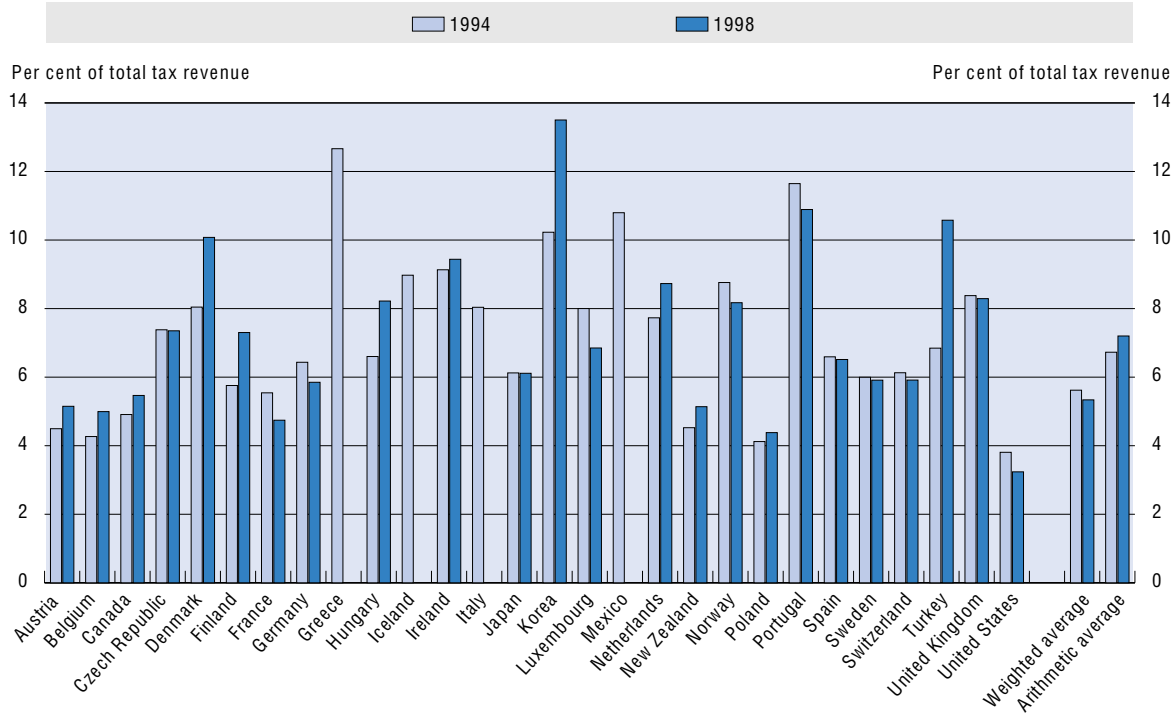
In 1995, motor fuel and motor vehicle taxes represented more than 90% of all the revenue from environmentally related taxes (Figure 5.2). Very small revenues are raised on tax-bases such as heavy fuel oil, coal and coke, which are typically used in heavy industries. This suggests that energy and transport-related taxes offer considerable potential for "greening", in particular by establishing a closer linkage with the polluting characteristics of these taxes. The fact that environmentally related taxes fall mainly on households, rather than on industry, explains why these taxes show little impact on industrial competitiveness so far.

Greening tax systems

Since the early 1990s, several countries[20] have introduced comprehensive green tax reforms comprising three sets of measures: *(i)* reducing tax distortions; *(ii)* restructuring existing taxes; and *(iii)* introducing new environmental taxes. In most cases, these reforms were introduced with the principle of a *constant tax burden*, in which new taxes offset reductions in existing taxes. In the effort to gain a possible "double dividend" from reduced pollution and increased employment (Box 5.7), some countries implementing these reforms have shifted the tax burden from labour to pollution by reducing the tax wedge on labour (in particular employers' social security contributions and income taxes).

Reducing tax distortions. Two main types of tax-related distortion can adversely affect the environment: *(i)* subsidies, that can be construed as negative taxes (see above); and *(ii)* tax rate variations and exemptions. Tax rate variations between substitute goods can influence market structure, often to the detriment of less environmentally damaging products. For example, diesel fuel is taxed at a lower rate than petrol in most OECD countries, although diesel vehicles pollute more than their petrol counterparts.[21] This tax differential

Figure 5.1. **Revenues from environmentally related taxes in per cent of total tax revenue**



Note: Data for France and Luxembourg are low-end Secretariat estimates.
Source: OECD database on environmentally related taxes.

Box 5.7. **Green tax reform and employment: is there a "double dividend"?**

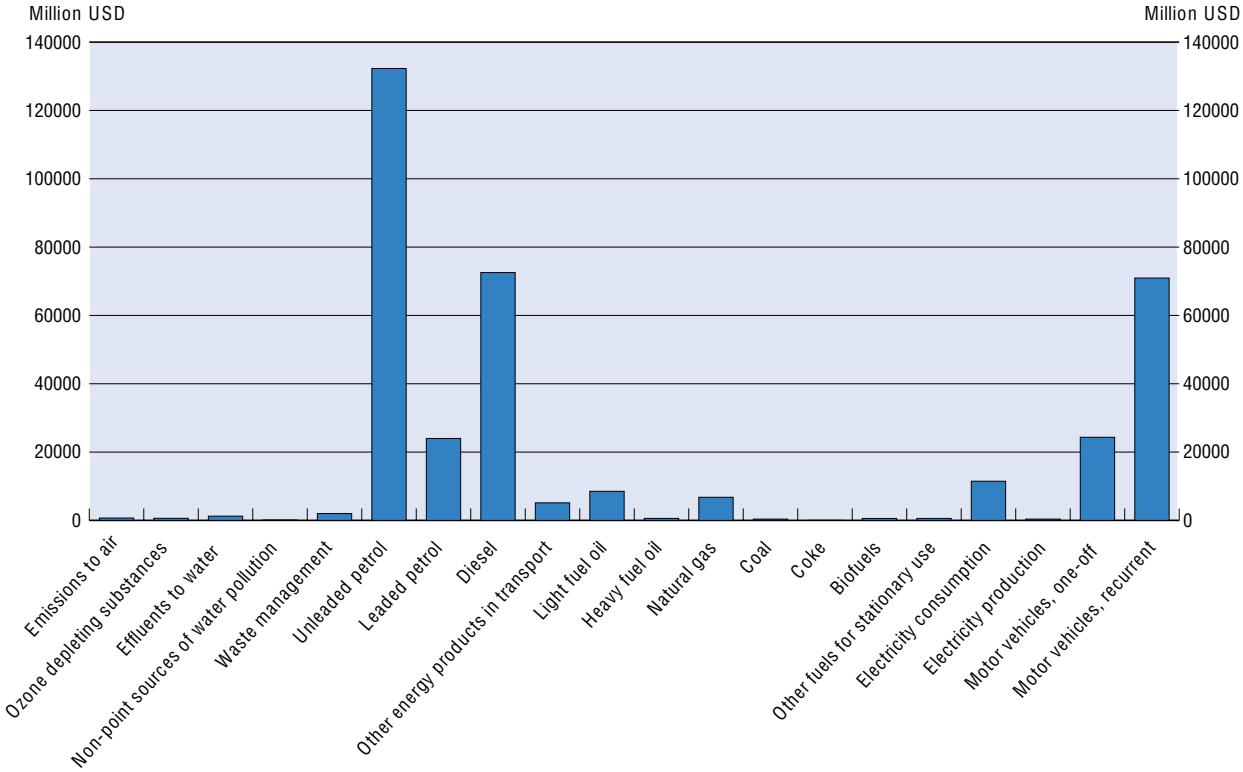
When green tax reforms are implemented in a context of *revenue neutrality*, a "double dividend" may be expected from more effective environmental protection (static and dynamic efficiency of environmental taxes) and from a more efficient economy (due to phasing out of other distortionary taxation). An important question is whether green tax reform could lower unemployment by financing a reduction in labour taxes with new environmental taxes, especially on energy (e.g. CO_2 tax).

Several studies using general equilibrium models indicate that a carbon-energy tax could yield *some* improvements in both employment and environment. However, the employment effect is generally limited (Majocchi, 1996, 2000).

Despite the many restrictive hypotheses necessary for the realisation of a double dividend, most countries attempting green tax reforms have explicitly referred to it. Yet the effectiveness of these mechanisms remains to be seen. Carrying out *ex post* evaluations of these programmes is a critical step in evaluating their success (OECD, 2001*b*).

has contributed to the large increase in diesel vehicles on the road: in OECD countries, the percentage of diesel fuel in total road fuel consumption grew from 15% in 1970 to 32% in 1997 (OECD, 1999*d*). In addition, special tax incentives (e.g. accelerated depreciation, resource allowances) to certain industries like mining and forestry can have negative consequences for the environment. These are but a few of the environmentally

Figure 5.2. **Revenues from environmentally related tax-bases, 1995**



Note: Estimates for 1995, based on information from 21 OECD countries.
Source: OECD database on environmentally related taxes.

damaging tax distortions currently in place in OECD countries. Green tax reforms can help solve this problem by doing a systematic inventory of these counterproductive measures and making the necessary corrections.

Restructuring existing taxes. Many existing taxes could be modified to benefit the environment by fully internalising the external costs of certain activities. A restructuring of taxes on the basis of environmental parameters such as carbon or sulphur content for fuels creates room to adjust other taxation. For instance, the introduction of a new CO_2 tax in Denmark, Norway and Sweden, was accompanied by a decrease in existing energy taxes, in particular on industry.[22] Finland, Ireland, Norway and Sweden apply differentiated taxes on unleaded gasoline, according to environmental criteria (e.g. in Sweden according to the sulphur, benzene and phosphorous content of fuels). Differentiation of diesel taxes is applied in Austria, Denmark, Finland, Norway, Sweden and the United Kingdom.[23] This has lead to a gradual reduction in the use of the most polluting automotive fuels. Several countries (e.g. Austria, Denmark, Germany, and Norway) have also differentiated vehicle taxation according to emissions characteristics.[24]

Introducing new environmental taxes. New taxes whose prime purpose is to protect the environment may be levied on emissions (e.g. atmospheric pollutants or water pollution) or on products, though the latter are more frequent. Since the beginning of the 1990s, many environmental taxes have been introduced on products ranging from packaging to fertilisers, pesticides, batteries, chemical substances (solvents), lubricants, tires, razors and disposable cameras.[25] However, a number of environmentally harmful products are still not taxed, for example coal or heavy fuels used in industry and aviation.

The distributive implications of environmental taxes

As mentioned above, stakeholders — particularly households and businesses — are increasingly questioning the regressive effect of environmental taxes. Evidence of the distributive effects of environmental taxes remains scant. While there is some evidence that energy taxes tend to be income regressive, this effect is weak in many cases (OECD, 1997*a*). A study of energy taxes in eleven EU countries found that the distributive impact of energy/carbon taxes differed by energy use: taxation on transport fuels was weakly progressive, while taxation on domestic energy was weakly regressive (Barker and Köhler, 1998). Overall, an energy/carbon tax was found to be weakly regressive.

Two types of measures can be envisaged to counter any potential distributive effect:

- *Mitigation* is an *ex ante* reduction of the rates of environmental taxes to alleviate the tax burden on specific segments of the population. This can take the form of reducing tax payments for low-income groups, or on specific mass consumption and indispensable commodities such as heating fuels or agricultural inputs. However, mitigation weakens the desired environmental impact of the tax, while adding administrative complexities. A large number of special mitigation provisions are applied in OECD countries, both on distributive and competitiveness grounds.

- *Compensation* is an ex post corrective measure, such as lump-sum compensation, calculated on the basis of average tax payments per household. Compensation has a progressive incidence when the poorest households pay less tax on average than the richest. Tax refunds are a typical compensation measure; in several countries, energy taxes are partly repaid to households and/or businesses in the form of subsidies for energy saving investments.

Environmental taxes and competitiveness

A key obstacle to green tax reform is the possible loss of international competitiveness. This potential loss has led some sectors (in particular energy intensive industries) to strongly oppose environmental taxes and rather promote other instruments such as voluntary approaches. Emissions taxes represent an additional payment (on residual emissions), on top of the costs of pollution abatement measures. A related obstacle to green tax reform is the threat of "relocation" of activities to countries with fewer environmental constraints and lower taxes, leading to unchanged (or higher) levels of overall environmental damage (so-called "leakages").[26]

These criticisms are to a great degree misplaced. At a macroeconomic level, environmental taxes should reinforce the overall competitiveness of an economy for at least two reasons. First, a tax is only a transfer between economic agents; there may be winners and losers, but overall the transfer is neutral. Second, an economically efficient tax should minimise the total cost of combating pollution ("static efficiency" of taxes). Therefore, environmental taxes do not produce a competitive disadvantage for a given environmental goal, even if there may be some short-term adjustment costs.[27]

Confronted with the issue of competitiveness, countries can either take a "wait and see" attitude, or introduce environmental taxes with special provisions to protect sectors subject to international competition. The latter approach is more common, as shown by the large number of tax exemptions in the OECD database, particularly for industry (Box 5.8.).

Available evidence does not show significant impact of environmental taxes on international trade (Jaffe *et al.*, 1995; Adams, 1997): *(i)* variations in economic performances are mainly explained by differences in factors such as skills and investment; *(ii)* environmental protection costs are relatively modest and in any case too low to affect competitiveness; *(iii)* environmental constraints in OECD countries are comparable (which is not necessarily the case in other regions of the world); even when environmental constraints are less restrictive in a given country, outside investors will, in most cases, tend to apply stricter standards than those of the host country; and *(iv)* harnessing market forces enables environmental improvements to be achieved at a lower cost.

Box 5.8. **Dealing with competitiveness concerns: current practices**

A review of current policies in OECD countries highlights a wide array of measures implemented to limit negative impacts on competitiveness:

- *Reduced tax rates for certain sectors, products or inputs* (in particular in the case of energy taxes on firms).
- *Tax exemptions for specific activities, sectors or products.* Overall, the OECD database shows 800 exemptions for 170 recorded taxes (in 21 countries), of which 26 exemptions were specifically targeted to industry (in 9 countries) in 1995. These exemptions are introduced for a number of social, environmental and economic reasons, with only a portion motivated by competitiveness concerns.
- *Tax refunds for certain sectors or activities.* The OECD database records 19 cases of refunds applied to the business sector. While a few refunds "reward" environment-friendly practices or processes, most are designed to lighten the tax burden of industry under specific conditions.
- *Recycling tax revenue* is a specific form of tax refund. In Denmark, for example, CO_2 and SO_2 taxes are fully redistributed to industry in the form of subsidies for energy-saving investments and lower social security contributions (for employers). Comparable forms of recycling exist in several countries.
- *Gradual phasing in of taxes* to soften their financial impact. For instance, the UK "Road Fuel Escalator" was designed to provide industry with clear and advanced signals enabling it to plan appropriate decisions.
- *Tax conditionality.* These are provisions whereby a new tax is applied only if industry does not achieve predefined objectives or commitments (e.g. negotiated agreements).

Source: OECD database on environmentally related taxes and OECD (2001), *OECD Environmental Outlook*, Paris.

These arguments do not suggest that competitiveness is not an issue. On the contrary, the presently negligible impact on international competitiveness is the outcome of the *mitigation and compensation measures* specifically designed to prevent such impacts.

This indicates that international co-operation and co-ordination in the introduction of environmental taxes would be required to pave the way for greater and more consistent use of environmental taxes. One way to address competitiveness concerns is for countries to share information, experiences and best practices regarding possible co-ordinated options for expanding the application of environmentally related taxes, and the co-ordinated phasing out of various types of exemptions.

Creating markets

Removing market failures and price distortions is one condition for making markets work for sustainable development. Another facet of this approach is to *create* markets where transactions would not otherwise occur without the establishment of a specific framework. Over the last decade or so, specific markets have been set up for the management of natural resources and pollution control in some OECD countries. Tradable pollution emission permits have been used only to a limited extent in most OECD countries. Successful experiences and new environmental challenges such as global warming are inducing countries to consider using tradable/transferable emission permits.

Definition and background

Transferable/tradable permits include environmental quotas, permits, maximum rights and/or minimum obligations that can be assigned to agents by a competent authority, or distributed between agents in

accordance with an administrative or economic procedure (Box 5.9). They may take the form of administrative authorisations or rules regarding the safeguard of property rights on environmental resources. Once initial allocations are made, these permits may be transferred between sources, geographical areas or time periods. The market price of permits will equalise marginal abatement costs of all agents participating in transactions, thus minimising the overall abatement cost.[28] Transfers may take place within an economic entity (as with different factories owned by the same firm) or between different agents (firms, landowners).

Box 5.9. **Different types of transferable permits**

Transferable permits fall into four main categories differing according to the benchmark used to determine individual permits and the nature of the problem targeted (pollution control or natural resource management):

- *Emission reduction credits* (baseline and credit for emission reduction) correspond to credits earned by participating agents when their emissions or abstractions fall below the level which had been authorised for a given agent over a given period. The reference situation is given by the pre-existing administrative permit system.

- *Quotas or allowances* (cap and trade or minimum limits and trade) correspond to quantified maxima or minima assigned to agents for a given period. Individual limits are determined by setting an overall volume for a delimited area. An example of a quantified maximum is the maximum annual volume of sulphur dioxide emissions from power plants on U.S. soil following the enactment of the Clean Air Act Amendments of 1990.

- *Averaging* consists in the competent authority setting average limit values for an entire range of similar products (e.g. cars or engines) manufactured by firms within the same industrial branch. Firms may exceed these limits for some of the products they sell, provided that they offset the excess with lower than average levels for other products. Transfers can also be made externally — i.e. if the overall product performance of a firm is better than the average, it can transfer unused permits to other firms whose performance is poorer. This approach was adopted in the CAFE programme to regulate the unit consumption of vehicles sold by automobile manufacturers in the United States.

- *Usage rights or rights to abstract natural resources* (transferable rights) regulate access to resources that are freely available or whose ownership is shared; and, in the case of building and construction rights, alleviate failures in property rights to secure environmental and development objectives. Transferable fishing and construction rights (separated from land ownership rights) are two examples of this approach in New Zealand.

Source: OECD (2001), *Strategic Guidelines for the Design and Implementation of Domestic Transferable Permits*, Paris, forthcoming.

Advantages of transferable permits

Transferable permits provide a range of advantages.

- *Certainty about environmental outcomes*: with transferable permits the total quantity of polluting emissions or use of resources is fixed *a priori* and allocated by the market.[29]

- *Reduced costs*: tradable permits equalise marginal abatement costs at the level of the market price of permits. Experience indicates that cost savings can be considerable.

- *Inducement to an effective and smooth functioning of the system:* all participants share an interest in making good use of their permit allocation.

Box 5.10. **Guidelines for the implementation of domestic tradable permits system**

OECD work has highlighted a number of key considerations for the implementation of domestic tradable permits:

- Definition of the tradable "commodity" (tons of SO_2 or CO_2, water volumes, fishing quotas, quotas of chlorofluorocarbons (CFCs), lead, construction rights, etc.).

- Clear specification of the allocation of tradable quotas (e.g. total amount of SO_2 per annum in a given area)

- Specification of system participants. Participants include: (i) those who receive an initial allocation of permits or are allowed to purchase them from authorities; (ii) those authorised to take part in permit transactions (buying and selling); and (iii) those entitled to use permits for their emissions or abstractions. Participants, whether private or public, should be encouraged to conduct their transfers on a competitive basis, and to ensure equitable and transparent access for all parties. Rules of allocation and transfer should not favour certain interest groups.

- Characterisation of the type of transferable permits: (i) emission reduction credits (based on pre-existing emission permits); or (ii) quotas (based on the distribution of an overall quantity between all emitters or users of the resource, i.e. the "cap and trade" approach).

- Choice of the initial allocation of permits: free ("grandfathering") or auctioned, or a combination of both. In each case, criteria should be specified from the outset and preferably negotiated with stakeholders beforehand.

- Appropriate organisation of geographical flexibility, so as to achieve the best compromise between the avoidance of local concentrations of pollution and the economic rationale of seeking maximum flexibility in transfers.

- Specification of the possibilities for temporal flexibility, in particular the definition of the time period (quarterly, annual, multi-annual) during which transfers can take place and the type of flexibility allowed ("banking" or "borrowing").

- Specification of the types and conditions for transfers: (i) internal transfers, taking place between different units of the same company; (ii) external transfers, in the form of bilateral transactions, trading on an exchange, transactions through brokers or other intermediaries, or operations organised by an administrative authority. Transfer contracts should be established so as to take immediate effect or deferred until a certain due date, as in the case of futures.

- Appropriate institutional setting: a new institutional framework specifically designed to tackle a new issue, or the adaptation/extension of existing institutions.

- Minimum transaction costs (costs related to negotiation, processing of authorisations, monitoring and recording transactions, inspection and sanctions). As far as possible, prior authorisation for each projected trade should not be required. Trading exchanges (such as boards of trade) and specialised brokers can greatly facilitate the system.

- Reliable, efficient and credible monitoring systems for emissions and transfers.

- Means to guarantee the legal and economic security of permits. This involves in particular: (*i*) penalties for non-compliance, so that non-compliance costs more than purchasing permits; and (*ii*) foresight and stability of rules.

Source: OECD (2001), *Strategic Guidelines for the Design and Implementation of Domestic Transferable Permits*, Paris, forthcoming.

- *Compatibility between economic growth and environmental protection*: expansion of a given activity (including new entrants) may not increase the total initial allocation of permits.

- *Diffusion of information in the market*: market prices provide invaluable information to all agents, breaking down the barriers that confine economic assessment to debates among experts (whose differences of opinion are often used by interest groups to gain strategic advantage in their efforts to influence the policy process).

- *Automatic adjustment of prices* to changes in economic conditions (inflation, growth, higher demand for resources and environmental amenities) without the need for a policy decision: this is especially important for countries undergoing the transition to a market economy, and whose macroeconomic environments have not yet stabilised.

- *Temporal flexibility:* by authorising the transfer of permits valid for a given period of time to a later period ("banking").[30]

- *Spatial flexibility:* when transfers between different areas are allowed, for example through an "offset" system whereby the total quantity of emission in each zone is constant.

- *Potential application to a wide array of fields*: for example, pollution emissions, natural resources (fisheries, water, natural species), and land use (e.g. development rights).

- *International potential*: in particular through the "flexibility mechanisms" for the implementation of the Kyoto Protocol of the UN Framework Convention on Climate Change.

Implementing tradable permits

With the exception of the United States, tradable permits have been little used until the late 1990s, partly reflecting different "cultures" and perceptions of this type of instrument. Also, some see the alleged complexity of tradable permits as insurmountable. This situation is now changing, though, and tradable permits are increasingly perceived as an important instrument to harmonise environmental protection and economic efficiency. Several countries are now testing or investigating possibilities for such systems, in particular for reducing CO_2 emissions: a pilot trading scheme for electric utilities is in place in Denmark and being designed in Norway and the UK; France, Netherlands, , and Sweden are actively considering CO_2 trading schemes; Australia, New Zealand, Canada and the United States are also studying how to implement such systems.) — The development of an international system of tradable carbon quotas is high on political agendas. The OECD has developed practical guidelines for the implementation of domestic tradable permits (Box 5.10) and co-operates actively in the elaboration of an international trading system for CO_2 emissions.[31]

Conclusions

In conclusion, several types of instruments will shape the basic framework conditions for sustainable development:

- *Improved policy frameworks*, to include: regulatory reforms that address the linkages between the economic, social and environmental dimensions of sustainable development; effective economic appraisal of regulations and valuation of externalities; enhanced public-private co-operation; and greater use of economic instruments.

- *Correction of market and intervention failures*, through the removal of distortionary subsidies in agriculture, fisheries, energy, transport, water and industry.

- *Green tax reform* that addresses sustainable development comprehensively.

- *Creation of markets* for pollution control and resources management. Although experience remains limited, there is a significant potential for greater use of transferable permits.

For each of the areas mentioned above, policy conclusions and recommendations have been presented, based on experience in Member countries and OECD work. Interventions in each of these areas should incorporate the following principles:

- All types of interventions are *complementary*. For example, removing market and policy failures is a prerequisite for the effective use of market-based approaches and improved governance; also, policy instruments — regulatory, economic or voluntary — can be implemented in complimentary ways with policy mixes.

- *Economic, social and environmental considerations must be integrated at each level of policy design* (for example, in dealing with the distributive implications of economic instruments). The assessment of social implications remains the weakest link in policy analysis and implementation, and much work still needs to be done in this area.

- *Improving economic efficiency* is a common rationale of interventions in all areas.

- *Combining different instruments in the context of policy mixes* is likely to be the most efficient approach. However, these mixes should avoid excessive complexity, which makes them difficult to comprehend and enforce.

- *Transparency and stakeholder participation* are an essential part of any intervention .

- *International co-operation* (including conformity with international conventions and rules) is crucial in a number of cases such as subsidy removal, taxes, and tradable permits.

- *Ex post evaluation* and feedback mechanisms must be put in place. Evaluation methodologies (such as the effects of subsidy reform) should be integrated into policy practices, to enable policy corrections when necessary.

These framework conditions will produce results only if implemented with a long-term perspective and strong, continuous political will.

NOTES

1. OECD countries have recognised their continuing responsibility to review their own regulations and regulatory processes, to promote the well-being of their people efficiently and effectively (OECD, 1997*d*).

2. Except for the United States where significant market liberalisation has already occurred.

3. In 1995, the Council of the OECD recommended that Member countries should take measures to secure the quality of government regulations by systematically examining their quality and performance, according to certain criteria ("Recommendation of the Council on Improving the Quality of Government Regulation").

4. In the United Kingdom, for example, monetary estimates of environmental costs are used for setting the Landfill Tax, (introduced in 1997) and the tax on the extraction of aggregates from quarries (Pearce and Barbier, 2000).

5. For instance, the report "Policy Appraisal and the Environment" published by the UK Department of the Environment (HSMO, London 1991); see also OECD (1994*b* and 1995*a*).

6. In economic terms, the marginal rate of substitution between environmental and private goods would be higher for the rich than for the poor (Baumol and Oates, 1988).

7. With regressive taxes, low-income groups spend a larger proportion of their income on the tax than higher income groups.

8. Final incidence refers to who actually bears the burden of a tax. It can differ from its initial incidence — i.e. where the tax is first levied.

9. The need for an effective integration between economic and environmental policies is reflected in the declaration of OECD environment Ministers in 1991 (OECD, 1991*a*).

10. Some governmental interventions could be justified to take into account the public good nature of goods and services.

11. Whereby governments utilise measures such as brokered sales contracts and border protection to ensure that domestic producers can charge above market prices for their goods.

12. Ideally, costs and benefits should be analysed by comparing cases with and without subsidies, including opportunity costs, where possible.

13. As much as three-quarters of the amount consumers and taxpayers transfer to farmers through market price support may leak away to input providers and through foregone earnings on diverted farm resources (OECD, 1995*b*).

14. Some examples include over-fishing, excessive energy production and associated pollution, and the expansion of agriculture onto marginal lands.

15. Thus, it is estimated that 26% of agricultural market price support in the United States accrues to the top 2% of producers, while small, subsistence farmers are generally not even in the support programmes.

16. While these subsidies may help to balance the playing field with the traditional, more polluting and often subsidised fuels, the first best response would be to remove the subsidies on the more polluting fuels and internalise the externalities of their use.

17. However, since these adjustments tend to be permanent rather than temporary they are often not suitable for compensation that is intended to ease economic hardships over a transitional period.

18. The first OECD report on this issue concluded that "environmental and fiscal policies can and should be made mutually reinforcing" (OECD 1993, p. 115). This conclusion was reinforced by a following report, (OECD, 1997*f*), which was endorsed by the OECD Council in 1997.

19. This database can be accessed at www.oecd.org/env/policies/taxes/index.htm.

20. Finland (1990), Norway (1991), Sweden (1991), Denmark (1992), The Netherlands (1988- 1992), France (1999), Germany (1999), Italy (1999) United Kingdom (1996-2001), Switzerland (1998-2000).

21. In particular for emissions of NO_x and particulates.

22. This restructuring of energy taxes was done with different modalities in different countries. For instance, in Norway, energy taxes were cut a few years after the introduction of the CO_2 tax.

23. Based on the OECD/EC database on environmentally related taxes.

24. The impact of this particular case of tax restructuring may be harder to discern as there are many other factors that determine consumer choice of vehicles, for example safety features and personal taste.

25. The OECD database indicates 51 different taxes (other than energy-related taxes) in 11 countries.

26. The concept of "competitiveness" can have different interpretations. In particular, it is important to differentiate between the competitiveness of individual companies and sectors, and the economy as a whole. On the one side, increased environmental taxes impact the relative position of different sectors (energy-intensive and/or carbon-intensive sectors bear the burden of taxation), and re-allocation of net taxes may create conflicts of interest and opposition to environmental taxes. On the other side, the impact on the competitive of the economy as a whole depends on its economic structure, i.e. the energy and carbon intensity of its open sector and the length of the transition to a new lower energy/carbon-intensity economy. Countries with energy intensive export industries will be subject to substantial adjustment costs in the transition stage in terms of losses of output.

27. In any case, any environmental policy is bound to affect costs to some degree, for instance through pollution standards, technical standards or regulations.

28. For instance, an industrial plant A that must reduce its emissions of sulphur dioxide by a given amount may purchase emission permits or quotas from another plant B which would then reduce its emissions by the same volume. Plant A would purchase permits as long as the market price of permits is below its marginal abatement cost. Plant B will sell permits as long as the market price is above its marginal abatement cost.

29. Notwithstanding the issue of the initial allocation of permits or quotas, by free allocation ("grandfathering") or by auction. Note that with permits, there is certainty about the quantity of pollution released, but uncertainty regarding the market price of permits. With environmental taxes the reverse will hold: certainty about the price (rate of the tax), but uncertainty about the quantitative environmental outcome (unless there is perfect information on marginal abatement cost curves).

30. Other forms of temporal flexibility are: *(i) budgeting* emissions or abstractions over a given period of time (quarterly, annually, five-yearly, etc.) during which transfers may be made freely; *(ii) borrowing*, which consists in authorising the advance use of permits that are valid for a given future period (this may be restricted in terms of the volume that can be borrowed or of the imputation of a cost in a form equivalent to that of an interest rate.

31. Framework conditions and rules specifically designed for an international trading system of greenhouse gases (in the context of the Kyoto Protocol) are being worked out in specific fora. The Annex I Experts Group on the UNFCCC, supported by the OECD and the IEA, does relevant analysis

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Chapter 6.

TECHNOLOGY

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TECHNOLOGY

Introduction

There is a growing awareness that innovation and technology play an ever-increasing role in economic growth. Indicators such as the increase in multi-factor productivity in some countries point to technology and innovation as major factors in recent growth performance. Investment in innovation is rising. OECD expenditure on research and development (R&D) is more than 2.2% of OECD-wide GDP. Data on patents granted in the United States also indicate that the ratio of patents to GDP has increased considerably in most OECD countries over recent years (OECD, 2000*a*).

In addition to these trends, which testify to the growing importance of innovation, some notable changes in the innovation process itself have recently occurred. R&D has become more market-oriented, and business funding of R&D has increased relative to government funding. Research cycles have shortened, and research has become more closely tied to business strategies. Recent evidence suggests that the interaction between the science system and the business sector is becoming stronger and more direct. In many fields, technological innovation makes more intensive use of scientific knowledge as fundamental discoveries often lead directly to commercial application, sometimes through the creation of new firms.

As the processes of knowledge acquisition and diffusion have become more complex, companies are shifting to a more outward orientation. Firms are co-operating with other firms through networks and alliances to share the cost of bringing new products and services to the market and to reduce uncertainty. Patent data show that a growing part of such co-operation takes place at the international level. In the changing innovation process, small start-up firms have gained prominence, because of their flexibility in emerging areas where demand patterns are unclear and risks are large. New financing mechanisms like venture capital have facilitated the rapid growth of these firms.

Innovation is clearly gaining importance for growth. But how does such growth affect sustainable development, especially environmental sustainability? Making innovation and technology contribute to sustainability requires internalising the dynamics of innovation-led growth. Yet this is not the case at present. Our socio-economic system does not provide sufficient incentives for innovation and technological change that are in keeping with sustainable development goals, although governments and businesses have started to adopt innovative public policy and corporate initiatives to diffuse cleaner technologies and enhance environmental performance. This chapter examines the role that technology and innovation have begun to play in achieving sustainable development, and looks at how this role can, and indeed *should*, be expanded.

Failures and obstacles to stimulating innovation for environmental sustainability

Environmental sustainability requires radical changes in the goods and services we produce, as well as how we produce, distribute and use them. During most of the course of industrial development, economic growth entailed parallel growth in resource consumption and environmental degradation. Though this relationship still holds, experience of the last few decades indicates that economic growth and increases in resource consumption and environmental degradation *can* be de-linked to a considerable extent. The path to environmental sustainability lies in maximising this de-linking process.

In order to allow technology and innovation to play their proper role, it is first necessary to understand the nature of the externalities involved. Technology is a double-edged sword and can generate both positive and negative externalities. Positive externalities flow from new knowledge resulting in improvements in productivity, which in turn enables growth and increased welfare. Negative environmental and social externalities can also flow from the use of new knowledge, resulting in environmental degradation and other social disruptions. In fact, technology was long held responsible for many negative environmental externalities, and this perception has at times impeded the search for ways to exploit the positive economic externalities of innovation for environmental sustainability.[1]

It is now well recognised that the spillover effects of knowledge discourage optimal investments in knowledge creation on the part of industrial firms. Private investment in R&D tends therefore to remain sub-optimal. Moreover, because of the "public good" nature of environmental benefits — which keeps firms from fully capturing the returns on environmental investments — private investments that contribute to upgrading the environment also remain sub-optimal. Therefore, innovation for sustainable development suffers from a double market-failure.

The fact that environmental innovations often arise from R&D in different scientific and engineering disciplines — in both the public and private sectors — adds an important systemic challenge. Insights from advances in various basic and applied sciences and engineering disciplines need to be combined to generate optimal solutions to enhance environmental performance. Environmental innovations require a trans-disciplinary and inter-sectoral approach to problem solving. Moreover, relevant process and product innovations often encompass networks that extend beyond specific firms and sectors. Research and innovation systems, as well as the industrial structure in many OECD countries, are not always adapted to address this challenge.

In addition, R&D efforts for sustainability need to focus on applicability. Innovations that serve the goals of sustainability necessitate focused R&D, and require the long time horizons typically associated with these efforts. Public policy must address market failures and systemic challenges to match the demand for and supply of appropriate innovations, while integrating environmental sustainability into the economic and research system.

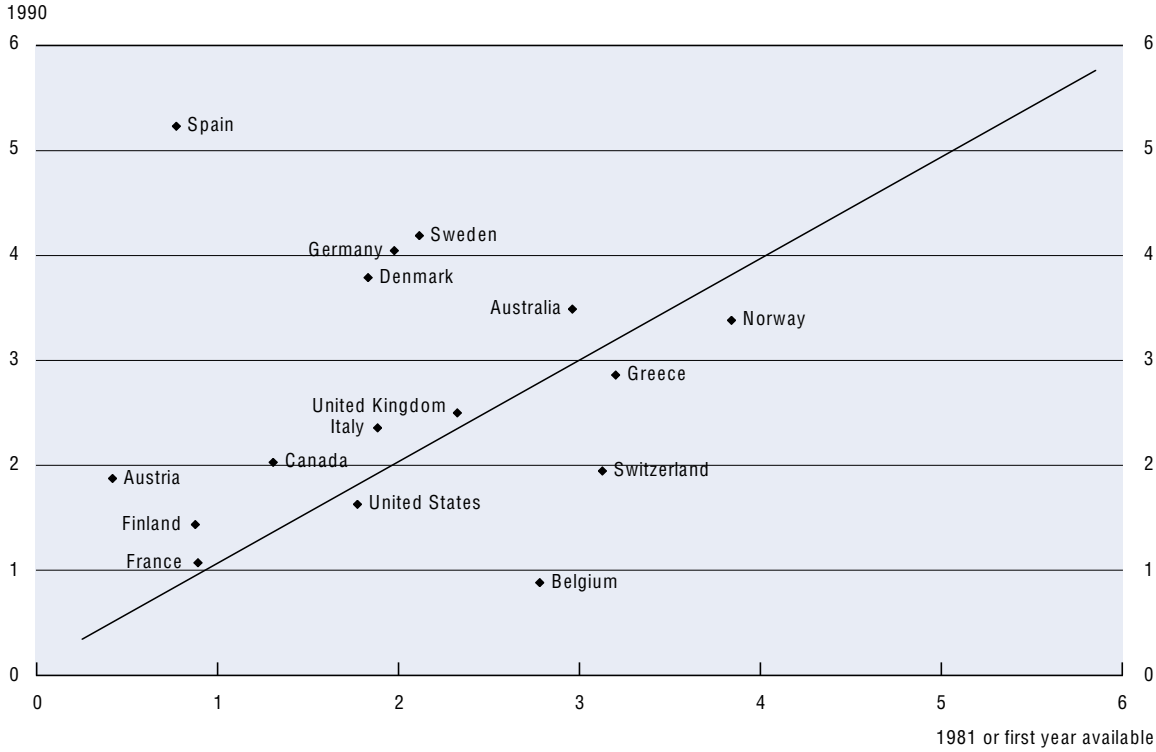
There are a number of obstacles to formulating effective policies. One is the diffuse nature of environmental technology or innovation. Until recently, the term environmental technology was more often used to point to pollution control or end-of-pipe technology and equipment, such as desulphurisation plants, developed to comply with regulations to improve air, water and other pollution problems. Today, however, technology to counteract pollution and improve the environment has diversified considerably. This is due in large part to the shift in emphasis towards "cleaner" technologies — meaning any technology that enhances environmental performance. The growing importance of these technologies is reflected in the difficulty of defining and measuring the expanding environmental goods and services sector (Box 6.1).

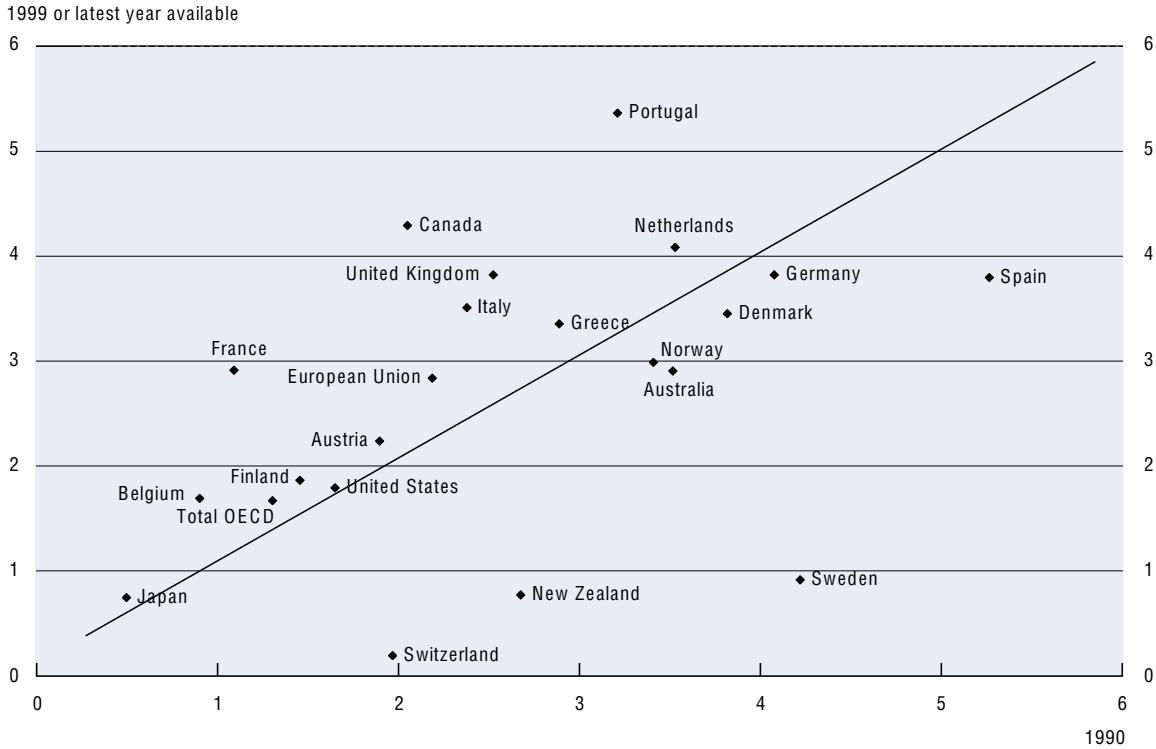
The shift towards cleaner technology also highlights the importance of organisational innovations. Enhancing resource efficiency depends not only on machines and equipment, but also on the organisation of production processes within a firm or industry.

The greater diversity of technologies useful for sustainability implies increasing importance of R&D. As yet, government R&D budget appropriations for environmental research in the OECD area are at about 2% of GDP (Table 6.1).[3] Here again, boundary problems arise and definitions differ among countries. However, the percentage clearly rises to about 5% when appropriations for environment-related research on other objectives, such as energy and agriculture, are added. Moreover, the percentage has been growing over the last two decades in many countries for which data are available (Figure 6.1). For countries with large environmental goods and services industries, such as the United States, Japan and Germany, industry participates more actively in environmental research (OECD, 1998*a*). More reliable information on environmental R&D is needed to assess whether the level of investment is sufficient, since low levels of R&D investments for environmental innovation make it difficult to accelerate the rate of technological change.

Figure 6.1. **Environmental R&D spending**

As a percentage of government budget appropriations and outlays for research and development





Sources: OECD, MSTI and R&D databases, July 2000.

Box 6.1. **The environmental goods and services sector**

This sector has as its core the "pollution management group" of industries that supply goods and services for an environmental purpose only.[2] While these are easily statistically identifiable, included also in the definition of the industry is the "cleaner technologies and products group", which comprises goods and services that reduce the occurrence of negative environmental impacts, but which are supplied for other than environmental purposes. There is no agreed methodology for measuring this group, and the statistical assessment of its importance remains difficult (OECD/Eurostat, 1999). Improvements that are less polluting cannot be separated from general improvements in efficiency that use fewer resources and produce less waste or harmful by-products. Despite these difficulties, available evidence indicates broad trends. World-wide, the environmental goods and services industry has been estimated to be larger in size than the pharmaceutical industry. In the United States, growth was around 5% per year in the 1990s. In Germany, which has the largest environmental market in the European Union, the growth has been estimated at 5-6% a year (Vickery and Iarrera, 2000). In the long run, cleaner production processes and products will reduce the need for end-of-pipe solutions to abate pollution, changing the structure of the environment industry and the relative importance of its core, pollution-management group of activities (OECD, 1996). The growing importance of cleaner technologies is likely to increase the role of small and medium-sized firms, often exploiting emerging technologies such as ICT and biotechnology, that serve niche markets in the user industries.

The environmental issues that have come up on the policy agenda over recent decades have evolved and added more complexity to an already complicated issue. The focus has largely broadened from local pollution problems to regional and global environmental changes, such as climate change and declining biodiversity. In addition to the issues associated with production processes, those related to consumption and post-consumption patterns now receive increased policy attention (Howes *et al.,* 1997). This shift in policy focus has given rise to the growing perception that managing the flow of materials through the economic system is the key to making society more sustainable. To manage this flow successfully, policy makers must identify common technological issues underlying environmental problems, whether global, regional or local, and make technology and innovation a unifying element in policy responses to environmental problems at all levels.

Drivers of environmental innovation

The corporate sector has invested in improving environmental performance, although sometimes reluctantly. Earlier, its response to environmental regulations was defensive and reactive, characterised by "resistant adaptation" — i.e. minimal compliance, resistance to the introduction of new regulations and general reluctance to internalise environmental issues (Howes *et al.,* 1997; Fischer and Schot, 1993). During the 1980s, however, a more proactive approach to enhancing environmental performance was adopted. This transformation in corporate attitude became manifest, for example, in the "Declaration of the Business Council for Sustainable Development", prepared to express the position of the Business Council for Sustainable Development at the Rio Earth Summit in 1992 (Schmidheiny, 1992). The declaration makes a clear commitment to sustainable development, with an understanding that economic growth is basic to achieving it and that new technologies are needed to permit growth while enhancing resource efficiency.

What drove the corporate sector to shift its position? And how can this trend be strengthened? Environmental regulations and related policy instruments are probably the main driver[4] for the change in corporate behaviour. Over the past two decades, environmental regulations have shifted from the command-and-control paradigm based on a specific technology towards increased use of incentives for improved environmental performance. There is some statistical evidence that the corporate response is shifting towards increased use of cleaner technologies. Lanjouw and Mody (1996), for example, show that, throughout the 1980s, in the fields of air and water, the US manufacturing sector devoted a growing share of its expenditure on pollution abatement to "change in process", as opposed to "end-of-pipe" technologies. (Table 6.2). More recently, US data show that the "process and prevention technology" segment of the

Table 6.1. **Government budget appropriations and outlays for environmental R&D**
Levels (in millions of 1995 USD at PPP rates) and percentage of total

	Millions USD	As percentage of total government appropriation and outlays for R & D							
		1981	1985	1990	1995	1996	1997	1998	1999
Australia[1]	67.5	2.7	1.9	3.1	2.9	2.5	2.6	2.7	..
Austria	26.4	0.4	0.9	1.9	2.5	2.2	2.1	2.2	2.2
Belgium[1]	26.1	2.8	2.5	0.9	1.5	2.2	2.2	1.7	..
Canada[1]	107.2	1.2	1.9	1.9	4.5	4.4	4.4	4.0	..
Czech Republic[1]	31.1	..	..	..	..	..	..	5.4	..
Denmark	33.0	1.8	1.5	3.8	4.4	4.4	2.9	3.7	3.4
Finland	22.5	0.9	1.5	1.4	2.5	2.6	2.3	2.3	1.8
France[1]	275.9	0.5	0.5	0.7	1.9	2.0	2.0	2.2	..
Germany[1]	528.7	1.8	3.1	3.5	3.6	3.7	3.5	3.5	..
Greece	14.4	3.1	3.4	2.8	3.6	3.8	3.4	3.3	3.3
Hungary	..	..	..	..	..	..	..	..	..
Iceland[1]	2.7	..	0.1	..	3.4	4.0	4.6	2.9	3.6
Ireland	2.5	0.4	0.8	1.2	1.4	1.7	1.6	1.1	..
Italy[1]	237.1	1.8	1.0	2.2	2.4	2.4	2.4	3.4	..
Japan	134.1	..	..	0.5	0.6	0.6	0.6	0.6	0.7
Korea	..	..	..	..	..	..	..	..	..
Luxembourg	..	..	..	..	..	..	..	..	..
Mexico[1]	17.0	..	..	1.4	0.6	0.7	0.8	1.0	..
Netherlands	116.6	..	3.2	3.4	3.9	3.7	3.8	4.0	4.0
New Zealand[2]	2.9	..	..	2.6	3.3	..	0.8	..	..
Norway	24.8	3.6	2.7	3.2	2.8	2.8	2.9	3.0	2.8
Poland	..	..	..	..	..	..	..	..	..
Portugal	50.6	..	..	3.2	4.6	4.7	4.9	5.1	5.3
Spain	124.0	0.7	0.4	4.3	2.6	2.7	2.2	2.6	2.7
Sweden[1]	12.9	1.8	1.5	3.2	2.3	2.3	..	0.8	..
Switzerland[1]	2.5	2.7	..	1.8	..	0.9	..	0.2	..
Turkey	..	..	..	..	..	..	..	..	..
United Kingdom[1]	191.2	1.2	1.2	1.4	2.3	2.2	2.3	2.3	..
United States	610.3	0.8	0.5	0.6	0.8	0.7	0.8	0.9	0.8
European Union[1, 3]	**1,630.3**	**1.6**	**1.6**	2.2	2.7	2.8	2.7	2.8	..
Total OECD[1]	2,582.4	..	..	**1.3**	**1.6**	**1.6**	**1.6**	**1.7**	..

Notes:
1. 1998 instead of 1999.
2. 1997 instead of 1999.
3. 1986 instead of 1981.

Source: OECD,MSTI and R&D databases, July 2000.

environment technology market grew 23% a year from 1989 to 1998, making it the fastest growing segment (Norberg-Bohm, 2000).

Parallel to this transformation in the corporate sector, a lively debate has arisen about the economic effects of environmental regulations on competitiveness. According to conventional economic thinking, developing environmental technologies imposes high costs on firms and would stifle economic growth and competitiveness at the macroeconomic level. A review of empirical studies on the effects of environmental regulations in some sectors (Jaffe *et al.*, 1995), however, concludes that there is little statistical evidence of adverse effects of environmental regulation on competitiveness, investment and productivity. Indeed, management researchers contend that, on the contrary, regulations can reduce production costs and stimulate growth and competitiveness. Advanced mainly by Porter and van der Linde (1995), this view has come to be known as the "Porter hypothesis".

The core of the hypothesis is that the corporate benefits of pursuing efficiency gains through innovation are, in turn, spurred by a learning process to overcome the resource inefficiencies that environmental regulations signal to firms. Consequently, environmental innovations can offset the cost of regulatory compliance through a dynamic innovation process that strengthens the competitive position of the firms and the industry. In industrial processes, these offsets can be achieved through technological change,

Table 6.2. . **Pollution abatement capital expenditures in the US manufacturing sector by abatement technique, 1980-94**

	1980	1981	1982	1983	1984	1985	1986	1988	1990	1992	1994
Air											
Millions 1994 USD	3,335	3,151	2,485	1,360	1,406	1,631	1,812	1,810	2,844	4,605	4,311
of which abatement technique (%)											
End-of-pipe	84	86	85	84	80	70	64	73	71	-	52
Change in process	16	14	15	16	20	30	36	27	29	-	48
Water											
Millions 1994 USD	1,815	1,477	1,328	1,083	1,203	1,284	1,286	1,531	2,943	2,625	2,429
of which abatement technique (%)											
End-of-pipe	87	87	86	88	83	88	82	83	78	-	70
Change in process	13	13	14	12	17	12	18	17	22	-	30
Total expenditures											
Millions 1994 USD	5,547	5,006	4,109	2,705	2,944	3,546	3,525	4,065	6,695	8,227	7,578
As a % of total capital expenditures	5.0	4.4	4.1	3.3	2.9	3.4	3.7	4.2	5.9	-	4.9

Source: Lanjouw and Mody (1996) "Innovation and the International Diffusion of Environmentally Responsive Technology", Research Policy, US Census Bureau (www.census.gov); OECD S&T database 2001.

leading to high yields and energy and material savings. Product "innovation offsets" may include higher quality, increased safety and lower cost. These offsets lead to a so-called "win-win" situation: the potential to reap both public and private benefits through regulation.

The "win-win" hypothesis has met with criticism from both environmental economists and other management researchers.[5] The current state of the debate may be summarised as follows. There is little doubt that win-win potential exists, but it is not clear how large the potential benefits are, or where they can be found within a firm. Also, it is not always easy for firms to exploit a win-win potential when it involves large investments. Public policy, not only in the form of environmental regulation but also R&D support and other measures, is necessary to motivate firms to exploit win-win opportunities, especially in cases of possible shifts away from incremental improvements and towards radical changes in processes and products (Norberg-Bohm, 2000).

The most important implication of this debate is that it is mainly through innovation that firms improve their environmental performance.[6] Given this, one of the main roles of regulation is to give *incentives* to innovate. Creating incentives to enhance environmental performance requires an understanding of the causal relationship between changes in production costs, R&D inputs, and process and product innovations — but the lack of disaggregated data can make these relationships difficult to identify. The win-win debate raises the issue of the general paucity of indicators on environmental innovation (Kemp and Arundel, 1998). This is due in part to the lack of a standardised environmental accounting method used by firms. Intensified efforts by international organisations and national governments to develop standardised methods or examine environmental innovation and accumulate relevant data would be needed to fill this gap.

If innovation is the main response to regulations, that is because it allows firms to reduce the cost of regulatory compliance (Box 6.2). This means that regulatory and commercial drivers are often inter-linked. Some surveys show that social awareness is also reflected in innovations that enhance environmental performance.

The interplay of the various drivers to enhance environmental performance through innovation requires corporate strategies that link R&D and technology management for environmental innovation more firmly

with corporate strategic planning. The need to link R&D and innovation when pursuing sustainable development objectives is apparent in the recent survey by the World Business Council on Sustainable Development (WBCSD) (Box 6.3).

Box 6.2. National surveys on environmental innovation

In a survey of Italy, Malaman (1996) used a literature-based innovation output (LBIO) method to select environmental innovations developed by Italian companies between 1970 and 1995. He found that product and process innovations often lead to cleaner products, input substitution, energy saving, recovery and recycling. The adoption of cleaner technologies was highly dependent on environmental regulations. While reduction in production costs was observed in about half the cases, their development was not always dependent on links with fundamental research, but was often based on available technologies.

Green *et al.* (1994) sought to identify factors that drive UK firms to develop more environmentally friendly products and processes and investigated the changes in R&D activity undertaken to facilitate such innovation. Their statistical analysis shows significant correlation between the influence of regulation and of commercial factors as driving forces for environmental innovation. Strong correlations were found in anticipation of regulation, fear of rival products, and threats to market share. According to the authors, these may indicate a growing awareness of the long-term competitive significance of being viewed as environmentally friendly. The study also shows that "green" social pressures have stimulated many firms to re-examine the technological basis of their activities, including strategic reorientation of various aspects of their R&D.

In a study of Germany — based on the 1996 Mannheim Innovation Panel (MIP) and an additional telephone survey of environmental innovators[7] — more than 80% of the companies pointed to "complying with existing legislation" as the most important reason for environmental innovation (Cleff and Rennings, 1999). Reductions in disposal, energy and material costs were also ranked highly, with over 60% of firms ascribing great importance to each of these goals. Interestingly, companies identified "company's environmental awareness" (over 70%) and "improving public image" (over 60%) as very important goals. In contrast, "maintaining or increasing market share", "entering new markets", "expected future legislation" and "reducing labour costs" received relatively low importance.

Box 6.3. WBCSD survey of "sustainable firms"

The WBCSD recently conducted an interview survey of the senior managers of some 80 leading firms that have indicated their commitment to sustainable development. Of these firms, 88% "strongly agreed" or "agreed" that sustainable development is a key business driver for the firm, and 83% confirmed that sustainable development is an explicit part of the firm's mission and values. The interviewees considered that improved technology and better engineering skills will remain essential tools for supporting sustainable development. Information and energy supply technologies, and biotechnology to a lesser extent, inspired most confidence as a means of supporting sustainability. The practical barriers were seen to reside in resolving the tension between short-term business goals and the longer-term objective of sustainable development. Managers expressed uncertainty about their ability to develop and assess the creative skills required to address the broader agenda of sustainable development. Even the firms that had made substantial efforts felt that they had only made modest progress towards a fully integrated management process that places sustainable development squarely within the innovation process. However, managers reported that considerations of sustainable development had helped their firms to launch new products and improve existing products and processes.

Source: A. Dearing (2000), "Sustainable Innovation: Drivers and Barriers", in *Innovation and the Environment,* OECD, Paris.

These results show that once companies decide to embrace sustainable development as part of their corporate strategies, links with R&D and innovation management become important. The number of such companies may still be limited,[8] but there are signs that the "sustainability" revolution is taking place in the corporate sector in a value-creating way. Notably, companies in the Dow Jones Sustainability Group began to outperform others several years ago (see http://indexes.dowjones.com/). These firms see sustainable development as offering an "organising framework" for corporate strategies, with innovation playing a key role in "harnessing economic and social trends and capturing the tremendous amount of knowledge and experience that exists in networks worldwide" (Dearing, 2000). Embracing sustainable development as a corporate strategy means that "process and product innovations will take place in the context of networks of collaboration and learning both within and with other companies and with stakeholder groups in society" (Clarke and Roome, 1995).

Environmental policies for innovation

If environmental policies drive firms to innovate for environmental sustainability, it is essential that they be designed to stimulate firms to conduct socially optimal levels of such innovation. The first-best incentives are those that "get the prices right" so that the cost of addressing the negative environmental externalities is fully reflected in the prices of the products that give rise to them.

Japan's industrial sector response to the petroleum crises of the 1970s demonstrates that resource price changes can induce environmentally friendly behaviour through innovation. The price increases in Japan's overwhelmingly petroleum-dependent economy provided a powerful incentive to the mature and, more generally, the most polluting sectors to conserve energy and improved their environmental performance. This change, in turn, may have led to increased international competitiveness of many of these sectors in the 1980s (Fukasaku, 1995). The oil price increases of the 1970s worked in combination with environmental regulations introduced at about the same time, and energy saving was presented as a cost-effective way to comply with these regulations.

In product innovation, a study found that increasing energy prices had an observable effect on the models of air conditioners and gas water heaters offered for sale over the last four decades in the United States. The "model substitution" effect was particularly strong after product-labelling requirements went into effect. The empirical evidence suggests that 25-50% of the improvements in the energy efficiency of new models responded to rising energy prices in the wake of the first petroleum crisis in 1973 (Newell *et al.*, 1999). At the macro level, it is suggested that appropriate energy pricing needs to be coupled with active innovation programmes to lower fossil fuel consumption (e.g. to meet CO_2 emission reduction targets) (Birol and Keppler, 2000).

These experiences show the value of economic instruments in environmental policy. Indeed, regulatory regimes in OECD countries have shifted from being largely reliant on command-and-control instruments to making greater use of economic instruments (e.g. pollution charges and taxes, tradable permits). The main benefits of economic instruments are their potential for stimulating more cost-saving approaches (by allowing flexibility in the innovative response) and the incentives they create for continued innovation to enhance eco-efficiency.[9]

The innovation effects of different environmental policy instruments have been reviewed in a number of studies (OECD, 1999*a*; Hemmelskamp *et al.*, 2000; Kemp, 1996 and 2000). Some observe that few environmental policy instruments employed in the past, such as subsidies, covenants and innovation waivers[10], have stimulated innovation, especially when applied independently. Effects of environmental policy instruments on innovation differ. Some instruments — notably regulations based on technology specifications — tend to stifle innovation, although diffusion of the specified technology may be stimulated in the short run. Those that tend to have positive innovation effects, although in varying degrees and in different ways, are product bans, performance standards and economic instruments.

Important criteria to bear in mind when choosing among different environmental policy instruments are the extent to which they stimulate innovation, the degree of neutrality of the policy vis-à-vis technological choices, and the cost-effectiveness of the policy instrument over the long run. Product bans no doubt induce innovation to substitute the banned product, but they do not guarantee that the immediate innovative response will be the best option, or the least costly, or that firms will be motivated to search for better ones. Performance standards allow some flexibility in the innovative response they stimulate, but if they demand hasty compliance, the cost to regulated firms can be considerable. Also, in practice, performance standards have tended to be based on the best available technology known to the regulatory authorities and thereby become effectively indistinguishable from technology specifications, when compliance time is too short to stimulate the development of alternative responses.

Theoretically, economic instruments are a superior choice and have been applied in a number of contexts in OECD countries over the past few decades. Despite their theoretical advantages, evidence concerning their innovation effects is limited. Lack of data is a problem, and separating out innovation effects from other efficiency effects presents a major difficulty. Another difficulty is that economic instruments are usually not applied independently but are used as complements to more traditional regulatory instruments (OECD, 1997*a*).

The most widely discussed application of economic instruments to date is the sulphur dioxide tradable permits programme in the United States. It was designed to encourage the electricity industry to minimise the cost of reducing sulphur dioxide emissions by trading emission allowances, which enables firms operating at high marginal pollution abatement costs to purchase permits from firms operating at low marginal abatement costs, thereby lowering the cost of compliance. Increased pollution control costs was the political factor that led to its implementation. The programme was also designed to be an acceptable means of reducing total SO_2 emissions, by setting an annual cap on average aggregate emissions. This cap formed an integral part of the scheme and was set at about half of 1980 emissions (Burtraw, 1998; Stavins, 1998).

Box 6.4. **Innovation effects of the US sulphur dioxide tradable permits scheme**

Title IV of the 1990 amendment to the Clean Air Act, under which the tradable permits scheme was introduced, allowed for the deployment of a variety of mechanisms to achieve compliance. The point of the allowance programme was to give firms this flexibility to reduce emissions in the least costly manner as they saw fit (Burtraw, 2000). The means included reallocating emission allowances within the firm, switching or blending fuels, installing scrubbers, conserving energy, retiring or repowering plants, or reducing or shifting production among plants. Since 1990, the prices of these abatement options have undergone dramatic changes due to reductions in the costs of hauling low-sulphur coal by rail, increased productivity in mining, and innovations in the use of fuel blending and in the design and use of desulphurisation equipment. Competition in the fuel market brought down not only fuel prices but also prices of scrubbers through technological change. Incremental process innovations and organisational innovations within firms and plants also contributed to reducing compliance costs. In fact, little trading took place, but the programme provided the incentive and flexibility to take advantage of the exogenous changes in input markets, including the decline in costs and the increase in the availability of low-sulphur coal (Burtraw, 1996). The marginal cost of compliance has been one-half to one-quarter of that projected when the programme was introduced.

The US allowance programme for sulphur dioxide induced innovative responses (Box 6.4), but few patentable innovations, at least not initially. Responses included organisational innovations by firms, in markets and in regulations, and process innovations by electricity generators and upstream fuel suppliers. The experience of tradable permits shows that organisational innovation plays a crucial part in the overall innovative response to environmental policy. The capacity of the policy instrument to allow firms and the industrial sector to capitalise on organisational innovations is important.

Organisational innovation in the form of fuel-switching has been a salient effect of the carbon tax in Sweden (Box 6.5). However, the effect of the carbon tax on the energy and resource efficiency of the Swedish industry has been limited because of the lower tax rates enjoyed by the industry, and because the paper and pulp industry (Sweden's most energy-intensive sector) uses mainly biomass and electricity generated by hydroelectric or nuclear power plants instead of fossil fuels (Johansson, 2000).

Box 6.5. **Carbon tax in Sweden**

Introduced in 1991 when the country's existing system of energy taxes was reformed, Sweden's carbon tax was targeted mainly at residential and commercial consumers of energy, with the industrial consumers and power generators taxed at a lower level. The carbon tax stimulated the increased use of biomass, the most abundant natural resource in Sweden's district heating system. The increased demand for biomass, in turn, encouraged the development of new methods for utilising wood fuels, ranging from new forestry resource extraction techniques, to improved wood fuel products, to improved flue-gas condensation in the biomass-based district heating systems. These developments led to cost savings in wood processing and increased thermal efficiency at biomass heating plants, with a resulting decrease in the price of biomass fuels from forests. The net effect has been reduced CO_2 emissions.

Source: B. Johansson (2000),"The Carbon Tax in Sweden", in *Innovation and the Environment,* OECD, Paris.

The Swedish experience points to the policy problem associated with the introduction of an economic instrument, especially a tax. In many OECD countries, the industrial sector is taxed at a lower rate or often exempt from environmental or energy taxes, because of strong opposition from that sector or disagreement about appropriate levels of taxes or charges. Such opposition was a major reason for the failure to institute an EU-wide carbon/energy tax and a system of tradable sulphur quotas. The process of negotiating a market-based instrument can be as tortuous as for traditional regulatory instruments, since these negotiations can involve a greater number of actors, and since industry most often resists higher taxes. Thus, although there is consensus that economic instruments offer a constructive way forward, they raise issues of equity and procedural problems concerning their negotiation (Howes *et al.*, 1997).

Designing effective environmental policy instruments — even market-based ones — that lead to cost-effective and lasting innovation is difficult. In general, no single instrument is sufficient to address the environmental problem for which the instrument is designed. Tradable permit schemes lead to certain quantitative outcomes because, by design, emission caps form an integral part of them. Like other instruments, they may require complementary measures, normally in the form of regulatory standards, especially when temporal peaks in emissions or local ambient concentrations need also to be limited.

Another example of effective policy combination is the Dutch water effluent charge, which — in combination with effluent standards — was effective in inducing the diffusion of biological waste-water treatment technology in the Netherlands. In general, policy instruments should be combined to achieve synergy, and the combination of standards with economic instruments is particularly useful in that it combines effectiveness with efficiency (Kemp, 2000).

The practical problems of designing and implementing economic instruments point to the importance of exploring and implementing other approaches, such as voluntary agreements (VAs). Like economic instruments, VAs are usually not applied independently, but operate in the context of policy mixes combining different instruments. As both empirical and theoretical analysis of VAs are underdeveloped, assessment of their effects on innovation remains limited. Theoretically, VAs are flexible, as they leave industry more freedom with regard to the method and moment of compliance; however, there is the danger of free-riding and under-exploitation of opportunities on the part of the industry (Kemp, 2000). Also, VAs are unlikely to provide firms with strong incentives to innovate, due to the fact that they rarely set technology-forcing targets,

but are likely to generate significant "soft effects" in terms of dissemination of information and awareness-raising (OECD, 1999*b*). To stimulate innovation, VAs should be combined with instruments such as technology compacts (Kemp, 2000; Banks and Heaton, 1998).

Despite these concerns, the use of voluntary agreements is proliferating, inducing development and diffusion of innovative responses. Examples are the Keidanren[11] Voluntary Action Plan on the Environment in Japan, mainly designed to reduce CO_2 emissions to meet Kyoto targets (Box 6.6) and voluntary agreements to reduce emissions of perfluorocarbon compounds (PFCs) in the aluminium industry in several countries.[12] VAs stimulate co-operation within the industrial sector to generate innovative responses and to monitor progress. Co-operation among various stakeholders characterises environmental compacts, which are a type of VA. The involvement of diverse groups may open the "pathway toward the discovery of hitherto untried technological approaches" (OECD, 1999*a*).

Box 6.6. **Keidanren Voluntary Action Plan**

The main rationale for the adoption of the Keidanren Voluntary Action Plan in Japan was to avoid higher costs from further government regulation (OECD, 1999*c*) on the industrial sector — a sector that is already operating at a high level of energy-efficiency and with a high marginal cost of CO_2 reduction. From the viewpoint of government, VAs can reduce the technical, administrative and political costs associated with regulations. Also, since in Japan both the government and industry are generally not in favour of energy or carbon taxes, VAs provide a way forward.

The Keidanren Voluntary Action Plan of 1997 follows the 1991 "Keidanren Global Environmental Charter" and the 1996 "Keidanren Appeal on the Environment" and involves 41 industries and 142 industry organisations. The incentive for action is generated by having industries declare specific goals as "public promises" and by conducting annual follow-up reviews of progress made towards those publicly stated goals. The Plan does not operate in complete isolation from government guidance, since progress is reviewed by government councils. The results of the second follow-up indicate that CO_2 emissions in fiscal year 1998 were 2.4% less than in 1990, and 6% less than in 1997. While these reductions mainly reflect declining industrial output, efforts to reduce CO_2 emissions through innovation have played a role (Ohta, 2000).

Innovation policies for sustainable development

When appropriately designed and implemented, environmental policies define the demand structure for innovative responses and can set broad directions for them. Successful instruments should provide incentives to innovate continuously and cost-effectively, but allow firms to choose the option that would maximise their benefits in internalising environmental externalities.

Yet, under current conditions, environmental policies alone cannot sufficiently stimulate dynamic efficiency. Due to the typically long time-horizons of R&D efforts, even if environmental policies send the right signals, it normally takes time to generate the most appropriate innovative response. Furthermore, firms may not choose to develop the best option in the long term, because it is not cost-effective in the short run. For example, the short-term, cost-effective option may be an incremental innovation, while in the long run incremental measures may be less cost-effective than more radical innovations. This is the case with technologies that are dependent on infrastructures whose costs are already "sunk", such as power generation and distribution. Finally, because of continued changes in the environmental issues that public policies need to address, it is unlikely that the directions set by environmental policies at one point in time remain adapted to these changes. These considerations imply that, for addressing environmental sustainability, matching the demand and the supply of innovations can be extremely difficult.

The above argument sets out a *rationale* for endorsing active innovation policies to help boost the supply of new knowledge and innovation so that, when the demand arises, it can be met with an appropriate

innovative response in a timely manner. Recent experience argues for this synergy between demand and supply, especially in the context of introducing radical innovations or new technologies that have not been used commercially on a significant scale. The experience of introducing wind-powered electricity in California is an example of the latter (Box 6.7). A move towards radical innovations or new technology systems is inevitable in the long run if OECD economies are to change their current resource and energy use patterns while sustaining economic growth and human welfare.

Box 6.7. **Wind power generation in California**

During the 1980s, publicly supported R&D programmes yielded some key innovations in turbine components. To stimulate demand for wind power, the U.S. Government offered tax credits and passed the Public Utilities Regulatory Policy Act of 1978 (PURPA), which required that utilities buy back electricity generated by small-scale plants based on renewable energy. This requirement was implemented at the state level and included long-term purchase contracts. California made the greatest use of PURPA, sponsoring a wind-resource assessment that identified the best sites for wind installations. The synergy of these supply- and demand-side policies succeeded in nurturing the immature wind-power market in the State in the 1980s.

Source: Norberg-Bohm (2000), "Beyond the Double Dividend: Public and Private Roles in the Supply of and Demand for Environmentally Enhancing Technologies", in *Innovation and the Environment*, OECD, Paris.

Because of the seriousness of many environmental problems confronting the world, the slow pace of change in environmental policy making, and the time-lag between incentives to innovate and results, strong initiatives from innovation policy are needed to push forward the rate of innovation for sustainability.[13] Governments need to employ a broad range of policy mechanisms that can effectively and synergistically create new technologies and new markets (Norberg-Bohm, 2000).

What characteristics of research and innovation policy best complement environmental policies and serve the objectives of sustainable development? Technology development depends on the effectiveness of R&D efforts in both the public and private sectors. In general, however, it is difficult to evaluate what types of support would be the most efficient use of public R&D funds for enhancing environmental sustainability (OECD, 2001*a*). In a survey of US firms in the environmental technology sector, there was a wide consensus that firms had insufficient commercial incentive to undertake basic research, and concentrated instead on applied research with clearer short-term benefits. However, the firms also reported that a large part of original basic research which eventually led to important environmental innovations was not directly targeted towards a specific environmental problem (Environmental Law Institute, 1997).

These results demonstrate the importance of the serendipity factor in R&D for environmental innovations. The trend towards increasing use of cleaner technology highlights this, since knowledge useful for environmental applications may come from any field of scientific inquiry. Therefore, promotion of broad-based, basic scientific research should form the foundation of innovation policies for sustainable development. Beyond support for basic research, however, research efforts may need to focus on particular sustainability objectives.

These considerations underpin the increasing government R&D appropriations directed towards environmental objectives discussed previously. Government appropriations, as well as private R&D activities, need to be carefully monitored to determine whether investments are adequate. That requires defining better what constitutes R&D that benefits the environment, since parts of research activities in diverse areas may have significant applications for environmental objectives.

Focusing R&D support requires great care. In the past, such support often tended to "pick winners" and to "lock in" technological development paths that were later judged to be sub-optimal from the

viewpoint of environmental sustainability or economic efficiency. Power generation technologies and transport technology are cases in point. These experiences have brought criticism of government-supported R&D. However, the positive externalities of R&D and the market failures in inducing optimal private investments in R&D underscore the importance of government support for R&D. How can R&D efforts be focused without at the same time trying to "pick winners"?

Recent approaches in research and innovation policies seek to address this question by shifting away from large, publicly supported technology programmes, and towards the use of public/private partnerships in funding and executing research. The partnership approach enhances the effectiveness of public investments in R&D since it leverages private funds (OECD, 1999*a*), while reducing public funding in sectors such as energy and pre-empting "free-riding" by firms. Partnerships can stimulate R&D at various stages, from basic research to near commercialisation. They normally require a larger share of public funding towards the basic end, and a larger private share nearer commercialisation. Public/private partnerships in the area of environmental innovation typically involve a variety of public and private actors in collaborative research efforts. The partnership approach can overcome institutional barriers, facilitate networking and address the systemic difficulties in R&D activities for enhancing interdisciplinary research.

An increasing number of OECD countries use technology foresight processes to set research priorities. A review of a number of technology foresight studies conducted in the 1990s shows that, among OECD Members, identifying technologies that can contribute to environmental sustainability is becoming increasingly important. These foresight studies have identified a broad range of future technologies, including: applications of biotechnology; information and communication technologies (ICT); new materials and micro-scale manufacturing; new energy technologies; and innovative waste treatment and recycling technologies (Fukasaku, 1999).

Many technology foresight exercises now involve experts across a wide spectrum of communities: research, government, business and civil society. Multi-stakeholder involvement guards against setting priorities on the basis of any one group or industry's interests, and increases the likelihood that when a choice is made it is in the interest of society. The involvement of the research community and business in the technology foresight process makes it possible to match the supply of new knowledge developments with market demand, by actively stimulating networking and inter-sectoral information exchange and collaboration. Some national foresight programmes, such as the UK Foresight Programme, are deliberately designed to stimulate this link (Box 6.8).

Box 6.8. **UK Foresight Programme**

The need to link the public research base and the market was a major conclusion of the first round of the UK Foresight Programme undertaken in the early 1990s. The new round of the recently launched foresight exercise is standing up to an ambitious task of enlisting diverse stakeholders in an interdisciplinary, inter-professional and intersectoral process for the restructuring of industries. This programme has three stages: identification of potential future technologies, stimulation of private initiative and commercialisation of such technologies. The most recent attempt is to link the foresight exercise to regional cluster development. It is quite noteworthy that this exercise is in itself a public/private partnership programme and public funding is supplemented by matching private funds

Source: Williams (2000), "Linking the Research Base and the Market through Technology Foresight", in *Innovation and the Environment*, OECD, Paris.

Networking and intersectoral collaboration are of vital importance for innovation-led growth, as well as for enhancing environmental innovations, and can be enhanced through the formation of research/industry

clusters. The Finnish Environmental Cluster Programme, one of the seven cluster programmes that the government funded between 1997 and 2000, is a recent initiative in this direction. The objective of the programme is to improve the quality of the environment by promoting eco-efficiency, developing new, more environmentally friendly products, encouraging entrepreneurship and creating new jobs. It targets the emerging environmental goods and services industry, one of Finland's fastest growing sectors. The government provides seed funding for research on new environmental technologies, to be carried out by consortia of producers and suppliers, universities and institutes. The projects launched aim to improve eco-efficiency through the application of life-cycle techniques in agriculture, forestry, basic metals and water management (Honkasalo, 2000; OECD, 1999*d*).

Possible undesirable effects of innovation policies (picking winners and locking in sub-optimal technology) may be avoided if radical innovations or entirely new technology systems are given a chance for experimentation. Innovations that lie beyond the accumulation of incremental innovations can transform large infrastructures that have been built up over many years. Transportation infrastructure is a case in point. Strategic niche management (SNM) is a new tool that induces such systemic innovations by allowing experimentation (Kemp *et al.*, 1998 and 2000). SNM is a means of trying out new technologies in a selected environment — market niches — by real users. In niches, the technology is temporarily protected from full market pressures and acts as a "test bed" and incubator. This tool has been applied for introducing light-weight vehicles in a Swiss town.

Infrastructures that need to be transformed encompass not only physical structures, but also social institutions that determine the flow of materials in the socio-economic system. Some of this is coming under scrutiny in response to sustainable development imperatives. For example, the Japanese government is trying to encourage a shift towards a "recycling-based" society. This programme aims to drastically reduce final wastes by recycling a broad range of products. The government is currently defining the legal framework, including laws that will oblige industrial sectors to recycle or reuse most of their products. The Keidanren Voluntary Action Plan, discussed above, integrates voluntary measures for recycling stipulated in these legislative measures.

New technologies for sustainable development

The shift to cleaner approaches implies the use of a wider range of technologies than those used in end-of-pipe processes. Biotechnology and ICTs have great potential for increasing the efficiency of resource use, and facilitating the shift to sustainable development. Potentially useful technologies could extend to other nascent technologies such as nano-technology and applications of superconductivity. Applications of these and other technologies could radically change production and consumption patterns, creating opportunities to drastically reduce resource use and wastes. At the same time, the potential of these technologies to generate negative environmental externalities needs to be assessed and addressed.

Information and communication technologies

The economic system is currently undergoing a fundamental shift, as the diffusion of information and communication technologies (ICTs) is changing the socio-economic institutions that have been built up during the past century. The change is analogous to that created by steam power, electricity and mass production, which has determined the shape of our techno-economic system since the Industrial Revolution. The current shift is characterised as the shift to a knowledge-based economy, in which knowledge is becoming the primary determinant of economic growth.

The impact of ICTs on environmental sustainability has recently become a subject of analysis, but evidence based on systematic analysis of its impact is still sparse. A recent review of available studies and evidence (Berkhout and Hertin, 2001) categorises the impacts into three orders.[14] First-order impacts are the direct effects of the production and use of ICTs, in terms of resource use and pollution

caused by the production of ICT equipment and networks, as well as associated power use and waste generation. Second-order effects are the indirect impacts of the diffusion of ICT use on industrial structure, production processes, products and distribution. Third-order impacts are the indirect effects related to increased consumption and changes in consumption styles. First-order effects, in the form of production, use and disposal of hardware such as computers, screens, network cables, etc., are mostly negative. Positive first-order impacts are generated by the use of ICTs for environmental protection purposes — e.g. monitoring of toxic emissions, remote sensing (including the use of satellites) and electronic controls.

Second-order effects are expected to be largely positive. The value added of the ICT-based service sector derives mainly from the manipulation of ideas rather than energy and materials. In the United States, for example, about 35% of economic growth between 1995 and 1998 is estimated to be attributable to IT business. Information technology is also changing the way in which virtually every product and service in the economy is designed, produced, distributed and operated. The economy is seen as growing not through the addition of more resources but through more intelligent use of resources to produce greater value. There is also evidence that ICTs have contributed to higher labour productivity. Such efficiencies are being achieved through the following applications of ICT:

- *Intelligent production processes and intelligently designed and operated products* — through the use of computer-aided design, precise control of operations through sensors and automated controls, resulting in fewer resource inputs.

- *Reorganisation of supply chains and business organisation by e-commerce* — leading to the closure of retail outlets, more efficient inventory and supply chain management and the rise of tele-working.

- *Intelligent logistics and distribution* — communications and computer-based management and tracking systems improve flexibility (just-in-time delivery) and efficiency of distribution systems.

- *"E-materialisation"* — through the substitution of tangible goods by intangible services.

However, there is uncertainty about whether these potential positive impacts can be realised. Possible impediments include :

- Resource productivity gains are slow, and only a portion can be explained by ICTs.

- The scope for e-materialisation may be limited.

- Incomplete substitution may result, and many ICT-based services and goods may only add to existing goods and services, especially during the transition phase. The mistaken expectation that computerisation would lead to "the paper-less office" (if anything, paper consumption usually increases with the spread of computers) is a case in point.

- Growth of the virtual economy may lead to growth in the material economy (e.g. e-commerce may induce the evolution of faster, more flexible transport infrastructure with greater capacity) bringing with it environmental and social stress.

Third-order effects refer to feedback processes, many of which are negative. They could well be very far-reaching but are difficult to assess. They include the so-called "rebound effect", often observed in the transport and energy sector, when a resource-conserving improvement lowering per-unit costs for consumers stimulates the use of the resource, thereby offsetting some or all of the efficiency gains. More generally, the economy may "re-materialise" as prices of raw materials fall and consumers become increasingly distanced from the environmental consequences of consumption. Better monitoring and evaluation of the links between ICT-driven productivity gains and environmental performance of OECD countries is needed.

Biotechnology[15]

The potential contribution of biotechnology to sustainable development is vast and diverse. Modern biotechnology makes use of recombinant DNA technology, building on recent gains in our understanding of genetics and the relationship between biological structure and function. In many industrial sectors, biotechnology has already yielded cheaper and cleaner ways to produce or clean up wastes (Box 6.9). Applications can be found in the chemicals, pulp and paper, textiles and leather, food and feed, metals and minerals and energy industries. These industries, which represent almost half of the manufacturing capacity of OECD countries, are also major contributors to global pollution. Many more industries are investigating opportunities from the use of living organisms and their constituent parts.

Biotechnology has the potential to produce equivalents to petroleum distillates, biofuels, which emit on a life-cycle basis much less CO_2 than fossil fuels — since biomass produces during combustion only as much CO_2 as it takes up during growth. In energy terms, annual production of biomass is some five times global energy consumption, but currently provides only 1% of commercial energy. Bioethanol is a CO_2-neutral liquid transportation fuel. As new technologies and more efficient separation techniques are developed, bioethanol will compete on cost with gasoline. One promising new application of biotechnology is the production of ethanol from cellulose using enzymes from genetically engineered bacteria to break down plant fibres, such as those obtained from forest waste and agricultural residues. Studies have shown that this process can reduce greenhouse gas emissions by 99% compared with gasoline. Until recently, ethanol-from-cellulose was impractical and costly to manufacture. However, demonstration plants are now being built, and expectations are that with further refinements the costs of the fuel could be brought down to close to, or even below, the after-tax price of gasoline. Over the next two decades, US ethanol production from ligno-cellulosic waste could reach 470 million tonnes a year, the equivalent in energy terms of current national gasoline consumption.

Box 6.9. **Industrial use of bio-catalysts**

Living systems manage their chemistry more efficiently than man-made chemical plants, and the wastes that are generated are recyclable and biodegradable. Bio-catalysts, particularly enzyme-based processes, operate at lower temperatures and produce fewer and less-toxic waste by-products and emissions than conventional chemical processes. Examples of the industrial use of bio-catalysts include:

- Cargill Dow Polymers has found a cost-effective way of making polylactide (a biodegradable plastic) from starch. Non genetically modified micro-organisms convert starch into lactic acid which is then chemically polymerised.
- Allied Colloids Ltd is developing an industrial-scale bio-process for making ammonium acrylate, a key component of many polymers. The current process is very energy-intensive and creates a by-product that is expensive to remove.
- Biochemie (part of the Novartis Group) has achieved significant reductions in waste and toxic chemical use by replacing a chemical process for the manufacture of 7-ACA (a key raw material for cephalosporin antibiotics) with a new enzymatic process.

There are a number of bottlenecks and challenges to the diffusion of clean-process biotechnology. The environmental advantages alone will not be sufficient to drive rapid adoption of biotechnology over existing chemical processes. The private sector will rarely make the investments necessary to develop and incorporate biotechnological processes into existing systems unless their benefits are proven. Novel processes often require significant capital expenditure, and conventional processing plants are built to operate for many decades. The slow uptake of biotechnology by the industrial chemicals sector suggests that the current economic advantage of biotechnology-based processes over existing methods is not large. In addition, the

entrenched infrastructure in industries that have relied on physical and chemical processes presents a significant challenge. The traditional training of chemical engineers and plant designers has not included the study of biological processes. Public understanding and acceptance is another important element for the widespread adoption of the new biotechnology. The major participants, — industry, government, the research community and not least the public — need to act in concert if biotechnology is to fulfill its potential contribution to industrial sustainability.

Addressing negative externalities and promoting public acceptance of new technology

Technological developments in sectors such as nuclear energy and agriculture provide examples of how not only environmental benefits but also risks to the environment or human health can accompany technological advances. New technologies have profound social impacts as well. Technology changes the nature of skills needed in workplaces, creating new categories of employment while eliminating others, with varying net impacts on employment. New technologies need to be assessed for their full potential impacts, both positive and negative. Working towards a better public understanding of the balance between the benefits and risks is vital.

A key challenge is creating an acceptable socio-political framework to continually monitor, assess and control technological developments, especially when safety issues are at stake. Open debates involving civil society and technology assessment processes involving the public, policy makers and the scientific community are ways to ensure full participation in a democratic decision-making process about technological options with due regard to their impact on sustainability. Technology foresight exercises may be linked more closely with technology assessment processes to steer future technological developments toward desirable directions while minimising negative impacts. In this regard, the recent attempt in the Netherlands to involve public interest groups in defining directions of research related to the environment is one example of how to engage civil society early on in discussions over the design and implementation of technology policy.

International co-operation for the development and diffusion of clean technologies[16]

Promoting sustainable development at the global level will greatly depend on the application of cleaner technologies in both non-OECD and OECD countries. Historically, advanced industrial countries have been the major generators of pollutants. Over the coming decades, however, most of the world's population growth and much of economic growth will take place in non-OECD countries with more rapidly increasing pollutant emissions than in the OECD countries. Non-members countries' share in global CO_2 emissions, for example, is projected to rise from around 45% today to 60% by 2020. Moreover, the global nature of issues such as climate change makes concerted international action indispensable.

Many barriers hinder effective international scientific and technological co-operation in developing and diffusing new technologies. Developing countries often face difficulties in gaining access to scientific knowledge and in developing appropriate technical skills. Their own knowledge base needs to be strengthened, and a pool of qualified human resource needs to be created to acquire, develop and implement environmental technologies efficiently. An adequate R&D infrastructure and an effective research network need to be built. However, international co-operation to favour "technology transfers" has so far not eliminated these barriers, mainly because the information and the capacities made available often did not respond to local needs.

International co-operation to develop and adapt appropriate technologies in developing countries should start with the identification of these needs. "Appropriate" technologies could be readily available ones, or innovative applications of technologies that would allow developing countries to "leapfrog" over the traditionally polluting stages of industrialisation. International co-operation should also address barriers to securing funds. Innovative financing mechanisms are needed to complement conventional loan financing and ODA. This could include new multilateral funds that may stimulate innovating financing such as

microfinance and "green" funds.[17] OECD Governments could also facilitate public/private financing partnerships so as to leverage limited public funds for R&D. Finally, they could help foster the formation of international "research and innovation" networks — such as the one developed by the Intergovernmental Panel on Climate Change (IPCC) — to more closely involve researchers from developing countries with their counterparts in developed countries.

Easier access to the results of public R&D for firms in developing countries will facilitate technology diffusion. National R&D programmes could be linked for regional or global collaborative efforts geared towards sustainable development. Since the private sector is the largest source of finance for cleaner production and a major actor in innovation, efforts should also focus on providing the private sector with an open and competitive environment, and on promoting public/private partnerships. Despite extensive efforts already made, more co-operation is needed in a wide range of areas. In this regard, current bilateral and multilateral international science and technology co-operation programmes need to be assessed from the perspective of developing countries' needs, and good practices identified and diffused.

OECD Governments can also play an important role in strengthening international co-operation for sustainable development by helping developing countries to create favourable framework conditions for research and innovation. They can also assist in vital areas of capacity building — for example, by helping to train local technicians in the operation and maintenance of pollution-control technologies.

International organisations can play a key role in facilitating scientific and technical co-operation for sustainable development by:

- Compiling data on national R&D activities and ODA devoted to sustainable development.

- Strengthening their role as a facilitator of international co-operation on science and technology.

- Creating new research and monitoring networks for sustainable development objectives.

- Establishing institutional mechanisms for the continuous assessment of environmental technologies.

- Fostering international co-operation in specific areas that can contribute to sustainable development, such as biotechnology and information technology.

Stimulating innovation that is beneficial for the environment: the role of policy

Research and innovation play a key role in paving the way towards sustainable development. However, they will not be entirely successful unless public policy gives the appropriate signals. Sound public-policy making requires a more systematic understanding of what drives firms to innovate, the extent and the type of efforts they are making to enhance environmental performance, and the obstacles they face. This is no easy task, since environmental innovations — and the barriers they face — are becoming more diffuse with the increasing role of cleaner technologies. A wide range of technologies can be used to improve environmental performance, including organisational innovations.

Information on public and private sector environmental research in OECD countries is still inadequate. There are no systematic and internationally comparable data on R&D expenditures for environmental objectives, nor is there a standardised method for indicators to analyse and compare environmental innovations in firms.

Available data indicate that public investment in R&D for environmental objectives remains at a rather low level. Given the pressing imperative to de-couple environmental pressures from economic growth, while continuing to satisfy human needs, the benefits of increased public commitment to generating new knowledge and supporting the development of new technologies are clear. OECD countries should step

up efforts in this direction based on a thorough understanding of the extent and areas of R&D efforts already taking place.

Environmental policies play a key role in sending signals to firms about where innovation is needed. Economic instruments are theoretically superior for providing the incentives and the flexibility to innovate continuously. Experiences discussed in this chapter also show that, in practice, economic instruments are not applied in isolation, and need to be designed and implemented with care if they are to stimulate innovation. They also show that it is sometimes difficult to negotiate an economic instrument and in such cases, voluntary agreements offer an intermediate alternative. Some recent evidence indicates that VAs can also stimulate innovation by allowing for flexibility in compliance.

The signalling role of environmental policies in stimulating innovation for sustainability needs to be complemented by innovation policies that ensure the adequate, appropriate and timely supply of innovations owing to the typically long time horizons needed, especially for radical innovations. Environmental policy instruments need to be complemented by innovation policies that put a premium on generic technologies whose wide-ranging application supports sustainability objectives beyond more narrowly defined environmental ones.

Because innovations useful for sustainability objectives may arise from any area of scientific inquiry, support for broad-based scientific advances should be the basic policy approach in the long run. However, in the shorter run, a more focused approach is needed, one that avoids picking winners and lock-in the effects of undesirable technology development paths.

Recent approaches to innovation policies respond to this need. Unilateral public support of large technology programmes is giving way to partnership approaches in funding and executing research. Partnership approaches leverage limited public funds for research and enhance their effectiveness by inducing private commitment. Diverse stakeholders are involved in the setting of research priorities through technology foresight processes. Research and industrial clusters facilitate the creation of innovation networks to stimulate innovation and its diffusion. Strategic niche management allows for experimenting with systemic technologies. Best practices reviewed in this chapter highlight the importance of fostering innovation clusters, of knowledge infrastructure, and of technology foresight exercises with explicit environment and sustainability objectives.

Sustainable development is a long-term objective that will determine the direction in which the techno-economic system evolves. It offers an "organising framework" for public policy makers, business and other stakeholders in reorienting their work. The new framework, in effect, defines the emerging technological paradigm within which future research and innovation activities will take place. Public policies should facilitate this fundamental transition.

NOTES

1. In this report, the term "environmental innovation" will be used to mean "innovation for environmental sustainability" without formally defining it. "Innovation", as defined in the Oslo Manual of the OECD (1997), includes process, product and organisational innovations. Some researchers call environmental innovation "eco-innovation", and propose to define it much broadly, encompassing social and institutional as well as technological and organisational innovations (Rennings, 2000).

2. This group includes providers of goods and services in air pollution control, wastewater management, solid waste management, remediation and clean-up of soil and water, noise and vibration abatement, and monitoring, analysis and assessment.

3. As far as environmental R&D *expenditure* is concerned, internationally comparable data are extremely limited. For instance, data on *the identification and treatment of pollution*, which is one of the two objectives of environmental R&D as defined in the Frascati Manual (OECD, 1994) are available only for Australia, Iceland, the Netherlands and Norway. They show that the share of environmental R&D in total R&D expenditure increased significantly during the period 1985-95 in all of these countries.

4. Corporate transformation seems to be progressing rapidly in some countries. According to a *German* industry survey, over 70% of innovating companies are engaged in environmental innovation. The survey also showed that about 80% of the environmentally innovating firms have been practising both end-of-pipe and integrated approaches (Cleff and Rennings, 1999).

5. Environmental economists point to the relative insignificance in terms of cost saving of such innovation offsets. Based on an analysis of the estimates of "cost offsets" associated with pollution abatement expenditures in the United States collected by the Department of Commerce's Bureau of Economic Analysis — which, according to the definition employed, includes both product and process offsets — Palmer *et al.* (1995) argue that these constitute less than 2% of estimated environmental expenditures. Walley and Whitehead (1994) criticise the win-win rhetoric of the Porter hypothesis by pointing to the fact that regulatory compliance is costly, especially in the traditional "dirty" industries such as petroleum, chemicals and pulp and paper. They argue, however, that from the corporate point of view, the crucial issue is not so much the cost of regulatory compliance itself but rather using corporate spending for environmental improvement through corporate strategies that increase the *shareholder value* of the firm.

6. There is some statistical evidence of this, although it is not consistent. A study correlating the relationship between environmental expenditures on one hand and patenting in environmental technologies on the other, has found that environmental expenditures have spurred increased patenting in environmental technologies in the United States, Germany and Japan (Lanjouw and Mody, 1996). Another study has found that increases in compliance expenditures within an industry in the United States are followed by increases in R&D, but not by successful patent application rates (Jaffe and Palmer, 1996).

7. The MIP survey has been conducted since 1993. In the 1996 survey, 2 264 firms responded to the survey, which included questions on environmental innovation. Of these firms, 929 were identified as environmental innovators. An additional telephone survey was conducted of those 929 firms, with a 45% response rate to more specific questions on the goals of environmental innovation.

8. A questionnaire to 481 executives worldwide on the importance of sustainable development by Arthur D. Little in 1999 shows that fewer than 20% replied that they were "well down the road" towards sustainable development; nonetheless, nearly half indicated that they were "making some progress".

9. The debate on dynamic efficiency is still open in the environmental economics literature. While the superiority of market-based instruments has been confirmed in models with perfect competition and complete information, standards could perform better under different circumstances such as imperfect competition. In addition, innovation efficiency of performance standards could be improved substantially by "technology forcing" — e.g. by setting long-term standards that go beyond existing technologies (Rennings, 2000; Carraro, 2000).

10. Innovation waivers allow firms to search for better technological options by extending compliance deadlines to install equipment to meet emission standards.

11. Japan Federation of Economic Organisations.

12. Including Australia, Canada, France, Germany, Norway, the United Kingdom and the United States.

13. According to a German industry survey, companies view "protracted approval procedure" and "unreliable environment policy conditions" as factors of great importance impeding environmental innovation. "Lack of opportunities to amortise or pass on costs", and "lack of financing opportunities" were also ranked highly as impediments. This confirms the severity of the double externality problem faced by firms, and the necessity to design and implement more focused and integrated policies for promoting environmental innovation (ZEW *et al.*, 2000).

14. This section is based on that study.

15. Based on work of the OECD Biotechnology Unit, including OECD (1998*b*).

16. This section is based on OECD (2001).

17. The creation of such an international fund is part of the "Policy Recommendations" of the OECD-Seoul Conference on International S&T Co-operation for Sustainable Development (Seoul, 15-17 November 2000).

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Chapter 7.

EXPERIENCE IN OECD COUNTRIES

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EXPERIENCE IN OECD COUNTRIES

Introduction

This chapter[1] overviews a number of special chapters of the OECD *Economic Surveys*[2] on "enhancing environmentally sustainable growth" in selected OECD countries. It highlights a number of themes that were common to these studies. It should be emphasised that, owing to the selective choice of issues treated for each country, the absence of a recommendation covering a particular issue for certain countries generally means that issue was not covered in the corresponding Survey — not that the issue was discussed and found to merit no comment.

The central focus of this chapter is how countries succeed in conducting cost-effective and consistent policies in the environment and natural resource areas, rather than on environmental outcomes themselves. Hence critical remarks are sometimes made of countries that have "good" environmental records but where policies seem unnecessarily costly.

Despite the desirable properties of economic instruments in reducing the cost of reaching environmental objectives (see Chapter 5), much of the environmental legislation in the OECD countries is still based on command and control regulation. Hence, the main focus of the country studies has been the extent to which countries are implementing, or extending the use of, economic instruments. Regulation *per se,* and how it can be made more cost-effective, has received less attention.

The first section examines how countries deal with policy co-ordination and formation in the environmental domain. Given the wide range of activities that affect, or are affected by, any particular environmental problem, co-ordination is particularly important for achieving good results. However, sectoral policies often ignore or even accentuate a number of environmental problems. While many sectors may be involved, those most frequently considered in the country studies were agriculture, transport and energy. The section also discusses some specific mechanisms that countries have put in place to improve policy co-ordination, including an assessment of the use of cost-benefit analysis.

The next section looks at how economic instruments, particularly taxes and tradable permits, are used in the countries studied, and areas where their use could be extended or improved. The role of voluntary approaches is touched upon.

The final section discusses some obstacles to implementation of economic instruments — competitiveness and distributive effects — summarising the view of these issues that was presented to and accepted by the OECD's Economic Development Review Committee and Economic Policy Committee.

Policy co-ordination

Attempts to increase the degree of co-ordination of policy across sectors have become a priority in all OECD countries. This section looks at some of the areas where discrepancies between sectors seem particularly striking — generally where environmental externalities that are recognised as important in

environmental policy are being ignored or even accentuated in sectoral policies — and then surveys the different ways in which countries are trying to improve co-ordination.

Sectors

Sectoral policies covering agriculture, fisheries, transport and energy can significantly distort resource allocation with adverse environmental side-effects.

Agriculture and fisheries

Agricultural policies in most OECD countries deliver substantial subsidies (see Chapter 14). In some countries, agriculture is also perceived as the guardian of nature and landscape, even while it exploits and alters them. Although agriculture contributes to a number of pollution problems, most notably of surface water, it is often exempted from the taxes and other measures that are applied elsewhere to deal with these problems. A major water user, agriculture generally benefits from subsidies for water use, usually implicit, often in the very areas where water is scarce. Most *Economic Surveys* made recommendations for policy changes in the areas of water supply and pollution.

Making quantitative cross-country comparisons for these problems is often difficult. A good illustration of this difficulty is water pricing, where the price of water supplied to agriculture is almost always substantially less than that supplied to households or industry (Figure 7.1). Although differences in the quality of water supplied to different uses make the direct price comparisons shown in Figure 7.1 somewhat hazardous,[3] the difference in the cost of water to industry and to agriculture seems much greater than could be explained by these quality differences. Among the countries shown, only the Netherlands and Austria seem not to provide implicit subsidy to agriculture through water pricing.

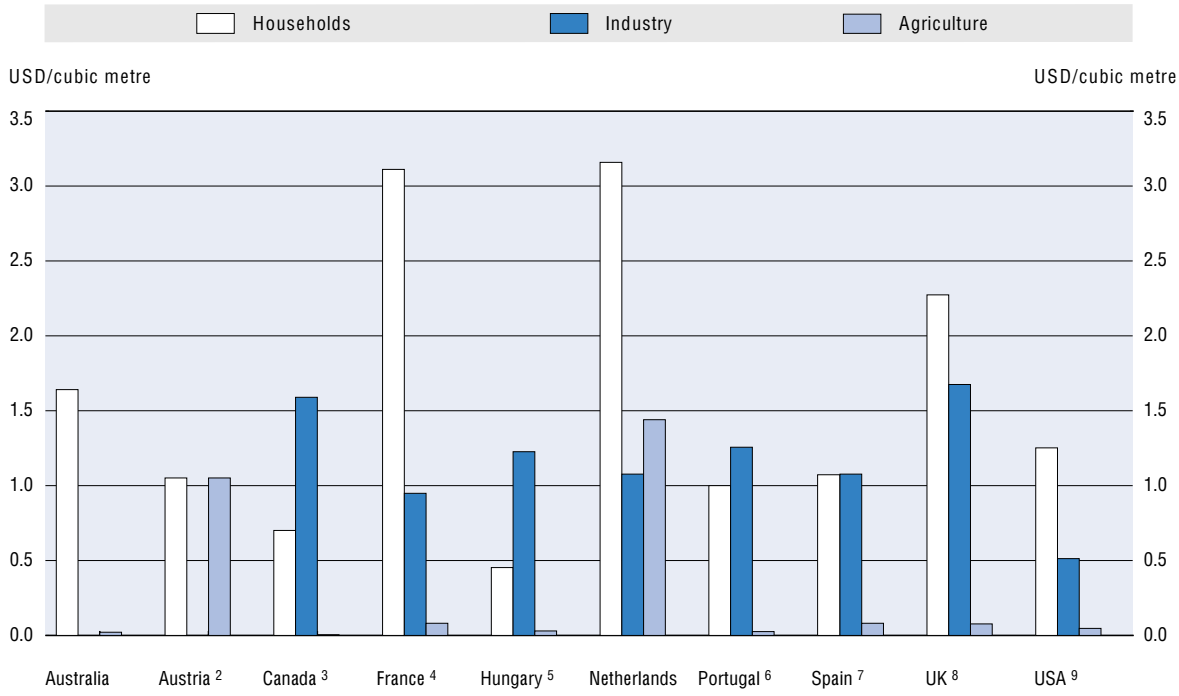
The environmental externalities arising from agriculture are also frequently subject to a different regime from those of other industry and households. This is particularly the case for water pollution from applications of mineral fertiliser or animal manure, which leach into ground water or run off into surface water. Initially, increasing problems with such water pollution have been tackled by concentrating on point sources of nitrates and phosphates in industry or public sewage treatment works, where discharges can be measured directly. These efforts have resulted in reductions of this type of water pollution from industry in many countries. Among the countries surveyed, Denmark, Finland and Germany have used regulation and higher charges and taxes, while the Flanders region of Belgium has introduced a tax on industrial nitrate discharges. However, agricultural regulation and subsidies have yet to achieve expected reductions in discharges in any of these countries.

This is partly because environmental targets for agriculture are less stringent than for other sectors, and because economic incentives are rarely used. Frequently, where fertiliser taxes are used, agriculture is either exempted (e.g. Denmark, where a fertiliser tax applies to household use but not to agriculture) or subject to very low rates (*e.g.* Belgium, where nutrient taxes are implemented at a low rate for applications below a relatively high level, the rate being multiplied by over 40 for "excess" application above the threshold). Nutrient accounts are used as a basis for taxation only in the Netherlands. Although these accounts are also maintained in Denmark and Belgium, they are not used for fiscal purposes.[4]

As most subsidies become capitalised in land prices or rents, individual farmers, especially small ones and tenants, feel that the profitability of their farms is low. In turn, this increases resistance to economic instruments. Farming lobbies have generally succeeded in persuading the authorities to use a regulatory approach, perhaps in the hope that it would allow them to claim subsidies. As noted below, however, economic instruments can be designed to moderate the net burden on farmers, by grandfathering tradable permits or tax credits— insofar as necessary for social reasons.

Managing fisheries in a sustainable manner is difficult, as many interests can collide. The experience of the Atlantic fisheries of north-east Canada illustrates the difficulty of separating regional policy from fishery

Figure 7.1. **Water prices in selected OECD countries[1]**
mid 1990's



Notes: 1. For agriculture, industry and households, prices are the median values for the range of prices for each category.
2. Water used for livestock activities is obtained from municipal systems and priced at households rates.
3. Industry: these rates apply to commercial establishments only. While this may include small industries, the rates do not apply for major industrial operations.
4. Agriculture: data refer to the regions of Adour-Garonne and Côteaux de Gascogne; industry - the value refers to 1990-93 and excludes taxes, pollution and abstraction fees.
5. Agriculture: the value refers to 1998 water abstraction charges; households and industry : the values refer to 1998 maximum and minimum user charges for public water supply.
6. Agriculture: data refer to the regions of Sorria and Vigia. When it is a two-part tariff, the values were based on the estimated water volumes and the value per cubic metre.
7. Agriculture: data refer to the regions of Andalucia, Castille and Valencia. Industry: the values refer to 1992:94.
8. Agriculture: data refer to Northumbria and Wales.
9. Agriculture: data refer to the regions of Sacramento River and Tehama.

Source: OECD, (2001), *Environmental Indicators for Agriculture - Volume 3: Methods and Results*, and OECD, (2001), *The Price of Water.*

management, to the detriment of the latter. Inappropriate capacity-expanding subsidies in the 1980s — motivated partly by concern to promote regional development in a remote part of the country — contributed to the collapse of groundfish stocks (as did overestimates of the size of the stocks themselves, along with the activity of foreign fishing fleets). The fishery was closed in 1992 when it was clear that certain fish stocks had been practically wiped out. At the time, measures were taken to compensate workers and boat owners These measures have prevented fleet capacity from contracting, with the effect of retaining people in a region largely dependent on a fishing industry that can no longer sustain the local economy (OECD, 2000*a*, pp. 133-140). Part of the problem has stemmed from the unemployment benefit system, which was used as a subsidy to labour resources remaining, even if on a part-time basis, in the fishery sector.

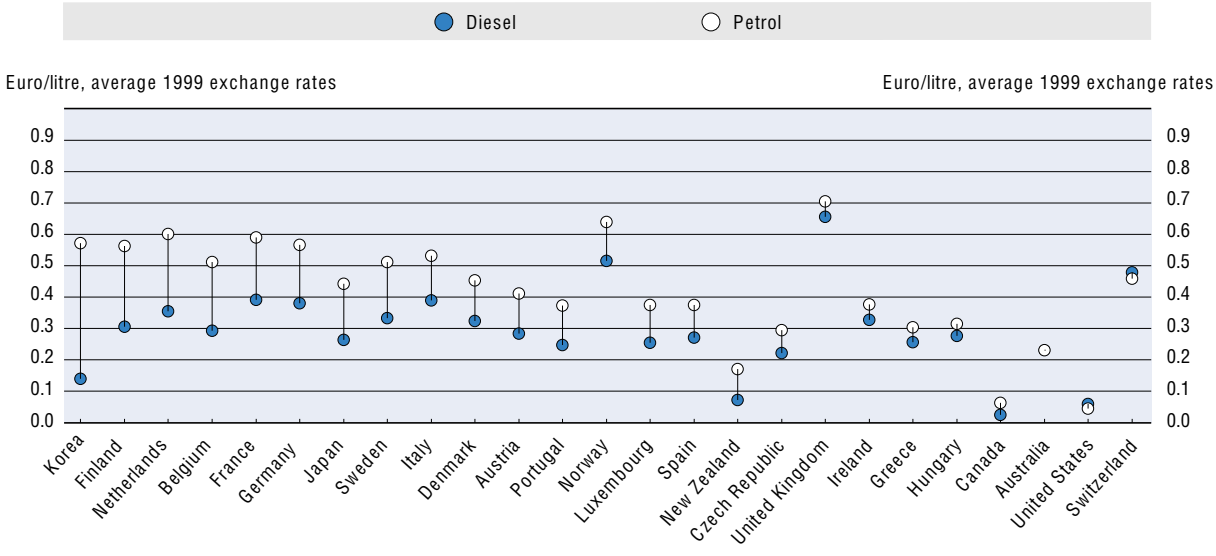
Transport and energy

Although some subsidies to transport may directly encourage pollution, the main problem in transport is that pollution or congestion externalities are not properly priced. As transport is rapidly growing, its contribution to environmental problems is also increasing. Generally speaking, policy measures that affect

transport (not all of which necessarily owe their origin to environmental concerns —notably in the case of fuel and vehicle taxes) appear a long way from equalising marginal abatement costs for the main emissions, whether across different forms of transport or between transport and other sources of these emissions.

In some cases, this lack of consistency is difficult to avoid, as it is not always possible to apply the same policy instruments in all sectors. Even where economic instruments — e.g. fuel taxes — are relatively simple to apply, there are anomalies. A clear example is the relative levels of diesel and petrol taxes. In almost all countries, the fuel tax on diesel is lower, per litre, than that on petrol (Figure 7.2). This differential appears to have its origins partly in intuitively attractive but mistaken reasoning that diesel is more economical than petrol — and so its use should be promoted — and partly in successful lobbying from transport enterprises. Pollution externalities from a litre of diesel, however, are almost always higher than for the same quantity of petrol (Figure 7.3). Petrol and diesel taxes are thus counterproductive from an environmental point of view, and no other considerations appear to justify the tax differential between the two types of fuels.

Figure 7.2. **Taxes on diesel and petrol as of January 2000**



Source: OECD/EU Database on environmentally related taxes.

Figure 7.3 shows how successive regulations have enormously reduced air pollution externalities per volume of fuel burnt in new motor cars (standards in North America, not shown in the figure, improved earlier). Regulations that forced these improvements would probably pass a cost-benefit test. But it would be interesting to ask whether using economic instruments — such as a tax on new cars based on relevant emission characteristics — might have been even more cost-effective. Other externalities, such as uninsured accident costs, noise, congestion and costs of wear and tear on infrastructure are also becoming more important relative to those on air pollution. To address these externalities, taxation will need to shift from fuel sales to tax bases more closely related to these problems. New technologies make it increasingly feasible to conceive better-targeted systems of charges. These can be related to road use, environmental and other characteristics of all kinds of vehicles (ECMT, 2000).[5]

Important in the transport sector, energy is more generally a key intermediate input and an important expenditure item for consumers. Energy supply produces a number of the most significant pollutants, but is often treated more favourably than other sectors causing similar externalities. Although coal extraction subsidies have declined considerably over the past 15 years, they remain significant in some countries. In

Figure 7.3. **Air pollution externalities due to motor car fuels, Belgium**

Note: The figures are based on estimates of emissions under certain typical driving conditions, Brussels: urban centre of a large city; highway: highway in a rural location; rural: a Flemish village and certain types of car, corresponding to successive European emission standards, for new cars: pre-1993; 1993 (directive 91/441/EEC),1997 (directive 94/12/EC), 2000 (directive 98/69/EC).

Source: Leo De Nocker, Luc Int Panis, Rudi Torfs: "Environmental damages from transport in Belgium: trends and comparison with excises on petrol and diesel", contribution of the Flemish Institute for Technological Research (VITO) to EU report, DGXII (2000), "External costs of Transport, Final Report, Office for Official Publications of the European Communities, Luxembourg.

a number of countries, depreciation and other tax allowances result in more favourable treatment for investment in oil and gas extraction than in other sectors. This treatment encourages overuse and depletion of exhaustible resources, and has other harmful environmental effects.

Co-ordination

Countries have implemented various procedures for assessing both the economic effects of environmental policies, and the environmental impact of other policies. Some of these procedures are discussed below. Table 7.1 gives an overview for a number of countries.

Environmental impact assessments (EIA) are today widely used for infrastructure *projects* undertaken by government departments or agencies, or for which government agencies need to give approval. Assessing the environmental impact of such a project allows these impacts to be taken into account alongside the other costs and benefits of the project. A comparative assessment of how well these procedures work in different countries is not available. Cost-benefit analysis of environmental impacts is almost never obligatory and rarely undertaken.

Less frequent than EIA are systematic procedures for assessing the environmental impacts of *policies*. Such procedures — for *new* policy measures — are now becoming more common, under the name of Strategic Environmental Assessments. The ministry sponsoring the legislation is generally responsible for carrying out the assessment. And, again, cost-benefit analysis of the environmental effects is not mandatory and rarely, if ever, included. Experience with such assessments of policies is relatively limited.[6]

Analysis of the economic costs of regulations — generally covering all regulations, not just environmental ones — is becoming a general requirement for introducing new policies in most countries. A significant feature of US procedures is the regular report to Congress from the Office of Management and Budget, which compiles and tabulates the expected costs and benefits of recently introduced regulations. However, after attempts in the United States in the early 1990s, the US Government abandoned efforts to direct policy actions to those areas where the ratio of benefits to costs was highest (OECD, 2001*c*, p. 127).

Another interesting approach to improving co-ordination was the establishment in Canada of the Commissioner of the Environment and Sustainable Development in 1995. Established in the office of the Auditor General, the Commissioner is charged with promoting the "integration of the environment and the economy", and operates as an auditor of federal policies in these areas. However, without direct powers over policymaking or implementation, the office's influence is limited to the publication of an annual report on progress in implementing announced policies, including recommendations on policy reform in various government departments. This report nonetheless provides a very valuable source of information and promotes public debate on these issues.

The legal system

A potential mechanism for improving coherence is the legal system. An extreme position might be that since most issues of environmental damage are similar to personal injury or damage, setting a general framework in which individuals can make claims in the courts for damages against polluters would remove much of the need for specific legislation and regulation. The threat of litigation would force enterprises to limit pollution to levels where the cost of further abatement exceeded what would be awarded against them in courts. However, with some of the main pollutants, establishing a link between specific cause and effect is practically impossible; considerations of information, cost and interdependencies make this an unworkable approach on its own. Nevertheless, the court system can play a role in, for example, ensuring that environmental legislation is evenly applied.

Use of the courts varies enormously among OECD countries, partly because of differences on liability law and standing, that is, who has the right to take court action (Table 7.2). Where compliance with the law by a polluter provides a defence against actions for damages, the ability of this kind of action to establish some

Table 7.1. **Environmental impact and regulatory assessment in selected OECD countries**

	Environmental effects		Economic effects of environmental policies	Public domain
	of projects	of policies		
Australia: federal	Required for actions that with a significant impact on matters of national environmental significance. Economic and social matters must also be considered.	No requirement.	Regulatory Impact Statements may apply	Yes
Australia: Queensland	Required, under defined procedures, for major projects. More limited EIA for others, can depend on risk and local government provisions. No CBA required.	None	Regulatory Impact Statements required for "new and revised regulations and other subordinate legislation likely to impose appreciable costs…" CBA of regulatory options	Yes, for EISs and RISs, with mandatory period for public comment.
Austria	Yes No CBA	Ad hoc. Some sectoral laws require it.	No (Fiscal impact only)	Yes
Belgium: Flanders	85/337/EEC implemented	Legislation for Strategic Environmental Assessments under preparation.	No (Some ad hoc examples)	Where 85/337/EEC applies, yes.
Canada: Alberta	Yes, with exemptions (list of exemptions includes oil wells). CBA required. Assessment often done even when EIA not formally required.	Part of normal inter-ministerial consultation	Fiscal implications only	Yes
Canada: Federal	Yes, when they have important environmental effects. Can be delegated to Provinces.	Strategic Environmental Assessment required (1999 Cabinet Directive) when policy proposal may have important environmental effects. No CBA required.	Regulatory Process Management Standards recommends cost-benefit analysis regarding health, social, economic or environmental risks; CBA guide. 1999 Regulatory Process Statement requires that benefits of regulations exceed costs, and that impact on economy is minimised.	Database of EIAs in Canadian Environmental Assessment Agency. Environmental Commissioner's reports
Denmark	Obligatory for projects which may have significant environmental impact. Done by agency sponsoring the project. No CBA required.	Environmental Impact Statements No CBA required. Checklist approach	Regulatory impact statements required for all bills. "The evaluation of the business economic consequences [of any bill presented to parliament] should as a minimum discuss the immediate effect of the bill on the costs for trade and industry, including administrative consequences."	Yes. Annual "Environmental Assessment of the Budget" reviews costs of environmental policy, with some evaluation of the environmental impacts of the national budget. Cost-benefit framework, but few formal analyses presented

Table 7.1. **Environmental impact and regulatory assessment in selected OECD countries** *(cont.)*

	Environmental effects		Economic effects of environmental policies	Public domain
	of projects	of policies		
European Union	1985 Directive 85/337/EEC, modified in 1997, requires Member states to carry out EIAs for certain kinds of project. Defines minimum standards for all EIAs. No CBA required.	85/337/EEC specifically excludes legislative action.	No EU provisions	Where 85/337/EEC applies, yes.
Finland	Obligatory for projects which may have significant environmental impact. Done by the agency sponsoring the project. No CBA required	Yes. No fixed procedures.	Legislative proposals are required to include "economic assessments."	Yes, for projects
Germany	EIA required for federal and Länder projects. No CBA required	Generally required for all laws and regulations. Specific procedures in some cases. No CBA required	All proposed laws must include analysis of effects on private interests. EIAs must present the economic impact of environmental measures.	Yes
Norway	Required under several laws, for major projects: 85/337/EEC implemented. No CBA required.	Assessment required by Administrative Order.	Assessment required by Administrative Order (for economic, administrative and environmental effects).	Yes, for EIAs under 85/337/EEC. Yes, with some modifications, for assessments required by Administrative Order.
United States	Required for "policies, regulations, and public laws of the United States," which includes private entities seeking a federal permit. Most often associated with Federal Infrastructure and permitted projects. No CBA required, but larger projects will typically include an economic impact analysis and CBA.	Environmental Impact Statements. No CBA required.	Economic Assessments (formerly Regulatory Impact Assessments) required for any "significant" regulatory measure (e.g. economic impact of over $100 million). Includes inter-agency review and CBA. (Conclusions of CBA not binding). Annual publication of costs and benefits of regulations (OMB) since 1998. New legislation is pending in Congress to make this a more permanent requirement. "Regulatory flexibility analysis" (RFA), for regulations that have a "significant economic impact on a substantial number" of small entities. Numerous provisions also in the authorising environmental legislation.	Yes

Note: The information in this table was compiled on an ad hoc basis through bilateral contacts. The coverage and accuracy of the information presented is not uniform.

Source : *OECD* Secretariat.

kind of consistency of treatment is limited, except as provided for anyway in the relevant law. Legal tradition may be as important as the letter of the law. For example, continued violation of European law (enforceable in national courts) in Belgium, with respect to Brussels sewers, resulted in no legal action from Belgian citizens— the EU Commission started legal proceedings in the European Court which appeared to accelerate the process of taking serious measures to establish appropriate sewage treatment in Brussels (OECD, 2001*a*).potential

In the United States, where the courts are most active in environmental issues, compliance with the law is generally a defence, but not always a complete one - provisions amounting to a duty of care can allow damages to be obtained even when the letter of the law was respected. Such provisions may be reinforced by being written into the relevant environmental legislation itself. In Belgium, where compliance with regulations is generally a complete defence, a recent Flemish law has changed this in the case of groundwater pollution, establishing a regime of absolute liability. Similarly, the Superfund regime in the United States foresees that contaminated but abandoned sites are the joint and several liability of any enterprise having used the site in the past. Yet the Superfund regime does not appear to have produced particularly cost-effective responses, even if many evaluations of this cleanup programme exaggerated its economic costs.[7] More generally, the OECD report on regulatory reform in the United States found that litigation in courts have imposed significant economic costs (OECD, 1999*c*). The assumption that private litigation can resolve conflicts optimally might have the additional drawback of leading governments to abdicate responsibility for environmental issues too readily.

Cost-benefit analysis

Use of cost-benefit analysis (CBA) in environmental policy varies considerably from country to country. Its use appears to be increasing, but CBA is rarely mandatory. In many countries, formal quantitative CBA analyses are still rare. Indeed, all OECD *Economic Surveys* on "environmentally sustainable growth" have included recommendations for increased or more systematic use of CBA. This section briefly surveys the variety of practices for the use of CBA in environmental policy in different countries.

While it is difficult to make comparisons, CBA seems to be more widely used in the United States than in Canada and Europe (though Denmark is rather more active in this regard). Overall, in most countries, CBA seems to play a rather small part in determining or quantifying the *targets* of environmental policies, as well as in assessing the *impacts* of other projects or policies on the environment (Table 7.1). In the United States, where explicit and quantified CBA is used most extensively, some legislation explicitly requires that CBA should *not* be used for such purposes[8] — though it is often equally explicit that, once an objective has been decided, it should be pursued at least cost. The pursuit of least cost solutions is, however, more systematically embedded in general mechanisms to review all regulations and legislation for their economic impact.

In the European Union, national environmental policies are partly responsible for the implementation of EU directives. Until recently, these EU directives were largely developed and implemented without formal cost-benefit analysis.[9] Although there might be EU-wide advantages in implementing common standards — even if in certain areas the costs of doing so may exceed benefits — the implicit assumption of these EU directives seems to be that benefits exceed costs *in all countries*. Once EU directives have been issued, they are binding on member states, and countries have little incentive to assess their costs and benefits (though they should still aim to implement directives in a least-cost manner). This is clear, for example, in the cases of Denmark and Belgium, countries who fall short of targets for surface water standards either because of agricultural discharges or (in parts of Belgium) because of household sewage. For example, despite evidence — admittedly circumstantial — that the costs of meeting the EU standards for bathing water in the Walloon region of Belgium are high relative to expected benefits, no explicit analysis of this issue has yet been undertaken in the region.[10]

In some cases, CBA has been used to illustrate the costs of environmental externalities and, thus, to support the introduction of environmental policy measures. For example, this has been the case for the Swedish Committee on Environmental Objectives in 2000 and the EU directive on emission standards.[11]

Table 7.2. **Legal liability and standing in selected OECD countries**

	Can polluted individuals take court action against polluters?	Compliance with the law a defence?	Can NGOs take court action against polluters?	Can citizens/NGOs take action against government agencies for non-enforcement or non-implementation?	Specific legislation
Belgium	Yes	In some cases.	Yes	Yes	There are specific liability rules in the Flemish region for damage as a consequence of e.g. groundwater extraction and soil pollution.
Denmark	Yes. Damages only for monetary loss or compensation for actual remedial expenditures undertaken	Basic test is negligence. Compliance with law likely to be a defence.	Yes (they must have "fixed structure" and have objectives that are relevant to the case.)		Danish Society for the Conservation of Nature has statutory right to make complaints against certain administrative decisions
Finland	Yes	No (except certain types of water pollution)	No (except for destroying or impairing nature, under the NCA)	No	Environmental Damages Act (1994). NCA: Nature Conservation Act (1996)
Ireland	Water and air: Yes (except for discharges by local authorities) Other: No	Water and air: Yes	Yes (at least for water, air and planning)	Yes, under judicial review of actions, not clear for inaction	
Norway	Yes	Usually	No	No. Specific decisions can be contested.	
EU				Individuals and NGOs can take action in national courts to require implementation of EU provisions if incorporated in national legislation.	
UK (England and Wales)	Yes	Probably no	Yes	Yes, under judicial review of actions, not clear for in action	
United States	Yes	No (may mitigate)	Yes (under specific citizen suits provisions in environmental laws)	Yes (where agency has statutory duty to act, and where plaintiff can show "injury")	Administrative Procedures Act Various Executive orders

Sources:
a) Belgium: Faure, M. (1999), "Environmental liability in Belgium," in K. Dekelelataere and M. Faure (eds). *Environmental law in the United Kingdom and Belgium from a comparative perspective*, Intersentia;
b) Denmark: E.M. Basse (1999), "Denmark" in *International Encyclopedia of Environmental Law*, Kluwer Law International, The Hague/Boston/London;
c) Finland: P. Vihervliori (1998), "Finland" in *International Encyclopedia of Environmental Law*, Kluwer Law International, The Hague/Boston/London; d) Ireland: Y. Scannel (1994),"Ireland" in *International Encyclopedia of Environmental Law*, Kluwer Law International, The Hague/Boston/London;
e) Norway: Ministry of Environment;
f) UK: Faure, M. (1999), "Environmental liability in the UK" in K. Dekelelataere and M. Faure (eds) *Environemntal law in the United Kingdom and Belgium from a comparative perspective*, Intersentia;
g) US: Richard Stewart, NYU Law School.

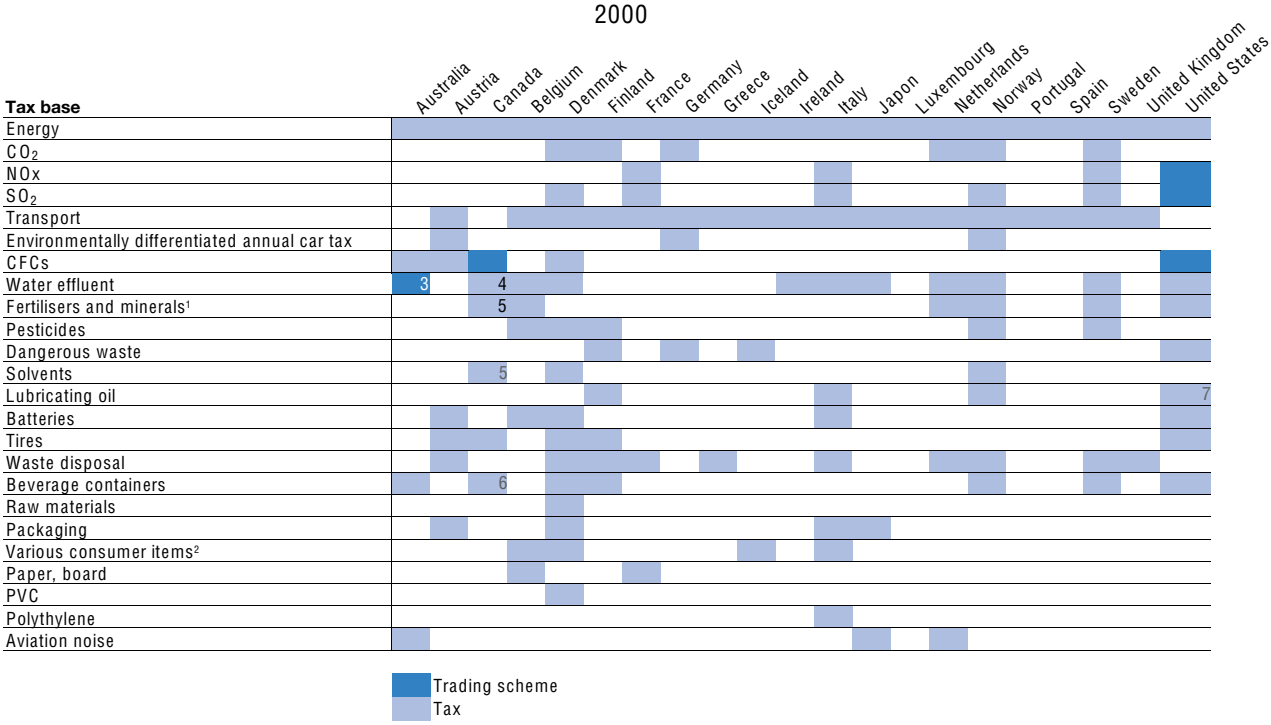
Valuation of environmental externalities raises a number of specific problems discussed in Chapter 5. But these and other difficulties should not imply that CBA should be ignored. In many cases, CBA may not be suitable as the sole decision criterion, and governments should not, in general, be required to limit their decisions to those measures where monetised benefits exceed their costs. However, when adopting policies that fail to satisfy a cost-benefit test, governments should at least be required to provide a reasoned justification of why non-quantifiable (or impossible-to-value) benefits have led them to reverse decisions based on CBA. In fact, an *implicit* cost-benefit analysis is undertaken whenever a project, regulation or policy is proposed — whoever proposes it, presumes that the benefits of this action exceed its costs. Formalising such analysis means that assumptions, which may otherwise be hidden, have to be made explicit and possibly checked for their validity, or at least for consistency of use. It is important, in this respect, that the presentation of the results reflects the status of the data being used, and the areas where differences of view on valuations could lead to different results.

Choice of instrument

Economic instruments

The OECD *Economic Surveys* provide several illustrations of areas where economic instruments are working well, as well as identifying others where their use is more problematic. An array of economic instruments is now in use in an increasing number of OECD countries, including taxes or tradable permits for polluting emissions to the air, and taxes on toxic products and various types of waste (Table 7.3). As discussed elsewhere, environmentally related taxes represent a small share of total tax revenues, less than 6%

Table 9.3. **Use of economic instruments in OECD countries**
2000



Notes:
1. Minerals are phosphorus and nitrates.
2. Such as disposable razors, disposable cameras, bags, disposable tableware, light bulbs.
3. Hunter river salinity.
4. Quebec.
5. British Columbia.
6. New Brunswick and British Columbia.
7. Rhodelsland.

Source: OECD (1999), *Economic instruments for pollution control and natural resource management in OECD countries: a survey.*

on average in 1998, a share which has not increased since 1994, with the bulk accounted for by motor fuel and motor vehicle taxes.

Taxes versus cap-and-trade systems

In principle, a tax is the "dual" of a cap-and-trade system — the former fixes the price of emissions, the latter fixes the quantity — and the choice between them depends on which of these policymakers prefer to set. In practice, the choice is blurred — a tax is rarely introduced without some estimate of the effect it will have on emissions, and cap-and-trade systems are usually accompanied by estimates of likely permit prices.[12] Given the growing interest in cap-and-trade systems interest, it is useful to rehearse some factors influencing the choice between these two types of instruments (see Chapter 5, Box 5.10, for guidelines on implementing tradable permits systems):

- When the shape of marginal abatement cost curves are unknown *ex ante*, both the quantitative targets of cap-and-trade systems and the levels at which environmental taxes are set are likely to change as experience elicits information about abatement and environmental costs. Decisions on which instrument to use will need to consider which is more easily revised, and which is more expensive if mistakes are made.

- The monitoring costs involved in taxing or capping-and-trading emissions are equivalent. However, when an environmental tax can be easily included in already established tax systems (as in the case of taxes on fuel) administrative and enforcement costs will be lower than for establishing a new cap-and-trade programme.

- Both taxes and cap-and-trade systems can be designed to deal with adjustment costs at their introduction. In a trading system, permits can be grandfathered (i.e. freely distributed based on past emissions) instead of being auctioned; similarly, in a tax system, tax credits equivalent to the tax payable on past emissions could be issued. To avoid discrimination against new entrants under either system, tax credits or free permits could be issued on some proxy basis, *e.g.* in proportion to output.

- A market for tradable quotas may not work efficiently if the number of participants is too small. Liquidity may be limited, and possible market power may raise the costs of emission reduction — since large potential sellers, or buyers, of permits would restrict supply, or demand, so as to cause prices to diverge from marginal abatement costs. Also, where there is a limited number of large emitters, grandfathering of quotas may adversely affect incentives to innovate, as firms that develop, implement and license abatement technology would cause the quota price to fall, thereby suffering a loss in the value of their grandfathered emission rights.

- When the creation of an international market for quotas in the same type of emission is envisaged, a national quota system may be preferable to a tax to facilitate integration with the international market. Domestic trading would also facilitate the use of international trading systems by domestic firms.

In some countries the choice between the two instruments may be influenced by idiosyncratic factors. For example, one factor behind the preference for cap-and-trade systems in the United States in recent years is the unpopularity of tax measures. Some features of the two main US systems, for sulphur dioxide (SO_2) and nitrogen oxide (NO_X) abatement, are described in Box 7.1.

While the United States is the only country to use permit trading for these types of emissions, a comparison with the Swedish NO_X charge shows how "grandfathering" emission rights or tax credits avoid imposing a burden on emitters while preserving the marginal incentives for abatement. In the Swedish system, revenue is returned to the payers in proportion to their share of energy produced. Hence, any producer with emissions lower than the industry average is provided a net benefit, while a net cost is imposed on firms with higher-than-average emissions.[13] The two NO_X schemes also show how to avoid that grandfathered permits or tax credits become a barrier to entry: Swedish refunds (equivalent to tax credits) are allocated

on the basis of *hypothetical* emissions — what they would have been on the basis of emissions per unit of energy consumed equal to the industry average. On the other hand, the SO_2 programme in the United States does impose a barrier to entry: although allowances are allocated on the base of hypothetical emissions, these are calculated from *past* energy use. New entrants have to buy permits on the open market, and incur higher costs than existing firms.

Although taxes on CO_2 are among the most efficient and easy to apply, they have been used only in a few OECD countries, namely the Scandinavian countries, Finland and the Netherlands, since the early 1990s. Also, in all these countries, CO_2 taxes are excessively costly for a given reduction in domestic emissions because their tax structure provides partial or complete exemptions to large sectors of the economy, in particular those which are most pollution intensive. This special treatment is motivated by concerns about the possible consequences of a CO_2 tax on the competitiveness of energy-intensive industries (see below). An initial proposal for extending the French general tax on polluting activities to CO_2 emissions from fossil fuels took a better approach to addressing possible competitiveness effects, but has been abandoned for the moment.[14]

Box 7.1. Transactions and prices in US emission trading

Two major trading programmes are in operation in the United States: the SO_2 program, part of the acid rain program; and the regional NO_X program, aimed at reducing ground-level ozone. Both are restricted to utilities.

The SO_2 emission cap was foreseen in revisions to the Clean Air Act in 1990, and took effect in 1995. In 2000, the program was significantly tightened, through a reduction in the size of installations subject to the cap and a reduction in the overall limit. These changes passed without any obvious perturbation in the market. The NO_X cap was effective as of 1999, with some trading beginning the previous year.[15] The penalty for non-compliance is USD 2 000 per ton for SO_2, whereas for NO_X the penalty is payable in permits, at a rate of three tons for each ton of overrun; individual states retain the power to fine non-compliers up to USD 25 000 per ton in their own state.[16]

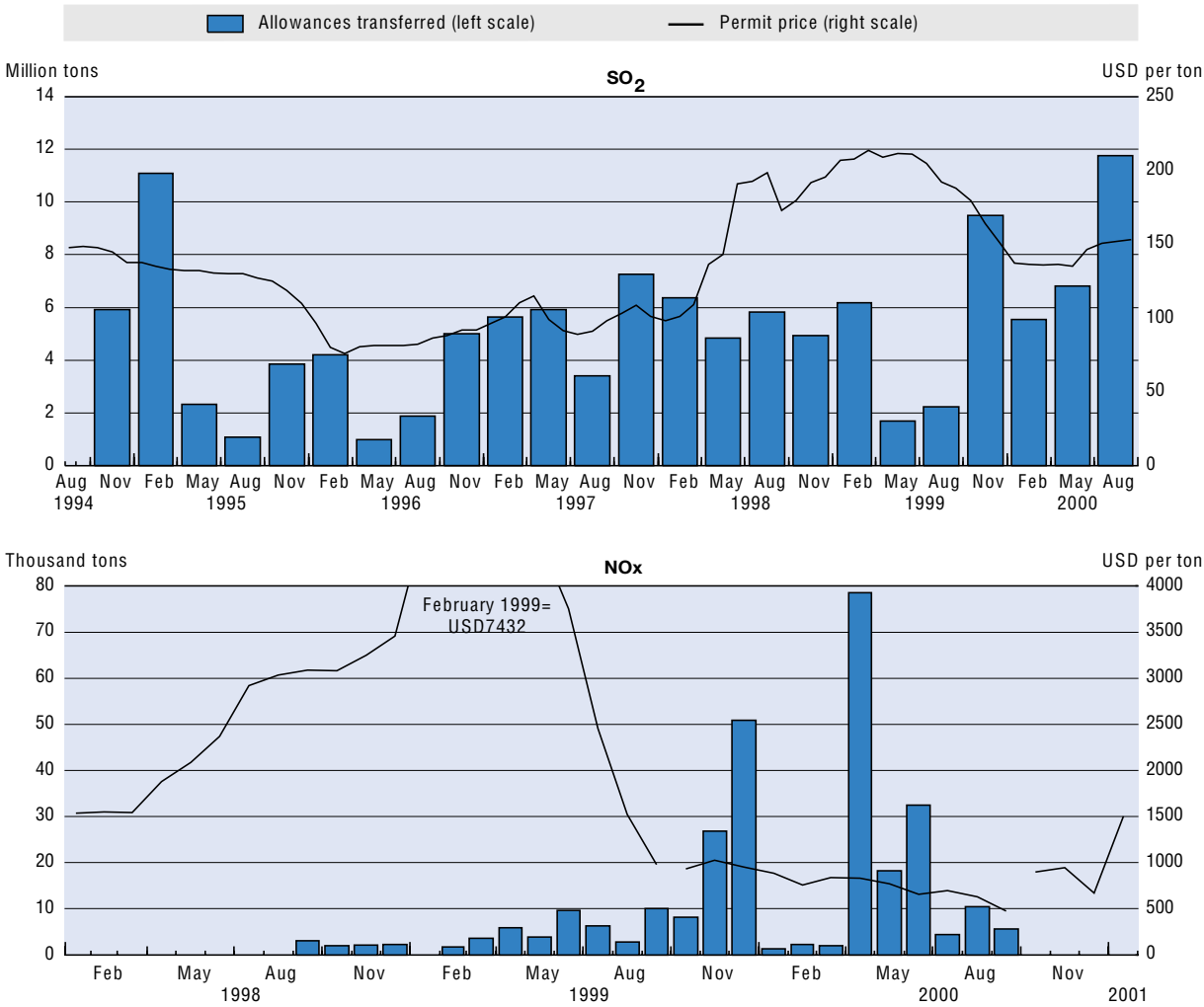
In both schemes, actual emissions are running below the cap. SO_2 permit prices are also somewhat below levels expected before trading began (USD 400-500 was thought to be a reasonable guess) (Figure 7.4). That prices are not zero is due to the possibility that the constraint may become tighter in the future, and emission permits not required for current emissions can be held over for future use. The rise in SO_2 permit prices in 1998 might reflect anticipations that supply would tighten in 2000, when the overall cap was reduced and the number of emitters included increased. A similar tightening is due in the NO_X regime in 2003.[17]

Banking provisions differ between the two programmes. In the NO_X programme, banked permits are discounted to avoid emissions exceeding the target in any one year by more than 10%. Hence permits of different "vintage" trade at different prices. In the SO_2 scheme, there are no restrictions on banking.

Much of the early SO_2 trading occurred between generating units owned by the same firm. This is still the case today, but the share of trades between distinct firms has tended to grow. Brokerage transactions are a minority of the total — perhaps 20% of those in NO_X and 10% in SO_2 — but are a higher proportion of those that occur between distinct organisations. Price data are from transactions through brokers, as there is no statutory requirement to report prices.

Two facts have been important in the success of both programmes. First, the targets appear to have been relatively easy to meet. Second, the absence of charges for issuing the permits has prevented any serious profitability problems. Further tightening of the constraints (either through economic growth or absolute reductions in allowable emissions) and a shift to charging for permits (not currently planned) will provide a more severe test of this approach.

Figure 7.4. **Emissions trading in the United States**



Note: 1998 to September 1999: price of 1999 "vintage". October 1999 to September 2000: price of 2000 "vintage". October 2000 to January 2001: price of 2001 "vintage". In 2000 the SO_2 cap was 8.95 million tons, the NOx cap was 219000 tons.
Source: US Environmental Protection Agency.

Many countries are pursuing air quality targets partly by increasing the share of electricity produced by renewables, frequently with specific targets. These targets, however, are rarely based on solid cost-benefit analysis, and are often inconsistent with the absence of taxes or trading systems on the polluting emissions from fossil fuel sources. However, there are better and worse ways to achieve a given target, as in the case of electricity from renewable sources. Moves to introduce a system of tradable green certificates, as done or planned in a number of countries such as Australia, Belgium and Denmark, promise a more cost-effective implementation than earlier approaches — which still exist in most countries — involving direct subsidies to renewables producers (Box 7.2).

Economic instruments could also play a greater part in reducing water pollution from agriculture. As discussed earlier, lack of progress is particularly evident in the case of leaching of nitrates — present in fertilisers, manure and animal feed — into ground and surface water. The main approaches to dealing with leaching are regulation and voluntary measures, but some countries — including Italy, the Netherlands, Norway and some US states — have introduced taxes on fertilisers. However, fertiliser taxes are not a well targeted instrument to deal with nitrogen leaching, as the link between fertiliser use and nitrogen leaching is complex, depending on agronomic practices, as well as on livestock production. Other countries, such

as Belgium and Denmark, have introduced systems equivalent to a fine on "excess" use of nutrient, but with a strong non-linearity reducing the incentive to reduce applications — "excess" is frequently defined so that only few farms face a penal rate, while charges on nutrient use below the "excess" threshold are very low or even zero.

Nutrient accounts (also known as mineral balances) — which measure the difference between the total quantity of nutrients entering and exiting the soil (embodied in crops, animals or animal manure) — may offer a better solution to reducing nitrogen leaching, through either a tax or tradable permit scheme. Countries with substantial water pollution from agriculture, such as Belgium, Denmark and the Netherlands, already have nutrient balance accounts in place at the farm level, so that no additional data-gathering costs would be incurred to implement such a system. However, once used to calculate tax liabilities, administrative costs associated with verifying the data may be significant, and would need to be weighed against expected benefits.

Box 7.2. Renewable electricity programmes

In general, policies to promote renewable energy in electricity generation have produced uncoordinated, frequently high-cost measures. Many countries pursue quantitative targets for renewable energy use — though there are an increasing number of exceptions to this practice — using an array of instruments shown to be unlikely to minimise the costs of reaching the targets (Table 7.4). However, the pollution problems addressed principally through increased use of such electricity generation — those due to emissions of NO_X, SO_X and CO_2 — are themselves rarely taxed or subject to quantitative constraints, although NO_X and SO_X emissions are frequently subject to regulations on technical standards.

The main advantage of renewable sources of energy for electricity generation is that they avoid emissions of SO_X, NO_X and CO_2.[18] These emissions are easily measured (at least in electricity generation) and thus can either be taxed or subject to cap and trade systems. Setting taxes equal to the estimated cost of externalities, or using a tradable permit regime to establish the marginal abatement cost of meeting quantitative targets, would give a more appropriate incentive structure. Specific NO_X-, SO_X- or CO_2- motivated subsidies to renewables would then be unnecessary and inefficient: unless supplemented by other measures, such subsidies give no incentive to reduce energy use — an important way of abating emissions.

As shown in Table 7.4, targets for renewable energy supply are in practice pursued in a number of different ways, and some countries have made considerable progress towards more cost-effective approaches. In Denmark, for example, an expensive wind-turbine subsidy scheme (OECD, 2000*a*) used during the 1990s is now being phased out in favour of a system of tradable permits for renewable energy, known as "green certificates".[19]

In this system, generators of renewable electricity will be issued with green certificates for each unit of electricity generated. In turn, electricity distributors will be required to obtain a quantity of these certificates equivalent to a certain percentage — the national target — of their annual electricity sales. The system also sets upper and lower limits on the certificate price. The upper limit caps the cost on the economy, by capping the implicit subsidy to renewable generation (effectively allowing the outcome to fall short of the target if the costs of reaching it turn out to be too high); the lower limit guarantees a certain level of subsidy even if the target is easily fulfilled. In the case of Denmark, the price floor mainly serves to maintain some continuity with the previous scheme, ensuring a subsidy even if it is unnecessary to meet the target. Australia and Belgium are planning to develop similar "green certificates" systems to reach renewable electricity supply targets.

Anther way of avoiding the excessive subsidy that can arise from price guarantees to support output targets is the Irish approach of using competitive tenders. Bidders compete to supply renewable energy. Competition among bidders should drive the subsidy down to the level necessary to make the investment profitable. The approach of competitive bidding to meet specified environmental targets has potential applications in other areas. For example, it is used in the US Conservation Reserve Program (see below), and has been proposed as a tool to reduce water salinity in Australia.

Table 7.4. **Incentives for electricity from renewable energy in selected OECD countries**

	Share of renewables in total electricity generation	Target, date	Instrument	Obligation on	CO_2, SO_X, NO_X tax on emissions from electricity generation in place?	Notes
Australia	9.8% of which 1.7% non-hydro (1996)	Additional 2% of non-hydro by 2010	Tradable "green certificates" R&D subsidies, some state based promotion through publicity.	Distributors	No	
Belgium	1.8% (1998)	3% 2004 (Wallonia, 5 % of total energy, 2010 Flanders, 5 % of total energy, 2020)	Green certificates (tradable?) Plus fines. Operating and capital cost subsidies and tax reductions.	Distributors	No	"Privileges" for combined heat and power (CHP)
Canada	63% (1996) of which 0.7% non hydro	No quantified target			No	
Denmark	10.4% (1998)	35% 2030 (12-14 per cent 2005)	R&D subsidies Operating cost subsidies Tradable "green certificates" from 2003	Distributors	CO_2 SO_2 CO2 cap & trade in electricity as from 2001	Green certificates to replace system of subsidies; upper and lower limits on certificate price.
Finland	26% (1996) of which 8.9% non-hydro	No quantified target	Tax reductions		No	Almost all renewable electricity is from biomass (wood)
Germany	5.8% (1996) of which 1.8% non-hydro	No quantified target	Cross-subsidy through guaranteed access with favourable pricing.	Distributors	No	
Ireland	4.1% (1996) of which 0.3% non-hydro	Approx 8% 2005 Specific targets for wind and hydro 2000-2010	Cross-subsidy through guaranteed access with favourable pricing	No obligation	No	Subsidy determined endogenously through competitive tendering. 1999 target share was 10%, achieved approx 6%
Norway	99.8% (1996) of which 0.2% non-hydro	7 TWh of non-hydro, 2010			CO_2	
Sweden	39% (1996) of which 2.1% non-hydro	No quantified target	Subsidies, tax exemptions		NO_X SO_2	1996 share exceptionally low due to low rainfall. More normal share near 50%
United Kingdom	2.7% (1996) of which 1.7% non-hydro	10% 2010	Exemption from climate change levy	Generators	No	Privileges for CHP
United States	11.9% (1996) of which 2.3% non-hydro	No quantified target	Subsidies, tax exemptions	Generators	SO_2 cap & trade NO_X regional Cap-and-trade	

Sources: IEA (1997), *Energy Policies of IEA Countries, Canada Reviews*, OECD/IEA, Paris and OECD Secretariat.

Applying economic instruments to waste management is particularly challenging, in part due to the difficulty of identifying the proper tax base. Ideally, waste costs could be internalised by a tax at the source, i.e. on the products generating the waste. It is difficult, though, to assess the environmental externalities of a given product at the source, since these depend on the method of disposal. Deposit-refund programmes are one way to solve the incentive problem for certain products, as the refund gives consumers a reason to return the product; the producer is then required to treat the waste. Careful cost-benefit analysis is nevertheless required for the whole range of concerned products. In Denmark, for example, a deposit/refund program for glass bottles has successfully encouraged recycling; but metal cans are simply banned altogether, while the implicit tax on non-recycled glass bottles is extremely high (compared with, for example, the tax on other glass disposed of in a landfill site). The "extended producer responsibility" approach adopted in Germany and Sweden — which obliges producers of some products to take them back — is another way to solve the incentive problem. If producers were then free to dispose of returned products as a function of waste treatment taxes, taking environmental costs into account, this could provide a cost-effective waste management method. In practice, the return of a product to the producer often comes with an obligation to recycle a certain proportion, a policy which is generally inefficient when subjected to cost-benefit analysis (OECD, 2001*a*).[20]

In some countries, including Australia, Canada, Denmark, Sweden and the United States, certain municipalities have implemented weight or volume based charging for household waste. Some evidence suggests that this has reduced waste generation, but at rather high collection costs. Taxes on the *treatment* of waste based on its weight have also been introduced in some countries. Finland, the United Kingdom and Sweden, for example, have introduced taxes on waste delivered to landfill, while others have introduced tax rates differentiated according to the type of disposal (Denmark), or to the efficiency of the landfill facility (Austria) or incineration plant (Norway).

Product-specific excise duties, which could internalise environmental costs associated with waste disposal, are often used more to support recycling or other targets than to internalise a calculated externality. These duties are generally associated with a small number of specific items, notably plastic bags and drinks containers, batteries, paper and packaging. In Belgium, "ecotaxes" on batteries, disposable cameras and disposable razors, for example, were deliberately set at levels thought sufficient to induce very big changes in behaviour, rather than with reference to any explicit estimate of the externalities involved. Producers recycling the products were exempted from the tax. The tax on disposable razors was so "successful" that sales fell to zero, and the tax was subsequently removed.

The large differences in the price of water for agriculture, industry and households have already been noted (Figure 7.1). In many countries (for example in Australia, Belgium and Denmark), water price levels and structures are being reformed towards full-cost recovery and pricing is being based on consumption, to reflect marginal costs (using combinations of fixed and variable charges). Despite the low estimated price elasticity of residential water demand,[21] consumption-based tariffs have reduced individual consumption significantly.[22] In other countries, such as Canada or the United Kingdom, metering is far from universal, and residential water consumption is still subsidised at the margin. In countries where industrial water used to receive favourable treatment relative to households, this difference is being eliminated, although some cross-subsidisation from households remains.

Water trading (either of water rights, or of water itself) can provide flexibility to increase the allocative efficiency of water use, so as to allow a smooth adjustment in mature water economies (i.e. economies where water entitlements are fully allocated). Up to now, only Australia and the United States have developed such markets, mostly in areas with significant agricultural water use. The province of Alberta, Canada is planning to do so as well.[23] A number of other OECD regions where water is relatively scarce (or intensively used) would benefit from such markets. Combined with a cap on total diversion, as in Australia, water trading would also be a cost-effective way to protect the environment when needed. Nevertheless, markets are certainly not "perfect", as diversion of water at one point of a river is not environmentally equivalent to diversion at another point. Limitations on trading may be required because of the variety of effects that moving large quantities of water can have. In Australia and the United States, most trading is still taking

place within the agricultural sector. This often reflects prohibition of transfers of water to commercial or municipal use, although the latter may provide the most valuable use in many cases.

Voluntary agreements

Voluntary agreements (VAs) have grown in use over the last ten years in all OECD countries, and were considered in a number of the country studies. They occur in all environmental domains and economic sectors. Examples include waste policy in Germany, greenhouse gases in Australia and Canada, energy efficiency programmes in most countries, and toxic waste in Canada and the United States. In principle, VAs can be useful if they reduce the cost of meeting environmental targets, and they may help to reveal information on abatement costs and to disseminate information on environmental impacts and costs. In practice, there is some evidence that VAs are not very effective instruments, since their effect on reducing costs is often offset by reduced environmental benefits.[24]

In most cases, industry plays a central role in the target-setting process, with the result that targets are frequently ill defined, or are defined relative to a baseline "business-as-usual" path that is itself not clear. Krarup (1999) provides an evaluation of VAs in the energy sector for a number of EU countries (Denmark, Germany, France, the Netherlands and Sweden), suggesting that the majority of reductions in energy use claimed to result from such voluntary agreements would have occurred anyway, even in their absence. Voluntary agreements aiming to reduce greenhouse gas emissions in Australia and Canada suffer from the same shortcoming.[25] The agreement to take back old cars free in Germany has been similarly criticised for achieving only what would have materialised without intervention, as the cars involved still have a market value. At the implementation stage too, negotiated agreements perform poorly due to non-enforceable commitments, poor monitoring and lack of transparency. In most countries, they are usually not legally binding, and even when they are, enforcement is difficult if the target is not clearly defined. Independent verification is still rare: no such verification was carried out in the first four years of the Greenhouse Challenge Programme in Australia, for example, though it has been introduced since 1999 for a random sample of participants.

Voluntary agreements could in principle make use of economic incentives, though in practice they do not. Negotiated burden-sharing between firms is typically driven more by equity considerations and by concerns about competitiveness than by cost-efficiency considerations. In Germany, where they are used extensively, voluntary agreements often attribute identical targets to individual firms rather than concentrating abatement where costs are lowest (OECD, 1999*b*). In some cases, such as waste (particularly in Germany), voluntary agreements are used to achieve targets that are not supported by cost-benefit analysis. More generally, voluntary agreements often result in a piecemeal approach to individual environmental problems and are unlikely to equalise marginal abatement costs.

Some obstacles to implementation: competitiveness and income distribution

The issue of competitiveness and income distribution as obstacles to implementing economic instruments has already been raised in Chapter 5. The country studies noted numerous occasions where this occurs. In practice, the distinction between competitiveness and distribution issues is rather blurred, as for example when industries vulnerable to competitiveness losses are concentrated in a particular region.

Competitiveness

Countries repeatedly make exceptions to environmental taxes for heavy polluters. Exempting some sectors from the tax or reducing tax rates means that marginal abatement costs are not equalised throughout the economy. As a result, meeting environmental targets incurs excessive costs. Too much abatement is carried out — and too much output lost — in sectors with relatively high marginal abatement costs, whereas too little advantage is taken of opportunities for abatement in sectors with low marginal abatement cost. In fact, sectors with high levels of pollution per unit of output are, *ceteris paribus*, those where the output losses per reduction in pollution are low — and these are usually the sectors exempted from environmental

taxes. Moreover, sectors competing strongly with overseas producers face high price elasticities of demand, so that small rises in their costs are likely to cause relatively large falls in their output — and hence in the pollution they produce. This means in effect that the level of a uniform tax or permit price necessary to meet quantitative domestic emission targets is lower than without such competition. Not taking advantage of this by protecting such sectors increases economy-wide costs, by raising the dead-weight loss associated with the higher tax rate in other sectors. What matters in the long run is the overall competitiveness of the economy, not that of particular sectors, and, for a given abatement target, such competitiveness is in fact reduced by exemptions (Box 7.3)

Box 7.3. **Competitiveness concerns as a factor shaping policies**

One illustration of the practical impact of competitiveness pressures is the close relation between motor fuel taxes and prices in neighbouring countries (Figure 7.5). The motivation for such close relation is partly one of public finances: if a small country increased its motor fuel taxes significantly above those of its neighbours, it could expect to lose revenue, initially from normal cross-border traffic choosing to refuel in the cheaper country and, at higher levels of taxes, from individuals or companies making cross-border trips for the sole purpose of refuelling at lower prices. The phenomenon is well illustrated in the case of Luxembourg, which has very low tax rates on motor fuel and where over 75% of sales are to non-residents.

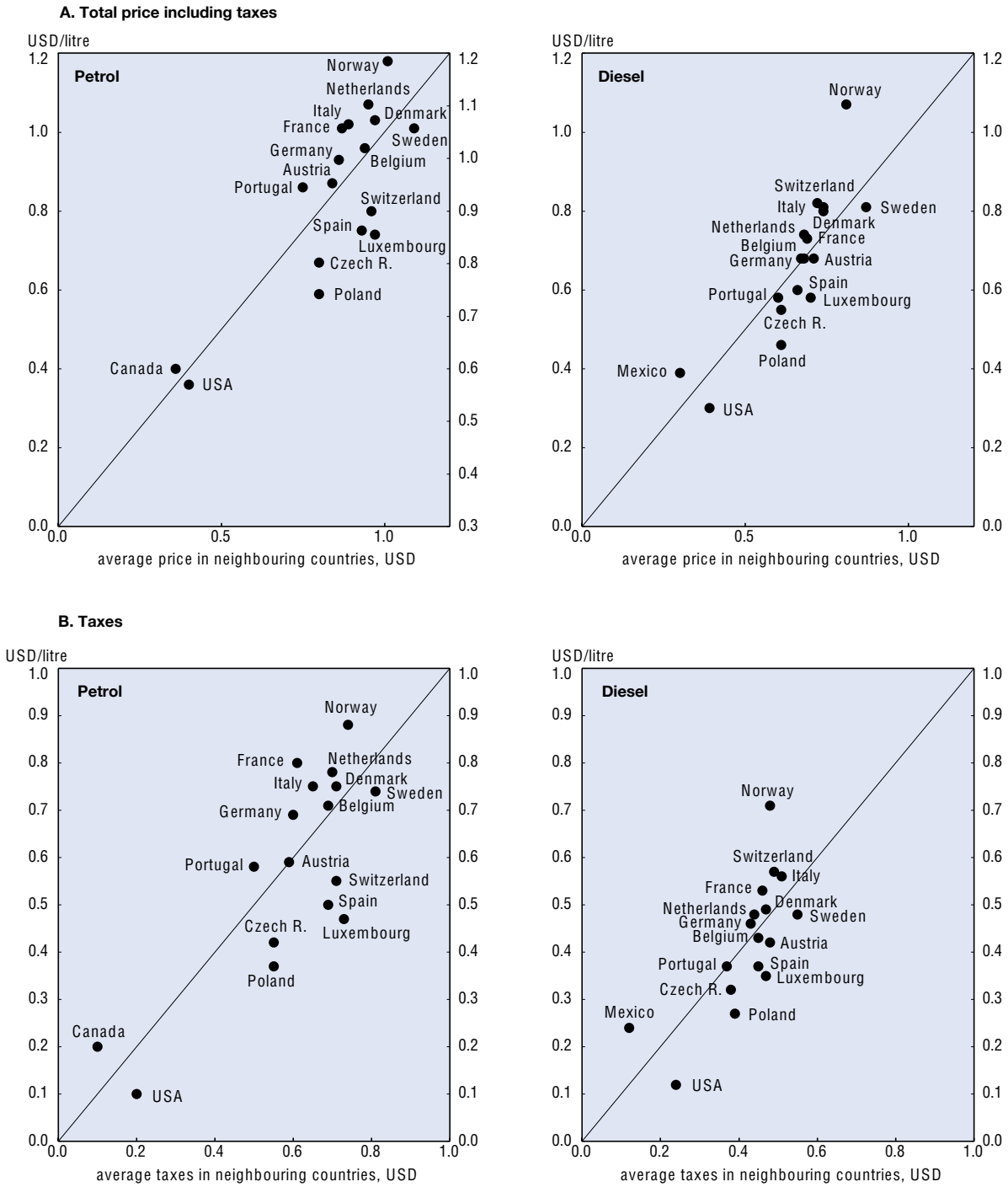
In Canada, opposition to higher fuel taxes is partly based on fear of competitive disadvantage for the transport and transport-using sectors *vis-à-vis* the United States. However, although the use of road transport in Canada could decline somewhat if fuel taxes were significantly increased, this would not favour US over Canadian hauliers in Canada (any truck refuelling in Canada would have to pay the higher taxes) nor discriminate against Canadian hauliers in the United States (since they could refuel there). Transport-using sectors in Canada would lose or gain according to the relative importance of transport in their costs.

In Denmark, where sentiment might otherwise be in favour of higher fuel taxes, the Ministry of taxation developed an econometric model of tax revenue as a function of the tax differential *vis-à-vis* Germany, which implied that the marginal cost of emission reductions through such tax increases would be very high compared with other taxes or measures. However, these losses could be reduced through a geographically graduated tax, with the rate increasing according to the distance from the German border.[26] It may be worth noting, that, as far as the Kyoto target is concerned, CO_2 emissions from gasoline bought in Germany would count as German emissions under the EU burden-sharing Agreement.

In justifying special treatment for specific sectors, countries often emphasise the problem of *leakage*, i.e. that the reduction of domestic emissions in an internationally competing industry would exceed the reduction in global emissions. The possibility of leakage is most obvious where national pollution contributes to a global environmental problem such as climate change. The argument used by countries that have introduced a CO_2 tax is that emissions associated with production could simply be shifted abroad due to increased production costs in the taxing country. In other words, the domestic costs per unit of global emissions reduction are higher than they appear, and the tax rate should be adjusted to take account of this.

In the case of CO_2, most OECD countries are parties to the UN Framework Convention on Climate Change and to the Kyoto Protocol, under which all countries have undertaken to reduce their emissions, In this situation, leakage to another "capped" country should not be a concern.[27] However, leakage may arise when some countries are not participating in an agreement to address a *global* environmental problem. In the Kyoto agreement, for example, the issue arises *vis-à-vis* non-Annex B countries, as only Annex B countries are subject to CO_2 emission caps. The costs of moving production to non-Annex B countries, however, may often be particularly high, and such a shift may be impractical for many firms. Empirical analysis on carbon leakage provides estimates of a "leakage rate" ranging from around 20% to 2 to 5%. In fact, the loss of competitiveness in energy-intensive industry is often found to be much less influential than what happens on international energy markets.[28]

Figure 7.5. **Fuel prices and taxes in neighbouring countries, 1999**



Source: Based on IEA data.

Where policy is targeting a *local* or *regional* environmental problem, there is no case for exemptions. In these situations, leakage does not undermine the effectiveness of the tax or cap-and-trade scheme in addressing the local or regional problem, unless the country in question attaches a weight to pollution in other countries that these, implicitly, do not (since they could, if they wished, introduce appropriate policies themselves). Among the justifications for this approach is the argument that political conditions in other countries may not allow populations' preferences to be adequately reflected in environmental policy.

Other factors that might justify some temporary special treatment are where countries lead in the introduction of specific environmental taxes, or where adjustment costs may be particularly high. In the first case, industries often argue that taxes will force them to relocate production abroad, only to have to move it back again when other countries introduce the same taxes. However, firms can calculate whether their costs of moving and returning are greater than the tax liability of staying. If firms decide to remain abroad even after both countries have the tax, this would suggest that the taxing country has little or no comparative advantage in that industry anyway. Conversely, if firms decided not to stay abroad, then it is unlikely that they would make a temporary move in the first place, unless the environmental gains were considerable (i.e. unless the tax were high).

Whatever the argument, countries should use caution in reducing marginal incentives to substitution towards less polluting activities or goods on competitiveness grounds (OECD, 2001*d*). A more appropriate answer to such concerns would be to retain marginal incentives, while setting up compensation for the energy-intensive sectors subject to international competition. When putting such compensation measures in place, they should announce *ex ante* their intention to phase out such compensation once other countries have followed suit. This can be done through the use of tax credits, or grandfathered emission permits, as mentioned above.[29] Maintaining exemptions and rebates for taxes can be administratively expensive, while tax credits or permit allocations — provided their calculation is simple — could reduce expenses.

Despite the weakness of the arguments for tax exemptions or reductions, affected domestic industry groups have an obvious interest in emphasising such measures in their lobbying. The country studies, and the OECD committees reviewing the evidence, take the view that the widespread use of exemptions reflects the success of *lobbying* rather than the merits of the exemptions themselves.

Distributive effects

The distributive implications of measures pricing environmental externalities have been of concern to OECD countries trying to implement them, and their potential regressive effect is often seen as an obstacle to effective implementation. In the United Kingdom, for example, the government has ruled out environmentally related taxation on domestic consumption of fuel and power because of expected undesirable distributive effects; the VAT rate on domestic fuels is lower than the standard rate for the same reason. Empirical evidence supports the notion that low-income groups do spend a higher share of their income on energy products than others, making them relatively more affected by energy taxes, although the difference is often not large.

A more comprehensive analysis of distributive effects would need to take into account the second-order effects of policies to price environmental externalities, such as those generated by the energy content of other goods, by changes in incomes (as the structure of production adjusts to new energy prices), and by reductions in the tax-exclusive price of energy (if overall demand is significantly reduced). Furthermore, the distribution of the environmental benefits themselves should also be taken into account: for example, low-income residential areas usually suffer relatively more from air pollution, so reductions in such pollution — due to fuel taxes and emission standards, or to road pricing to reduce congestion —may benefit those groups more than others. The results of empirical work in this area, which takes some of these considerations into account, are inconclusive.[30]

OECD countries for whom income distribution is an important factor in public policy generally have well-developed safety nets. In fact, as noted in OECD (1996), the concern for income distribution is not

specific to environmental measures and may apply to any other policy measure or reforms as well as to ongoing economic developments. Hence, compensating specifically for environmental policy measures is generally inappropriate. Certainly, compensation measures should seek to avoid offsetting the desired incentive effects. However, where only a small number of people are affected, the environmental or resource consequences may not be large. It is also important to note that the administrative costs of such ad hoc approaches to income distribution can grow substantially over time.

In practice, new environmental taxes are often introduced as part of a more comprehensive tax reform. When such reforms generates net revenue gains, indirect compensation may be possible. Green tax reforms implemented in a number of European countries have combined new environmental taxes with reduced taxes on labour, as in Denmark, Finland, Germany and the Netherlands, for example. In these situations, other taxes can be reduced (in Norway and the Netherlands, income taxes were reduced) or the revenues can be used to fund compensation schemes directed at energy-intensive firms. The availability of such revenue is sometimes thought to represent a bonus — "double dividend" — from environmental taxation, but the extent to which this is justified is debated (see Chapter 5). Certainly any second dividend is largely political — easing the introduction of reforms that are desirable on their own terms — rather than economic. What is clear, in any case, is that grandfathering emission permits (or compensating for an emission tax with a tax credit) on competitiveness grounds deprives governments of the revenue to compensate for possible distributive effects.[31]

NOTES

1. A fuller version of this chapter will be available as an Economics Department Working Paper, O'Brien and Vourc'h (2001).

2. These Surveys are reviewed by the Economic Development Review Committee which, every year or 18 months, assesses economic policy and developments in member countries. These assessments are subsequently published as OECD Economic Surveys. Countries for which chapters on "enhancing environmentally sustainable growth" have so far been published are: Belgium, Canada, Denmark, Finland, Germany, Norway, Sweden, and the United States. Examinations Australia, Austria, France Ireland and Poland will be conducted in 2001.

3. Systematic data on the cost of water supplied to industry and, even more so, to agriculture are sparse. The countries shown in Figure 7.1 are the only ones where volumetric prices were available for both as well as for households. In Austria the water price shown is that for supplies of drinking water for animals, whereas in other cases it is generally water for irrigation where quality standards can be much lower than for water supplied to households.

4. See OECD (2000*b*) pp. 113-117 and OECD (2000*a*) pp. 61-62 for more details.

5. For example, Iceland, which has no diesel tax, imposes a tax on diesel vehicles based on the weight (and other characteristics affecting road wear) of vehicles and the distance travelled. (OECD, 2001*b*)

6. A recent report on the Danish experience suggested that the strategic environmental assessment on two recent bills introduced in parliament was not very helpful. See OECD (2000*a*), p. 112. The report said that the EIA's influence on Parliament's decision to adopt legislation was "murky and vague," and that claims in the bills that they would bring substantial environmental benefits were unsubstantiated. See Elling and Nielsen (1998).

7. See OECD (2000*c*), p. 155 and Probst, *et al.* (1995).

8. In the United States, the rules that govern the use of CBA are not entirely transparent, and their interpretation in the courts can lead to paradoxical results. For example, following an unusual challenge to new air quality standards proposed by the Environmental Protection Agency (EPA), a court ruled that the EPA had not in fact been given the power to set such standards because it had been given no objective rule to follow in deciding what standards were appropriate. The court suggested that a cost-benefit standard could be such a rule, but that the legislation (as interpreted in previous rulings of the same court) forbade the use of CBA in setting standards. In fact, in the inter-agency discussion that had preceded the EPA proposals, there had been criticism of the estimation of the expected health benefits for part of the new standards. This case (in the Washington D.C. Circuit Court) was appealed by the EPA to the federal Supreme Court. Previous air quality standards had been set under essentially the same legislation.

9. In the last few years, the European Commission has devoted much effort to analysing costs and benefits of environmental policies. This has not yet affected the implementation of existing directives.

10. See OECD, (2001*a*). This is not to argue that costs *do* exceed benefits in this case, but that it might be easier to implement the policy if there were stronger evidence that it is fully justified locally.

11. In Sweden, the economic costs of ongoing environmental damage (excluding global warming) were evaluated at around 1% of GDP per year. The preamble to EU directive 98/69/EC on vehicle emission standards notes that external costs due to motor vehicle may be equivalent to as much as 3% of EU GNP.

12. Generally with restrictions on those prices, either implicitly (through fines for non-compliance) or explicitly (by setting limits to permit prices).

13. A potential danger of such compensation programmes may be that, if there is a relatively small number of firms, they may agree on fixing emissions at an "easy" level. This should be monitored by the government or the competition authority.

14. A government proposal to extend the French *taxe générale sur les activités polluantes* (TGAP, "general tax on polluting activities") to fossil fuels and electricity in 2000, planned to issue tax credits based on a percentage of past emissions. The percentage would have varied according to emission intensity. Substantially modified in parliament, among other things through the addition of further exceptions and exemptions, the bill was subsequently ruled unconstitutional by the Constitutional Court in early 2001.

15. The NO_X cap covers emissions from May to September, when ozone risk is significant. The SO2 cap applies to annual emissions.

16 . In 2000 there was one case of an overrun by 1 ton.

17. The NO_X scheme will also be extended to cover a further ten states, from 2003-4 onwards

18. Energy diversification, however, may contribute to security of supply. Some governments believe that support for renewable energy technologies is worthwhile as a means for countries to acquire exportable technological expertise. This is true for wind turbines in Denmark, for example. This "infant industry" argument, however, is dubious. Denmark is indeed a major world supplier of wind turbines (generally depending on subsidies in other countries' renewables programmes) and is an example of a government having guessed right (at least about other countries' future policies). However, governments may equally guess wrong. In any case, although the level of Danish wind turbine exports can be easily measured, whether the industry earns sufficient profits to justify the subsidies is harder to assess.

19. This is not to be confused with the proposed EU system of green certificates, intended to certify particular methods of electricity generation as renewable.

20. Another possible problem associated with the extended producer responsibility approach is that co-operation among firms to deal with their responsibilities may cause risks to competition. It should also be noted that when firms are grouping at the sectoral (or other) level to deal with waste collection or treatment, the incentive to reduce individual waste generation is diluted.

21. For a review of the literature on the price elasticity of water demand, see Nauges and Thomas (2000). Their own estimate for France is -0.22. Hansen (1996) found -0.1 for Denmark.

22. In Denmark, household water consumption decreased by 13% between 1993 (date of introduction of the new tariff) and 1998. Water use in Brisbane, Australia, has been reduced by 20% between 1995-96 and 1997-98, after the adoption of metering and use-based charges.

23. All the legal necessary reforms have been legislated. There is no certainty, however, as to the effective implementation of transferability.

24. See OECD (1999*d*), which provides more detail on what follows.

25. See IEA (2000) for Canada.

26. This would not be wholly unprecedented. In Minnesota (United States), fuel taxes may "be lowered to a rate of USD 0.03 above the contiguous state tax rate for sales from service stations competing with stations in other states located closer than 7.5 miles from the Minnesota station" (OECD database on environmentally related taxes).

27. Indeed, the Danish authorities have stated that they would revise their system of reduced CO_2 tax rates if the Kyoto Protocol comes into force.

28. See OECD (1999*a*) and Burniaux and Oliveira Martins (2000), which provide empirical evidence using a general equilibrium model (GREEN). The usual trade channel is less influential in determining leakages than often thought, as the leakage rate is found to be not very sensitive to changes in elasticities of substitution in non-energy markets. By contrast, unilateral carbon abatement in a group of countries corresponding to a large fraction of world carbon demand would cause a fall of the international price of carbon, thus increasing energy demand and carbon emissions in the rest of the world, depending on the structure of the international energy markets. However, this effect departs from the "competitiveness" argument used by countries to justify exemptions.

29. Grandfathered emission permits or tax credits amount to raising a tax whose revenue is redistributed to producers. Under some circumstances these transfers may be more than is necessary to compensate producers for losses of competitiveness, and, in these circumstances, it may be possible to achieve full compensation by grandfathering only a proportion of permits based on past emissions. See Bovenberg and Goulder (2000).

30. Considerable empirical research has been conducted on this topic. Studies looking only at the "static" effects of environmental energy taxes, with input-output analysis, generally conclude that these are quite regressive. They may be less regressive, however, when general equilibrium or dynamic macro-economic models are used, depending on, among other things, how the revenues are recycled and on wage behaviour. For example, Metcalf (1998) found that a tax reform in the United States (comprising a CO_2 tax, higher motor fuel excise taxes, waste taxes and taxes on a number of emissions to air) in which revenues were recycled through lower marginal rates of income tax and social security contributions, would be highly regressive. Yet he also shows that, depending on how the revenues are returned to households, the environmental reform can be made distributionally neutral. Empirical evidence on the distributional effects of non-energy taxes, on the other hand, is quite scarce (perhaps because non-energy environmental taxes cover much less spending and have less of an impact); the same is true for the distribution of environmental benefits.

31. It is sometimes thought that a cap-and-trade system with "grandfathered" permits has no distributive implications since there is no tax revenue. This is obviously not the case. Even when permits have been grandfathered, if the overall constraint is binding, the value of permits will be passed on to final consumption prices, just as a tax would be. This is equivalent to a consumption tax whose revenue is wholly returned to *producers* in proportion to their historic emissions. Governments could choose to sell or auction all or part of the permit allocations, using the revenue to reduce other taxes or increase expenditure, and thereby making an implicit choice between alternatives just as they would if a revenue tax were imposed. The same would be true for an environmental tax compensated by tax credit.

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Section III

GLOBALISATION AND SUSTAINABLE DEVELOPMENT

Chapter 8.

INTERNATIONAL TRADE AND INVESTMENT

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INTERNATIONAL TRADE AND INVESTMENT

Introduction

Trade and investment promote growth, alter the composition and geographical distribution of economic activities, stimulate competition and facilitate the international diffusion of technologies. By improving resource allocation, liberalising trade and investment regimes can also directly enhance environmental protection as well as indirectly promote demand for better quality of ambient air, water and other media. Similarly, the evidence suggests that economic growth contributes directly to poverty reduction. While trade and investment are not the only factors driving these trends, they both clearly amplify and accelerate these more fundamental processes — with implications for sustainable development. The linkages between trade, investment, the environment, and social issues need to be analysed — along with the role of existing policies in each of these areas — before deciding whether and how to intervene to better promote sustainable development.

Globalisation, in economic terms, can be thought of as a process in which business decisions, production processes and markets gradually come to exhibit more "global" characteristics and less "national" ones. Globalisation is characterised by structural reforms — especially trade and investment liberalisation — and increased trade and international investment flows. Trade and investment represent two complementary ways for firms to sell abroad, and are driven by a common set of factors such as market size or proximity to trade partners. Trade and investment (in particular, foreign direct investment, or FDI) also encourage each other: exports encourage investments, and investment encourages both imports and exports. Government policies towards trade have a strong impact on FDI and vice-versa.

The growth in trade and investment means that a country's sustainable development outlook is increasingly influenced by multinational enterprises (MNEs). While the analysis of MNEs usually focuses on the top 100, 200 or 500 largest firms, size is not part of the definition of an MNE. There are over 60 000 MNEs world-wide, and many of them are small and medium sized firms (SMEs). This chapter makes no distinction between larger or smaller MNEs, and the analysis presented here is applicable to both. While we focus primarily on international investment, the economic, environmental and social impacts of international investment and their relationship also hold for domestic investment.

The increase in the international activities of firms raises concerns regarding the reach of regulatory control in environmental areas such as resource management and pollution control, and social issues like income distribution and labour standards. The questions raised by the activities of MNEs relate to both cross-border investments and to the performance of established enterprises under foreign control. For example, the strategies of MNEs regarding different modes of entry — buying an existing plant or building a new one — can have different developmental impacts. Changes in ownership and control (i.e. corporate governance) — even when it does not mean an increase in productive capacity — can still have a critical impact on the performance of firms and ultimately on their contribution to sustainable development. Increasingly more MNEs are also responding to public concerns regarding environmental and social issues, as can be seen in the recent rise in corporate voluntary initiatives. This rise in corporate social responsibility (CSR) also affects sustainable development.

The rest of this chapter is divided into three sections. The next section describes the increase in international trade and foreign direct investment and changes in their composition in the 1980s and 1990s.

It also discusses the policy developments that have accompanied and contributed to these trends — liberalisation, regulatory reform, and privatisation. The possible risks and opportunities trade and investment bring for the three pillars of sustainable development — economic growth, environmental protection and social development — are discussed next. The final section describes current policies and practices related to trade and investment that promote sustainable development.

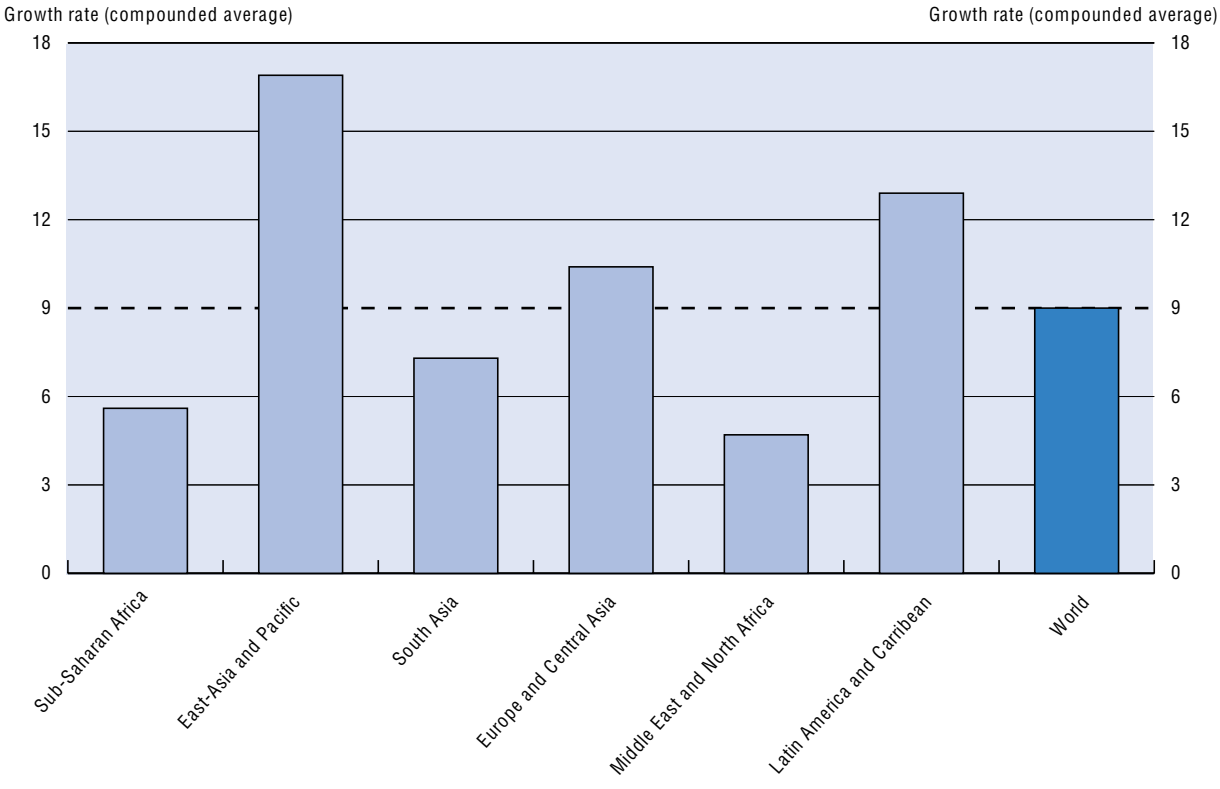
Recent trends and policy developments concerning trade and international investment

Trends

The last two decades have seen the world-wide production and consumption of goods and services become increasingly internationalised. Whereas, in 1980, the stock of foreign direct investment (FDI) abroad accounted for only 5% of world GDP, by 1998 this number had almost tripled to 14%. In the six-year period 1993-1999, world FDI flows increased from just over USD 200 billion to around USD 800 billion, and are expected to pass the USD 1 trillion mark in 2000 (UNCTAD, 2000). International trade has also increased dramatically. During the period 1985-1998 the ratio of trade to world GDP rose three times faster than in the preceding decade.

A distinguishing characteristic of world trade and investment is that the vast majority takes place between OECD countries. More than 90% of FDI world outflows originate in OECD countries, and in recent years the OECD has accounted for around three-quarters of FDI inflows as well (UNCTAD, 2000). On the

Figure 8.1. **Annual growth rate of merchanise exports from low and middle income countries 1987-1997**



Source: MF, Direction of Trade Statistics

other hand, despite the fact that OECD countries account for the bulk of world trade, an important feature of the growth in that trade over the past two decades has been the growing involvement of non-OECD countries. The share of developing countries in world merchandise trade in 1984 was less than 20%, but by 1998 it had risen to 30%. Trade between developing countries is also on the rise, with more than 40% of their exports being sold to each other in 1998 compared with less than a quarter a decade before (OECD, 1999a). The services sector has been the fastest growing area of world trade: between 1990 and 1998 the value of world trade in commercial services expanded at an average annual rate of 7%. It is currently estimated to represent over one-third of total world trade (Karsenty, 2000).

Outside the OECD region the growth in overall trade has not been evenly spread among regions. Figure 8.1 illustrates the different growth rates of non-OECD low and middle-income countries during the ten-years to 1997. Trade from non-OECD countries has been concentrated in East Asia, South America and some non-OECD European and Central Asian countries. During the period 1987-1997, annual growth in merchandise exports of Sub-Saharan Africa (SSA) averaged 5.6%, well below the world average of around 9%. Thus SSA's share in world trade fell from 4% in 1987 to 1.3% in 1997, and countries in the Middle East and North Africa also ended the period with a smaller share of global merchandise trade.[1]

Foreign direct investment to developing countries is also highly concentrated in Latin America and Asia (Table 8.1). Together these two regions comprise two-thirds of total OECD FDI flows to developing countries. Furthermore, in 1998 all the countries listed in the top ten recipients of OECD FDI outflows were located in these two regions, and changes in the composition of the top ten countries throughout the 1990s have been minor (Table 8.2). While for OECD countries FDI outflows to developing countries have accounted for only a small part of their GDP and total outflows, from the developing countries' perspective FDI has been of great importance.[2] Not only is foreign direct investment becoming more important for developing countries in relation to GDP, it is also overshadowing other capital flows such as official development assistance (ODA) or export credits. While ODA has declined in absolute terms over the 1992-1999 period, FDI flows have experienced a near quadrupling.[3] Portfolio flows are also playing an increasingly larger role in the total financial flows towards developing countries. In 1999 they accounted for approximately 10% of total resource flows to developing countries (World Bank, 2000*a*). Box 8.1 describes the greening of portfolio flows — a trend that may contribute importantly to achieving sustainable development.

Table 8.1. OECD foreign direct investment outflows by region

	In USD million				Percentage of total			
	1985	1990	1995	1998	1985	1990	1995	1998
WORLD	61.280	235.845	324.744	571.707	100	100	100	100
of which:								
OECD countries	42.058	189.121	267.262	453.765	68.6	80.2	82.3	79.4
NON-OECD countries	19.222	46.724	68.698	117.943	31.4	19.8	21.2	20.6
of which:								
Africa	404	823	2.972	8.304	0.7	0.3	0.9	1.5
Asia*	2.171	12.651	25.371	26.225	3.5	5.4	7.8	4.6
Europe*	8	410	2.221	6.062	0.0	0.2	0.7	1.1
Latin America and Caribbean*	9.102	18.948	22.622	53.045	14.9	8.0	7.0	9.3
Near and Middle East	212	1.056	1.365	4.107	0.3	0.4	0.4	0.7
Unallocated	7.325	12.821	14.154	20.200	12.0	5.4	4.4	3.5

* excluding OECD countries

Source: Compiled from OECD (1999*c*), *International Direct Investment Statistics Yearbook: 1999*, Paris.

Table 8.2. **Major recipients of OECD foreign direct investment outflows**

	1985		1990		1995		1998	
1	Brazil	785	Singapore	2 458	Brazil	8 342	Brazil	21 903
2	Indonesia	616	Brazil	2 118	China	7 005	Argentina	4 990
3	Singapore	562	Hong Kong	1 949	Hong Kong	3 812	Malaysia	4 899
4	Egypt	425	Indonesia	1 931	Indonesia	3 290	China	4 198
5	Hong Kong	322	Thailand	1 645	Argentina	3 040	Singapore	3 749
6	China	319	Malaysia	1 272	Singapore	2 961	Thailand	3 534
7	Neth. Antilles	247	Chinese Taipei	816	Thailand	2 798	Colombia	2 851
8	Malaysia	182	Argentina	748	Chile	1 825	Venezuela	2 477
9	Chinese Taipei	137	Chile	646	Malaysia	1 756	Chile	2 464
10	Israel	128	Philippines	510	South Africa	1 437	Philippines	2 374
Top 10 as % of total non-OECD		*19.4%*		*30.1%*		*52.8%*		*45.3%*

Notes: USD million; While China is fourth in the top ten recipients of FDI outflows from OECD countries, it is the largest recipient of worldwide FDI flows to non-OECD countries, due to large investments from non-OECD countries such as Singapore, Chinese Taipei and Hong Kong, China.
Source: Compiled from *OECD (1999c), International Direct Investment Statistics Yearbook: 1999*, Paris.

Box 8.1. **The "greening" of portfolio investment**

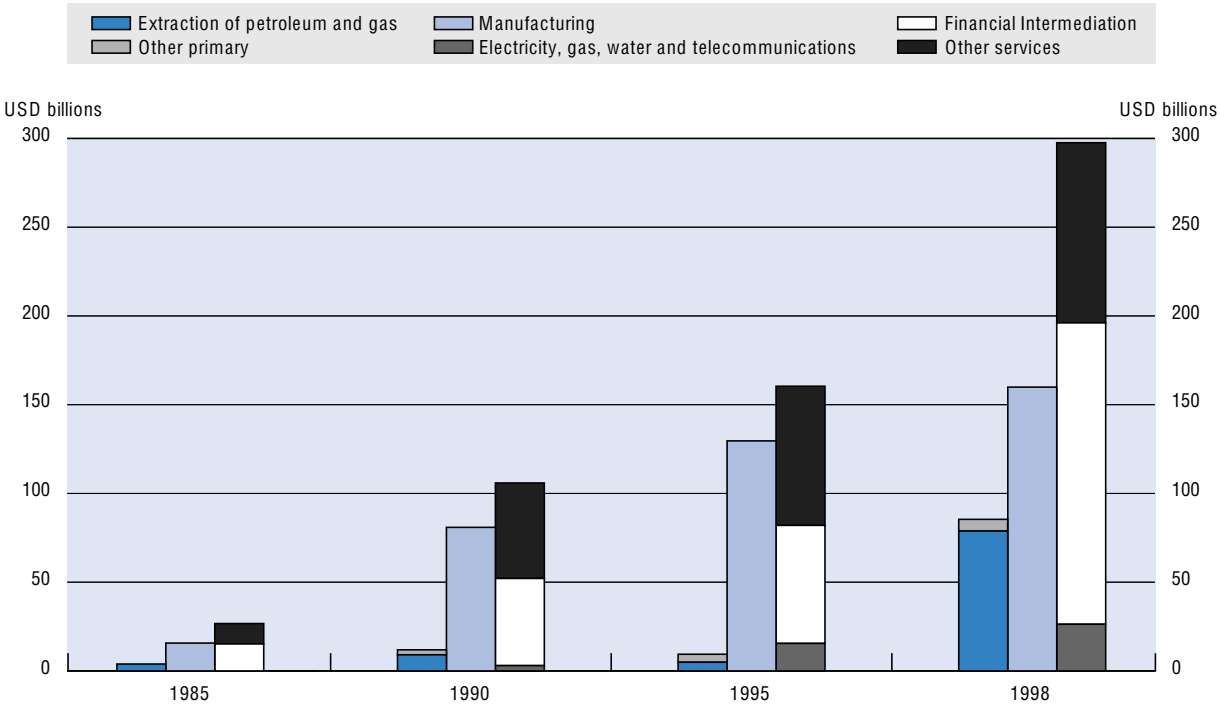
Since the late 1980s an increasingly larger share of portfolio flows are oriented towards "green", "ethical", "socially responsible", and lately "sustainable" investment funds and indexes. In the United States alone, more than USD 2 trillion was invested in socially responsible funds in 1999, or roughly 13% of the total amount of investment assets. This is up from 9% in 1997 (Social Investment Forum, 1999).

These investment funds and indexes usually comprise a range of stocks which are screened to exclude particular firms operating in environmentally or socially harmful sectors or activities, or which do not meet other criteria set by the fund or index. For example, firms that manufacture alcohol, tobacco, or weapons, or engage in potentially environmentally damaging activities are usually excluded. Criteria are also sometimes set for the level of social, environmental, health and safety reporting, or the adherence to world-wide minimum social and environmental standards. Examples of these indexes are the Domini Social Equity Index, the Dow Jones Group Sustainability Index, and the entire Calvert portfolio of Socially Responsible Investment Funds.

The performance of these funds shows that social investing is profitable. Several of these indexes outperform the S&P 500. A recent review of 70 studies exploring the link between environmental and financial performance found that companies with the best environmental management practices were rewarded with stock market returns up to 2% higher than their peers (Earle, 1998). Also, positive environmental performance never translated into negative returns.

In recent years, an increasingly large part of FDI flows have been through mergers and acquisitions (M&As). While it is difficult to estimate the share of FDI that is accounted for by M&As,[4] their growth rate has outstripped that of FDI throughout the entire 1990s (UNCTAD, 2000). Foreign direct investment flows from OECD countries are also increasingly oriented towards the services sector. In 1998, more than half of OECD FDI outflows occurred in this sector, with financial intermediation accounting for the bulk of this. Also interesting to note are the increases in FDI in electricity, gas and water, and telecommunications, reflecting the extensive privatisation and regulatory reforms which have taken place in these sectors over the past two decades. While the primary sector showed a declining share in total FDI in the period 1985-1995, large investments in the extraction of petroleum and gas reversed this trend in 1998 (see Figure 5.2). Manufacturing, on the other hand, increased steadily over the same period, but witnessed a relative drop in 1998 due to the surge in services-related FDI.

Figure 8.2. **Total OECD foreign direct investment outflows to selected sectors**



Source: Compiled from OECD (1999), *International Direct Investment Statistics Yearbook.*

Policy developments

In the past few decades, the reduction of barriers to trade and investment, along with subsidy reform, have played a major role in facilitating the growth in trade and investment. This improvement in the trade and investment climate in the 1990s was partly influenced by the recognition of the benefits of FDI and trade. The 1990s brought an explosion of unilateral trade liberalisation, often as part of a broader shift from import substitution to export promotion. Removal of domestic impediments through regulatory reform and privatisation was also widespread. These reforms have removed significant restraints to investment and trade, increased the efficiency of resource allocation, and made it possible to capture the benefits of FDI and trade.

On the trade side, the World Trade Organisation (WTO) oversees the various multilateral agreements to which the WTO's current membership of 140 countries subscribes. These agreements cover areas as diverse as tariff reductions on agricultural and industrial products, sectoral commitments to promote services trade, as well as undertakings to protect intellectual property rights. A few highlights of the Uruguay Round Agreements include greater clarity in the system of customs valuation rules, enhanced control and clearer rules on the use of anti-dumping duties, subsidies and countervailing measures, the creation of the Committee on Trade and Environment, and the establishment of a new system for arbitrating trade disputes, as well as the General Agreement on Trade in Services (GATS). The GATS provides a framework for liberalisation of barriers to services trade, and has offered WTO Members the possibility of making pre-commitments in accordance with their development needs. The GATS, whose mode 3 of delivery covers trade in services through the establishment of commercial presence abroad, is also relevant for foreign investment. In addition, the Agreements on Technical Barriers to Trade and on the Application of Sanitary and Phytosanitary Measures reduce the possibility that technical regulations and standards become unpredictable and unjustified barriers to trade. While countries have the right to take measures to protect

human, animal, plant life or health deemed to be at risk, these measures should not be more trade-restrictive than necessary to meet that objective.

On the investment side, OECD members are committed to provide non-discriminatory treatment to inward direct investment and related financial flows by virtue of the legally binding OECD Codes of Liberalisation of Capital Movements and Current Invisible Operations. The 33 countries that adhere to the OECD Declaration on International Investment and Multinational Enterprises[5] have also undertaken a political commitment to provide national treatment for established foreign controlled enterprises, to avoid conflicting requirements on those enterprises and to work together to improve the investment climate. These instruments have provided an effective framework for international co-operation and have served to underpin the liberalisation achieved in recent decades.

Bilateral investment treaties (BITs) have become an increasingly important vehicle for promoting and protecting investment flows by providing legal security to foreign investors and their investments. They establish rules concerning: the treatment of foreign investors and their investments by host countries, including national treatment and most-favoured nation treatment; prompt, adequate and effective compensation in the case of expropriation; and free movement of capital and other financial flows related to the investment. In addition, BITs include rules on dispute settlement, both with regard to state-to-state arbitration and investor-state arbitration. Most of the BITs were signed in the 1990s, paralleling the rise in investment flows. In the three decades leading up to 1990, only 500 BITs had been signed, whereas by the end of the decade this number has almost quadrupled; and in 1999 the vast majority were concluded between developing countries (UNCTAD, 2000).

Regional integration schemes have been used to liberalise trade and investment regulation. Examples include the North American Free Trade Agreement (NAFTA), the Association of Southeast Asian Nations (ASEAN[6]), the Australia/New Zealand Closer Economic Relations Trade Agreement (ANZCERTA), Mercosur[7] (the Common Market of the South) and the Southern African Development Community (SADC[8]). Talks on the Free Trade Area of the Americas (FTAA), designed to set up a hemispheric-wide free trade zone by 2005, are currently underway. Besides removing barriers to trade and investment, harmonisation and mutual recognition of regulations is also important since the large variety of different legal systems and regulations — though intrinsically not restrictive — can also serve as a barrier to trade and investment. Regulatory reforms at the European Union level and the harmonising of European legislation, combined with a liberalised internal market, have been important drivers in the increase of intra-European investment and trade.

In addition to liberalisation and regulatory reform, OECD countries further increased their reliance on market systems through privatisation. The OECD public enterprise sector is currently estimated to be less than half the size it was at the beginning of the 1980s (Gonenc *et al.*, 2000). The privatisation movement was in large part induced by dissatisfaction with the performance of state-owned enterprises, and the increased capital investment needed to upgrade infrastructure, especially in the public utility sector. Privatisation offered the opportunity to restructure and introduce competition in sectors previously dominated by state monopolies, to increase investment, and to improve productive and allocative efficiency, all of which benefit consumers and the economy as a whole.[9] However, in some economies in transition that have recently become OECD members, the benefits from the change in ownership have sometimes proved disappointing, due to weaknesses in the legal, institutional or market environment. For such reforms to work, the privatisation process needs to be open and transparent and allow foreign participation in a non-discriminatory manner.

Remaining barriers to trade and investment

With more countries acknowledging the benefits of FDI, barriers to international investment are gradually being removed. Of the almost 1000 changes in FDI regulations undertaken world-wide in the 1990s, 94% were aimed at creating a more favourable environment for FDI (UNCTAD, 2000). Many countries now employ *incentives* to attract FDI. Examples of such incentives include tax holidays, preferential access to (government) credit and the reduction of import duties for goods needed for production. But barriers to investment have

not disappeared. In order to maintain national control over the economy many exceptions for "strategic sectors" exist. Restrictions on foreign ownership provide another important barrier to entry and prevent the market for corporate control from functioning efficiently. Other restrictions include measures designed to align firm strategy with national development goals — e.g. demands that firms live up to specific performance requirements. A lack of political and economic stability and predictability can also act as a barrier to investment, as can a lack of transparency of regulations, corruption and weak protection of intellectual property rights. Both liberalisation by services sector and improvement and extension of rules, including on mode 3 covering foreign investment, began as planned in 2000 under GATS negotiations.

On the international trade side, liberalisation under the General Agreement on Tariffs and Trade (GATT) and the WTO has led to significant tariff reductions (OECD, 1999d). Tariffs imposed by OECD countries now average 3% on imports from other OECD Members and 4.8% on goods from non-OECD countries. This compares to tariffs in non-OECD countries on imports from the OECD of 10.7% on average. However, despite significant liberalisation, ample scope for further multilateral tariff liberalisation still exists. Though the average tariffs in OECD countries have declined, according to a recent study by the United Nations Conference on Trade and Development (UNCTAD) and the WTO (UNCTAD/WTO, 2000), tariff peaks remain in six sectors: (*i*) major agricultural staple food products; (*ii*) fruit, vegetables, fish, etc.; (*iii*) the food industry; (*iv*) textiles and clothing; (*v*) footwear, leather and travel goods; and (*vi*) the automotive sector and a few other transport and high technology goods such as consumer electronics and watches. Tariff escalation also remains an issue for a number of raw material-based products. Although imports of the basic commodity face a zero tariff, intermediate and processed products face successively higher tariffs. This makes it difficult for developing countries to export manufactured goods.

The agricultural sector is central to many economies. The price-depressing effects on world exports of subsidised agricultural production and exports, particularly in OECD countries, directly impacts market opportunities for agricultural exports by food-exporting developing countries. The subsidies on agricultural products and consequent decreased market opportunities also negatively affect job-creation possibilities in these developing countries, since job possibilities are generally greater in agriculture than in manufacturing activities (OECD,1999a). Developing countries that are net food importers are also affected. In these countries, where agricultural production for both the domestic and export market remains largely underdeveloped, dependency on cheap food imports can impede development. Textiles and clothing are also of significant export interest to non-OECD countries and this sector is often considered a first step towards industrialisation, providing significant employment opportunities for unskilled workers.

The Uruguay Round Agreements on Agriculture (URAA) and on Textiles and Clothing (ATC) have put an end to exemptions from basic GATT principles and disciplines that these sectors have received for decades. Nonetheless, in addition to high tariffs, there remain significant non-tariff barriers in OECD markets on imports of agricultural, textile, and clothing products originating from developing countries. In the area of agriculture, some developing countries have expressed concerns regarding the limited trade liberalisation resulting from the implementation period of the Agreement, particularly as regards market access, domestic support, and export competition. In the textiles and clothing sector there have been concerns that liberalisation under the ATC mainly relates to relatively low value-added products. Also, almost half of the quantitative restrictions (those shielding the most sensitive items) will only be removed at the end of the transition period. The World Bank estimates that OECD tariffs and other distortions, such as farm subsidies, cause annual welfare losses of almost USD 20 billion for developing countries — equivalent to about 40% of total ODA given to developing countries (World Bank, 2000*b*).

How trade and investment affect sustainable development: opportunities and risks

This section analyses the main mechanisms by which trade and investment impact upon the three constituent parts of sustainable development: economic growth, environmental protection, and social development. The long-term focus inherent in the notion of sustainability implies that the most important influence of trade and international investment may well be their impact on economic growth and on

environmental and social performance both nationally and globally. Much of the analytical work on the impact of trade and investment on sustainable development has focused on how environmental and social policies respond to the ensuing challenges and opportunities of trade and investment activities. Growing international economic integration also implies that international trade and investment are increasingly shaped by domestic policies — e.g. environmental policies, competition policy, intellectual property protection and other regulations. Economic, environmental and social concerns are discussed separately below.

Economic growth

Whether trade and investment stems from foreign or national sources, it has been shown that market openness — to investment as well as to both exports *and* imports — increases economic growth. Open markets promote more efficient and productive use of resources. They can provide countries with technology not locally available. And by helping firms to tap into world markets, they can increase sales and realise economies of scale. Efficiency, in turn, contributes to economic growth and rising incomes. The observed average increase in trade exposure in OECD countries between the 1980s and 1990s has been estimated to have resulted in about a 4% increase in output per capita (Bassanini *et al.*, 2001). The gain from trade liberalisation under the Uruguay Round alone has been estimated to range between USD 258 billion and USD 510 billion, when dynamic effects are taken into account (OECD, 2001d). Trade liberalisation can also benefit citizens in tangible ways, through lower prices, greater product diversity, and an increase in the purchasing power of wages. In the case of Australia, for example, recent unilateral trade liberalisation has put AUD 1000 in the hands of the average Australian family (OECD, 1998).

In the last decade, countries that have had more open trade and investment regimes have achieved double the annual average growth rates of others, and have attracted more FDI (OECD, 1998). There is also an increasing body of empirical-econometric evidence showing that countries with more open trade and investment regimes have had higher rates of growth. For example, a study by Sachs and Warner (1995) finds that developing countries with open economies grew by 4.5% a year in the 1970s and 1980s, while those with closed economies grew by 0.7% a year. And a recent study by Ben-David *et al.* (1999) finds that major trade liberalisation events have coincided with movements to higher — and in the majority of cases, steeper — growth paths. These results concur with a recent study by Dollar and Kraay (2000) which confirms that openness boosts economic growth, and that the incomes of the poor rise one-for-one with overall growth.

Benefits associated with the inflow of FDI include an increase in the production base, the introduction of new skills and technologies and the creation of employment — all of which lead to more long-term, dynamic effects, such as increased efficiency, better resource allocation, increased productivity and economic growth. MNEs are a powerful and effective means to disseminate technology from developed to developing countries, and are often the only source of new and innovative technologies not readily available through the market. Technology disseminated through FDI generally includes the "entire package"— the experts, skills and financial resources needed to exploit the technology appropriately. FDI also brings other tangible and intangible assets that have large impacts on development. For example, the inflow of FDI through mergers and acquisitions can bring improved corporate governance, including better organisational and managerial skills.

Looking at the impact of FDI on capital accumulation and productivity growth, de Mello (1999) finds that foreign investors increase productivity in host countries and that FDI is often a catalyst for domestic investment and technological progress. Markusen and Venables (1999) find that FDI has a positive effect on domestic firms' productivity. They claim that increased competition associated with the entry of an MNE upgrades the efficiency and product quality in national firms, and opens up possibilities for export. Empirical evidence on OECD countries also shows that foreign affiliates of MNEs have a higher labour productivity compared with local firms.[10] Foreign investment plays an important role in the dissemination of gains from innovations, especially in developing countries (Ahn and Hemmings, 2000). And studies by Borensztein *et al.* (1999) and the OECD (1998) find that foreign direct investment not only stimulates growth but also has a larger impact than investment by domestic firms. Recent literature shows, however, that developing countries need to have reached a certain threshold of development (e.g. education or infrastructure) before being able to capture the benefits associated with FDI (Saggi, 2000).

The degree to which corporations observe basic principles of good corporate governance is an important factor for international investment decisions. Corporate governance programmes establish rules to protect shareholders and encourage clarity and transparency in financial reporting. They play an essential role in economic growth and the development of equity markets, which enable companies to access financing from a larger pool of investors (Maher and Andersson, 2001). Corporate governance mechanisms facilitate the efficient functioning of capital markets (including the market for corporate control) and promote the efficient allocation of resources. This is particularly relevant for international investment given the increase in FDI via mergers and acquisitions. A good corporate governance regime helps to maintain the confidence of investors — both foreign and domestic — and to attract longer-term capital, which is particularly important for developing countries. Good governance also helps eliminate bribery and corruption — two critical impediments to economic growth. Corruption is not only a serious obstacle to investment, but also acts as a brake on social improvement (e.g. education or health) since it diverts funds away from development (see Box 5.2).

Box 8.2. **Bribery, corruption and sustainable development**

Bribery and corruption — stemming from lax economic, political and institutional systems — have a strong impact on sustainable development. For example, the latest report of Transparency International's (2000) *Corruption Perception Index* (CPI) shows a striking correlation between the CPI and national environmental performance. In contrast to the idea that corruption and bribery can "grease the machinery of commerce", empirical evidence has shown that countries with high levels of corruption have poor economic performance and lower rates of investment, both domestic and foreign (Mauro, 1995; Wei, 1998).

The mechanisms through which corruption hinders economic growth are straightforward. First of all, bribery and corruption distort economic decision-making, and increase transaction costs and uncertainty in the economy. Once corruption has spread, a vicious circle is established whereby economic actors continue to operate illegally without trying to revert to the rule of law. Moreover, corruption inflates government expenditure and distorts the composition of this expenditure away from investment in sectors such as health and education towards large public-infrastructure projects. Hence, development is slowed as crony capitalism is promoted at the expense of economic efficiency. Similarly, corruption misallocates talents to rent-seeking activities and distorts sectoral priorities and technology choices. Last, but not least, corruption undermines the state's legitimacy and its ability to raise revenues, reducing the provision of public goods.

Enterprises have responded to these concerns by adapting management techniques commonly used in many other areas such as quality and environment. OECD research on corporate codes of conduct shows bribery and corruption to be among the most commonly cited issues in codes. But the definitions used and the scope of commitments vary widely. This suggests that the international business community is still struggling to come to grips with the complex ethical questions that arise in defining appropriate business conduct.

Available evidence suggests that many of the poorest developing countries have not been able to integrate successfully into global markets in order to participate in the growth-inducing benefits of openness to trade and investment. The failure of the majority of the least-developed countries (LDCs) to grow and to integrate into the global economy as rapidly as other developing countries has occurred despite multiple efforts at reform. Market openness clearly is not a sufficient condition for economic growth; sound macroeconomic policies and institutional stability are also necessary, as is social stability (Rodrik, 1999; OECD, 2001*d*). With weak institutions, poor governance (both public and private) and unsound policies, market reforms can fail with great costs, especially to vulnerable groups in society.

Indeed, during the 1990s, output growth in low-income countries was less than the developing country average, largely as a result of conflict and macroeconomic instability.[11] Since 1980 more than half of all low-income countries, including 15 of the world's 20 poorest countries, have been involved in foreign or civil

wars. However, low-income countries that had both macroeconomic stability and avoided conflict achieved annual per capita growth rates of 2.9% and real export growth rates of 11.6%. Though hardly conclusive, the performance of these countries during the 1990s suggests they can achieve rapid growth while increasing their integration with the global economy (despite limited capacity and weak institutions) provided they exhibit minimal social and macroeconomic stability. Good regulatory reforms to encourage competition and foster consumer protection are also crucial to such growth.

Environmental protection

Effects of trade and investment on the environment

In general, while trade and investment are not the root cause of environmental problems, they can have significant effects, both positive and negative, on the environment. Most environmental consequences of trade and investment liberalisation are the result of an expansion of world economic output (scale effects), a reallocation of production and consumption, both world-wide and between sectors (structural effects), and the stimulation of technological development and diffusion (technology effects).

On the one hand, trade and investment liberalisation — like any policy fostering economic growth — may lead to increased production and consumption of polluting goods or to an expansion in industrial activity. This can lead to growing pressures on the environment such as increased pollution and use of resources, rapid urbanisation, or damage to protected areas, etc. — posing problems for pollution control, ecological protection and public health issues. In developing countries these risks are often exacerbated due to weak environmental policies, as well as inadequate frameworks for resource tenure and enforcement of ownership rights. Increased economic activity brought about by trade and investment liberalisation brings out the distortions and weaknesses of the existing policy framework that can result in severe environmental degradation (Box 8.3). When sources of environmental degradation or under-priced resources (e.g. forests, fish, water or air) are not adequately addressed, rapid export growth — while not the root cause — can worsen the problem.

Box 8.3. **Examples of environmental benefits and risks linked to trade**

The conversion of open-access resources to agricultural uses

Although in many countries resources such as forests or coastal wetlands are formally owned by the State, indigenous or local communities, the responsible authorities have been unable or unwilling to enforce this ownership. Thus these resources have often become de facto accessible to any user. For instance, increased international demand for seafood has led to a major expansion of shrimp farming in many developing countries, generating increased welfare and employment in some areas. However, in many countries of Asia and Latin America, the growth of shrimp farming has also resulted in large-scale conversion of mangrove swamps to shrimp ponds. These shrimp ponds have often proved to be financially and environmentally unsustainable, destroying not only the mangroves, but future production possibilities as well.

Subsidy reform in the energy sector

The reduction or removal of subsidies is an important element of trade liberalisation and generally has a win-win effect. For example, China has made remarkable progress in reducing energy subsidies since the mid-1980s — notably to its the coal sector, which produces more than 70% of the country's energy supply. Subsidy rates for coal fell from 61% in 1984 to 11% in 1995. At the same time, China removed price controls on coal, and encouraged the development of private coal mines. These reforms have produced multiple benefits. The economic performance of coal mines has improved rapidly, reducing government spending and — along with other policy reforms and technological change — contributing to energy conservation and environmental protection. Energy intensity has fallen by 30% since 1985, leading to reductions of energy consumption (in oil equivalents) and CO_2 emissions, of, respectively, 0.3 billion tonnes and 1.1 billion tonnes (Watson *et al.*, 2000).

On the other hand, trade and investment liberalisation — when paired with the implementation of strong regulatory frameworks to protect the environment — can have a beneficial impact on the environment by improving resource allocation, promoting economic growth and increasing welfare. Trade and FDI can improve structural efficiencies and make new investments in environmental protection possible. Furthermore, by contributing to economic growth, trade and investment also increase society's demand for a healthier environment, since wealthier societies are more willing — and able — to pay for protection of the environment. Some evidence supporting this relationship has been found by examining the number of environmental regulations and various indicators of environmental quality, both of which increase or improve steadily with growth in per-capita income (Furtado *et al.*, 2000).

Still, there are several reasons for not relying exclusively on this "market solution" to protect the environment. Not all measures of environmental quality fit this pattern (e.g. growth contributes monotonically to global emissions of carbon dioxide, volume of waste and urban congestion). Also, it might take years of economic growth before environmental quality begins to improve, at the risk of possibly irreversible environmental damage in the short term. While economic growth may well be necessary, it may not be sufficient for environmental improvements. Furthermore, just as growth might help to improve environmental quality, environmental policies might also help to promote growth. For example, the Asian Development Bank estimates that the welfare costs to China from environmental damage could be equivalent to 10% of GDP. Global warming, to the extent that it affects weather patterns, disrupts the agricultural sector. Policies to limit global warming would mitigate such effects. Instead of relying solely on economic growth and market mechanisms, governments will need to improve the coherence of their policies and implement and enforce adequate environmental regulations to limit environmental damage.

In general, sectoral studies have underscored that trade liberalisation can go hand in hand with environmental improvements. Opportunities to realise economies of scale and the effects of increased competition on efficiency can be expected to lead to welfare gains. For example, opening markets to foreign suppliers of environmental goods and services (EGS) by reducing tariffs and other trade-distorting measures enables advanced know-how and environmental technologies to become more readily available, thereby spurring economic growth and employment (OECD, 2001*b*). Economic modelling of energy markets has indicated that trade liberalisation and energy policy reforms would not only increase economic welfare, but also reduce global carbon emissions. Energy subsidies, particularly those encouraging energy consumption by keeping prices below costs, impose a heavy weight on economic efficiency and environmental performance. In this case, reductions in both local and global pollution can accrue from proper pricing.

Trade and investment flows can further assist in abating pollution (or have other positive environmental impacts) through the dissemination of technology. With tighter regulations at home, MNEs have a strong incentive to innovate in areas that improve resource efficiency or reduce industrial waste. New technologies can be introduced on a global basis by such firms, and thereby exploit economies of scale. These modern technologies can be licensed directly to foreign producers, imported through abatement equipment or installed directly by MNEs in their foreign affiliates. FDI by multinational enterprises can also have positive spill-over effects on the technological characteristics of national firms, since domestic firms may imitate multinationals' technological practices in order to improve their own production practices. This process of technology diffusion can be encouraged by host country policies, voluntary corporate codes of conduct, and broader guidelines such as the OECD Guidelines for Multinational Enterprises[12] and the UN Global Compact initiative. However, even if industrial production plants use advanced technologies, FDI can increase the total environmental burden on a country through scale effects.

While the role of trade and FDI are important vehicles for both technological change and diffusion, international capital flows are also an important determinant of the technologies of production. By giving firms access to foreign sources of savings, the internationalisation of capital markets can ease financial constraints that prevent firms from investing in potentially more efficient and environmentally preferable technologies. In some cases, these financial constraints have arisen from national policies towards foreign capital, such as foreign exchange restrictions, international credit controls, and ownership restrictions.

The pollution haven and halo hypotheses

Long-term environmental impacts of trade and investment will depend in large part on how government environmental policies respond to their pressures and opportunities. For example, the so-called "pollution haven" hypothesis implies that competitive forces would move foreign direct investment away from countries with high environmental standards, or attract it towards those with low environmental standards. Closely related to this hypothesis is that of the "regulatory chill", which would reflect resistance to enacting or upgrading home country environmental standards on competitiveness grounds.

FDI flows to a wide range of industries and companies — some of which are careful environmental stewards, some of which are not. However, empirical research shows that the risk of redeployment of productive resources towards low standard countries is rather small. Environmental costs are only one of a broad number of factors — quality of infrastructure, access to inputs, wage costs, labour productivity, political risk, the size and growth potential of markets — that investors take into account in location decisions. The costs of adhering to environmental regulations are also a small part (on average 2-3%) of total production costs for most firms (OECD, 1998; Adams, 1997; UNEP/IISD, 2000), although in certain resource-intensive sectors costs may be higher. Instead, multinational enterprises generally seek *consistent* environmental enforcement, rather than *lax* environmental enforcement (OECD, 1997). In spite of the strength of empirical findings concerning the relative unimportance of pollution havens there is some evidence that competitiveness concerns have dampened governments' enthusiasm to raise environmental standards.[13]

The converse notion of "pollution halos" suggests that FDI might promote the establishment of higher environmental standards through technology transfer or via existing management practice within multinational or other firms. For example, a large share of FDI directed to non-OECD countries is related to privatisation, and privatised firms are typically better managed and more accountable, factors that contribute to reducing waste and pollution. Moreover, the bulk of international investment is undertaken by large multinational enterprises that operate at the highest corporate standard of environmental performance world-wide, rather than tailoring their production methods to the level of regulatory enforcement prevailing in host country markets.[14] Close to three-quarters of global FDI flows originate in, and are directed towards, industrialised countries, and are subject to stringent environmental standards. However, it is important that appropriate policies be in place at the national level to ensure effective enforcement.

Links between trade and environmental policies

As described earlier, trade agreements leave room for countries to take the measures they deem appropriate for the protection of human, animal, plant life or health. In certain cases, though, trade disciplines affect how governments apply national environmental standards or measures. Two issues in particular have generated extensive debate — the application of process and production method-based requirements to imports, and the use of precautionary measures to prevent environmental damage.

Process and production methods (PPMs) — how products are manufactured, or natural resources are extracted — can have significant environmental impact. Countries have adopted a variety of regulations that attempt to mitigate the negative impacts of processes and production methods, often with success. Measures that address environmental problems at the production stage, however, raise complex trade issues (e.g. if a country tries to impose national requirements on imported products, or tries to enforce its standards or production requirements to activities outside its jurisdiction). WTO rules are attached to "products": "like products" are to be accorded "like treatment". These rules do not explicitly recognise import restrictions based on non-product related characteristics. There are some examples of international agreement on trade restrictions based on PPMs, such as the ban on products that use chlorofluorocarbons during the production process under the Montreal Protocol on Substances that Deplete the Ozone Layer. Recent interpretation of the relevant GATT rules, in a highly qualified ruling involving the protection of endangered species, suggests that it might be acceptable to apply national measures based on non-product-related PPMs to imports. The application of such measures, however, is subject to strict conditions and must respect the rules of the trading system, such as non-discrimination.

In the last few years, discussion on the use of precautionary measures to prevent environmental damage has intensified. While the potential environmental impact of many human activities is known, for others it is not, or at least not sufficiently. Several multilateral environmental agreements (MEAs) and other international instruments, as well as some national legislation, advocate the use of precaution, and recommend that in cases where there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental damage.[15] In some cases, for example, where countries have different approaches to the potential risks involved, the implementation of precautionary measures can be seen as unduly protectionist and discriminatory.

Social development

The social effects associated with trade and investment, and their liberalisation, come essentially from two factors. First, trade and investment can affect the labour market. Though foreign firms have been shown to create employment, the quality of that employment is sometimes questioned. Especially where governments compete to attract FDI, some may be tempted to be less vigilant in enforcing national laws that promote core labour standards. In some cases, less stringent legislation is in place in export processing zones. However, a number of recent studies point out that there are major constraints on a race to the bottom in labour standards (OECD, 2000). Fears about a race to the bottom are therefore probably exaggerated. Second, trade and investment and their liberalisation — while not the root cause — can exacerbate differences in income distribution and inequality that result from inadequate national policies (e.g. tax policies). The benefits of the changes in global production and trade patterns, therefore, will be distributed differently among nations and among different groups within nations.

With respect to the definition and recognition of *core* labour standards, the international community has made significant progress in developing consensus. Core labour standards are accorded particular importance internationally because they reflect basic human rights in the workplace, provide for framework conditions that facilitate the meaningful application of other labour standards, and promote the expression of free choice — a key element in the healthy functioning of market economies. According to the International Labour Organization's (ILO's) *Declaration on Fundamental Principles and Rights at Work* (adopted in 1998), these principles and rights include freedom of association and the effective recognition of the right to collective bargaining; the elimination of all forms of forced or compulsory labour; the effective abolition of child labour; and the elimination of discrimination in respect of employment and occupation.

The interplay between trade and investment, core labour standards, and employment is complex. Countries that strengthen their core labour standards can increase economic efficiency by raising skill levels in the work force, and by creating an environment which encourages innovation and higher productivity. Van Beers (1999) and Jessup (1999) suggest a negative relationship between observance of labour standards and trade performance. This result, however, does not challenge the findings of a recent OECD study that countries with low core labour standards do not enjoy better export performance than high-standard countries (OECD 2001*b*). One important difference is that the analyses by Van Beers and Jessup focus on labour standards *generally* rather than on *core* ones.[16] On the investment side, too, the absence of core labour standards does not change the location decisions of OECD investors in favour of less strictly regulated countries. In the majority of cases, core labour standards are not important determinants for investment location decisions, thereby making policy competition between governments in core labour standards unnecessary and even harmful for society (OECD, 1998).

Using trade measures to encourage respect for core labour standards is controversial, and not an *optimal* instrument to that end. For example, the use of trade measures to ensure compliance with a ban on child labour may produce ambiguous results. In certain circumstances, a ban on child labour may be effective in shifting the economy into an equilibrium where adult wages are high and children do not work; this could apply to countries with relatively high labour productivity that are able to support children without sending any to work. In other circumstances, a ban may worsen the economic condition of households. Moreover, while a ban on the import of goods that use child labour as an input might drive child labour out of export industries, it is unlikely to prevent child labour in the informal sector — the major employer of child workers

in such countries (Basu and Van, 1998). Recent analysis, drawing on experience in Brazil and Mexico, suggests that a subsidy to families to keep their children in school is likely to be a superior policy instrument, in terms of curbing child labour, than trade interventions.

The other social effect of trade and investment is on the distribution of income, both within and across nations, and on poverty reduction. Economic growth driven by liberalisation helps to alleviate poverty, and the social and environmental damage engendered by poverty, but may not by itself be sufficient to reduce it. Poverty can foster political and social instability, as well as encourage practices that result in environmental degradation (e.g. deforestation to increase farmland or provide firewood, and soil erosion from over-intensive farming). Ensuring that economic growth translates into poverty reduction and environmental improvements requires that supporting policies be in place at the national level.

Over the last fifty years, trade and investment have contributed to a rise in prosperity and living standards, and a substantial reduction in poverty in many parts of the world. The share of the world's population experiencing extreme poverty — defined as living on less than USD 1 a day — has fallen from 29% in 1990 to 24% in 1998 (World Bank, 2000*a*). That still leaves a total of more than one billion people in poverty. In Asia, where most of the world's poor live, poverty has declined significantly over the past two decades, although the recent economic crisis has slowed progress. In contrast, the incidence of poverty is rising rapidly in countries with economies in transition in Europe and Central Asia, and continuing to rise in Latin America and Sub-Saharan Africa.

Though people are poor for a variety of reasons, empirical studies show that market openness has a positive impact on per capita income.[17] Frankel and Romer (1999) have estimated that a one-percentage-point increase in the openness ratio (the ratio of trade to GDP) increases both per capita incomes and subsequent growth rates by between 1% and 2%. However, while liberal trade policies are beneficial in most circumstances, enhancing the integration of less-developed countries into the global economy involves more than the opening of markets or a welcoming environment for international investment. Policies concerning macroeconomic stability, good governance and capacity building are also of crucial significance. So too are the right environmental and social policies to ensure that development is sustainable, and that the benefits of openness are widely shared.

Although experience shows that properly sequenced market-friendly reforms do produce economic growth and increased welfare, these effects might not be distributed equally among different groups in society. Liberalisation of trade and investment can lead to transitional disturbances in the markets on which the poor operate. Extreme shocks are often associated with the disappearance of a market, while strong poverty alleviation arises when markets are introduced for previously non-traded goods. Where markets do exist, liberalisation is likely to have major effects on the price of factors of production — of which wages are the most important for poverty purposes. If reform boosts the demand for labour-intensive products, it will increase the demand for labour. Either wages or employment (or both) will then increase. Whether this increase will reduce poverty depends on whether the poor are strongly represented in the type of labour for which demand has risen (Ben-David *et al.*, 1999). Policy makers thus need to complement policies stimulating economic growth with policies intended to broaden access to income opportunities.

Policies to promote sustainable development in an integrating world economy

In order to reap the benefits (and mitigate the negative effects) of trade and investment, it is important to integrate the various goals of sustainable development — economic growth, environmental protection and social development — into coherent national and international policy frameworks. Adequate governance regimes are critical to this process. These include effective and transparent institutions, an accountable government, and a solid and consistent legal framework (see Chapter 4). For developing countries, adequate governance regimes may be particularly hard to achieve due to the high costs associated with reform, as well as the skills, knowledge and competence it requires. Development assistance programs are therefore increasingly tailored to capacity building (see Chapter 9).

Strengthening national policies

Within the OECD area, various initiatives have been taken to strengthen national trade and investment policies in line with the objectives of sustainable development. For example, OECD governments are promoting the integration of environmental considerations and objectives into these policies, in particular through the implementation of economic instruments. In addition, governments have been putting more effort into assessing the environmental impact of projects and policies. The promotion of environmentally sound product policies and of General System of Preferences (GSP) schemes has further helped to achieve sustainable development goals.

Promotion of market-based instruments

Since the early 1980s, policy makers have developed and introduced market-based (or economic) instruments to protect the environment. These instruments can help to achieve environmental goals in a cost-effective manner. The trade and investment effects of economic instruments depend on the particular instrument, its design and the particular market in which it operates. Well-designed instruments should allow prices to more fully reflect costs, including environmental costs. However, if discriminatory or not well designed, these instruments could negatively affect market access for foreign producers. Economic instruments, and related policies, include environmental taxes and charges, tradable permits, and the removal of subsidies — all of which also improve resource allocation (see Chapter 5). This section deals with one instrument that is particularly relevant for trade and investment, the removal of environmentally harmful subsidies.

A subsidy can be defined as "environmentally harmful" if it results in more environmental damage than that which would occur without the subsidy. Such subsidies come in a wide variety of forms, including direct and indirect support payments, tax concessions to specific industries or regions, market price support and other regulations that enhance the competitive position of particular industries or sectors. Environmentally damaging subsidies may also serve as a disincentive to reduce material and energy inputs, thereby delaying, or even preventing, the entrance of other technologies or products into the market (leading to international trade and resource allocation distortions).

The harmful environmental effects of certain types of economic support have attracted considerable interest. Support removal has been identified as a potential "win-win" policy in that it may benefit both the economy and the environment. Despite national and international pressure to reduce subsidies, levels of support remain high in many OECD countries. Lobbying from well-organised interest groups often makes the removal of environmentally damaging subsidies politically difficult. And while a fear for loss of competitiveness may be justified in certain cases, it is often exaggerated: a wide variety of actual support reductions have taken place in OECD countries without significant losses in competitiveness (OECD, 1999b).

Environmental assessment

Prior assessment of the environmental impact of a specific project is required in virtually all OECD countries (OECD, 1997). It is therefore an important element for both domestic and foreign investors. It is also an increasingly important factor for lenders and institutions providing export credits and investment guarantees for projects. Environmental impact assessment (EIA) is essentially a planning and decision-making tool. It can help to focus environmental policy on the effects of economic activities stimulated by trade and investment liberalisation. Studies undertaken to evaluate the results of environmental assessment procedures conclude that their benefits have exceeded the costs.

Environmental impact assessment may also covers social impacts, such as disruption of land used by indigenous people or forced resettlements, especially with regard to large infrastructure projects. An EIA aims to identify the adverse environmental and social consequences of a proposed project, so that relevant authorities are fully informed of its potential impact when deciding whether to approve or modify its design, or to incorporate mitigating measures. Other important elements of an EIA include giving the public an

opportunity to voice concerns, and providing a tool for ongoing monitoring and oversight of the project, to ensure that all mitigation measures are carried out and the concerns of the affected communities are addressed.

More recently, the scope of EIA has broadened to examine for instance draft laws and regulations prior to their adoption. Environmental assessments of trade agreements[18] help trade negotiators, in both developed and developing countries, in predicting probable environmental effects of liberalisation measures. Many OECD countries are currently committed to undertaking environmental (sustainability) reviews of WTO and regional/bilateral trade agreements in order to identify those trade measures most likely to exacerbate environmental (and social) pressures, as well as those areas where liberalisation is likely to bring benefits. More recently, the United Nations Environment Programme (UNEP) has produced a manual for the integrated assessment of trade policies (UNEP, 2001). Through its support to developing countries institutes, UNEP is building capacity in the implementation of assessments and helping these countries' to better integrate their policy making.

Promoting environmentally sound product policies

Growing international economic integration, along with increased consumer concern about the environmental impact of what they buy, have intensified the tension between a narrow focus on the physical characteristics of products, and a broader one on the environmental externalities generated throughout the production process. To promote sustainable development, a range of environmentally sound product policies are currently being put in place, such as eco-labelling, extended producer responsibility and green public purchasing.

Eco-labelling schemes aim to promote the consumption and production of more environmentally friendly products by providing information to consumers regarding the overall environmental quality of the product. This information can relate to a variety of environmental concerns associated with the product during its life cycle. Increasingly, eco-labelling programmes tend to be based on life-cycle criteria, including production-related criteria. Trade concerns arise in relation to the transparency of the process of awarding the eco-label (particularly for producers not represented domestically) and the potential for criteria to be biased in favour of domestic production processes, resulting in potential *de facto* discrimination. A 1996 OECD study on the actual effects of selected eco-labelling schemes, recognising data limitations, did not reveal hard evidence of changes in trade flows arising from the schemes studied (OECD, 1996*a*). However, access to information and participation in criteria development may be more difficult for foreign producers. In order to avoid these schemes becoming disguised market barriers, they need to be non-discriminatory, transparent, involve widespread consultation on eco-label criteria and, above all, be non-protectionist in intent. This is especially important when criteria related to the production phase are included. They may then also serve as a means to enhance the competitiveness of developing-country products.

Extended producer responsibility (EPR) places ultimate responsibility for a good's disposal and recycling process on the producer, by promoting the internalisation of environmental externalities in the treatment and disposal of a product's life cycle. EPR shifts the responsibility, financial or physical, upstream towards the producer and away from municipalities, and provides incentives to design more environmentally friendly products (OECD, 2001*c*). Some EPR programmes require producers or retailers to "take back" the product, or its packaging, after use. The proliferation of different types of national environmental packaging, recycling, labelling, deposit refund and other programs that are developed independently, risk creating obstacles to trade and investment. Also, these programmes may inherently discriminate against foreign suppliers or firms.[19] Problems of adaptation can also arise, at least initially, for developing-country producers. In some instances, OECD donor agencies have helped developing-country producers overcome specific problems for key exports facing EPR related barriers. These issues underscore the need for greater transparency in the way EPR programmes are designed and implemented and for international co-operation aimed at achieving harmonisation, equivalency or mutual recognition of different countries' programmes.

Greener public purchasing (GPP) programmes provide incentives for public authorities to purchase environmentally friendly goods. Given that public consumption in OECD countries ranges from 5% to 15%

of GDP, such programmes can have a considerable impact in improving natural resource management. As a general rule, tenders for goods to be procured can include environmental specifications among other technical characteristics — such as quality, safety, dimensions, packaging and labelling. Here, too, trade concerns can arise, even if GPP schemes do not appear to discriminate among potential suppliers. Use of GPP can be optimised through credible and factual information, so that the criteria for making GPP decisions result in improved resource allocation rather than in the establishment of disguised trade barriers.

GSP schemes: encouraging sustainable development policies

Most industrialised countries have developed schemes under the General System of Preferences (GSP). These GSP schemes provide preferential access regimes for various products to certain developing countries. Two of these GSP schemes also incorporate compliance with certain labour and environmental standards.

The GSP scheme of the European Union (EU), for example, includes various labour and environmental clauses. It provides for special treatment of products that have been produced in an environmentally sustainable way. The environmental protection clause applies only to products originating in tropical forests (such as tropical nuts and fruits, and tropical wood). These incentives may be granted only to countries that provide proof that they apply legislation in line with International Tropical Timber Organisation (ITTO) guidelines. Extra preferences vary from 15% to 35%, depending on the environmental sensitivity of the product. Up to now, no country has applied for this scheme. The labour clause ensures additional tariff reductions to countries that prove compliance with the standards laid down in the ILO conventions. At present, the Republic of Moldova and the Russian Federation have applied for the social scheme, and five other requests are under examination by the Commission.

The United States' GSP scheme grants preferential treatment to those countries that have "taken steps to afford internationally recognised worker rights". These rights include: the right of association; the right to organise and bargain collectively; freedom from compulsory labour; a minimum age for the employment of children; and acceptable conditions of work with respect to minimum wages, hours of work, and occupational safety and health. In the GSP review that designates countries, the primary objective of the US scheme is to encourage the promotion of improved workers' rights. The threat of withdrawal of preferences has, in the view of the International Confederation of Free Trade Unions (ICFTU), contributed to the amelioration of workers' conditions.

Whether in the form of "carrots" (additional preferences) or "sticks" (withdrawal of preferences), the use of unilateral trade measures to influence policies is politically sensitive. Although some potential GSP beneficiaries have expressed opposition to the monitoring of social legislation in their territories, fearing that such tools could be used for protectionist purposes, such schemes appear to have been used effectively to support more environmentally friendly and socially acceptable trade flows. This underscores the importance of establishing consultative mechanisms for appropriate dialogue with potential beneficiary countries.

International policy responses

Multilateral, bilateral and regional trade and investment agreements

While individual WTO agreements do not aim directly at achieving environmental objectives, environmental considerations are included in some of them. The Preamble of the Agreement establishing the WTO recognises that parties should conduct their relations in the field of trade in a way that allows for the optimal use of the world's resources, in accordance with the objective of sustainable development. The GATT provides an exception from obligations under other provisions of the General Agreement, such as the national treatment and most-favoured-nation principles and trade restrictive measures, to allow measures necessary to protect human, animal or plant life or health, or that relate to the conservation of exhaustible natural resources. However, these measures must not be applied in a manner that would

constitute arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Since its creation in 1995, the principal forum in the WTO for exploring such linkages between increased international trade and the environment is the Committee on Trade and Environment (CTE).

Similarly, international investment agreements do not necessarily promote better environmental and social performance. Nor do they necessarily *interfere* with effective policies to promote sustainable development. For example, the core non-discrimination principle of investment agreements call on host governments to treat foreign investors no less favourably than domestic investors (national treatment) and no less favourably than other foreign investors (most-favoured nation, or MFN, treatment) *in like circumstances*. This principle provides ample scope for the (non-discriminatory) exercise of national regulatory powers of government, including in the environment and social fields. However, it would not prevent a host country from lowering its standards to make its economy *more* favourable to foreign investors. How these matters are addressed in investment agreements is still in discussion, and some countries have included clauses against the lowering of standards in their bilateral investment treaties (BITs). Transparency and enforcement (of national laws and regulations as well as international agreements) should be encouraged.

The OECD Code of Liberalisation of Capital Movements, while calling for the progressive liberalisation of all capital movements, including FDI, permits OECD members to take action they consider necessary to protect public health and safety. At the regional level, NAFTA makes it possible for parties to adopt measures that ensure that investment activity in their territory is undertaken in a manner sensitive to environmental concerns. Under NAFTA it is inappropriate for countries to encourage investment by relaxing domestic health, safety or environmental measures. The NAFTA side agreement on labour co-operation (NAALC) links each of the North American countries' labour laws to the regional trade agreement. It promotes eleven mutually recognised labour principles, including those regarding occupational injuries and illnesses and the protection of migrant workers (OECD, 1996b). In the EU, unjustified restrictions on the freedom of establishment and the movement of capital from one member-state to another are forbidden.

Environmental or social issues are not generally addressed in bilateral investment treaties. Exceptions to national or most-favoured-nation treatment are permitted for reasons of public order or national security, and restrictions on the applicability of the entire BIT are extremely rare (UNCTAD, 1998), though recently there have been signs of change. For example, the most recent U.S. BITs address labour and environment issues in the preamble, stating that the objectives of the BIT can be achieved without relaxing health, safety and environmental measures.

Some developing countries have also adopted regional integration agreements, some of which include investment provisions. Of these agreements, the Mercosur and ASEAN agreements are among the most comprehensive. The 1992 Agreement on the Common Effective Preferential Tariff Scheme for the ASEAN Free Trade Area (AFTA) gives exceptions to its provision when measures are necessary for the protection of human, animal, or plant life and health. The 1998 Framework Agreement on the ASEAN Investment Area extends national treatment for ASEAN investors by 2010, and to all other investors by 2020. It makes a general exception for public health or environmental protection as long as these measures are not used as arbitrary or unjustifiable discrimination, or as a disguised restriction on investment flows.

Multilateral Environmental Agreements

Trade and investment may interact with environmental concerns in the implementation of MEAs (OECD, 1999*e*). Of the approximately 200 MEAs currently in force, some 20 contain trade measures, ranging from bans on trade in endangered species, labelling of internationally traded living modified organisms to prior approval procedures for hazardous chemicals and transboundary movements of wastes. Some MEAs clearly recognise the need for coherence of environmental protection with trade and investment policies. Notably, the Protocol on Biosafety and the Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals recognise that trade and environmental policies should be mutually supportive with a view to achieving sustainable development. And under the Kyoto Protocol to the Climate Change Convention, parties are to progressively remove or phase out market imperfections, fiscal incentives, tax and duty exemptions

and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention. MEAs are often based on co-operative endeavours to attain general goals and do not always specify duties and obligations in detail, making compliance difficult to monitor and enforce. Attempts are now being made to improve compliance by, among other means, specifying more clear-cut targets and actions (e.g. emission reductions under the Kyoto Protocol).

Hypothetical situations can be envisaged where a state may not be able simultaneously to meet both its obligations under the WTO and some MEAs. This possibility has elicited questions as to which agreement would take precedence over the other in case of conflict. This uncertainty is reflected in recently adopted MEAs (such as the Cartagena Protocol on Biosafety). So far, trade measures in MEAs have not been challenged in the WTO. Several proposals for addressing potential conflicts have been made, but none have attracted consensus.

International Financial Institutions

International Financial Institutions (IFIs) are now systematically incorporating social and environmental criteria in their lending policies and practices, and have put in place procedures to assess the impacts of their development projects and lending activities. Most IFIs today use guidelines to assess the environmental risks of the projects they finance. The World Bank, for example, requires all proposed projects to be screened in order to determine their potential environmental impact. This includes private-sector projects financed through the Bank's International Finance Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA). The IFC policy is that all its operations are carried out in an environmentally and socially responsible way. To this end, the IFC has set up environmental, social and disclosure policies for all projects, as well as obligations to adhere to international standards and to comply with host country regulations. Some projects — such as those involving forced or child labour, illegal activities, trade in wildlife and wildlife products regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), production of radioactive material, unbounded asbestos fibres, and ozone depleting substances —are excluded from IFC financing. Multilateral development banks, including the European Bank for Reconstruction and Development (EBRD) and the Asian Development Bank (ADB), address the environmental impacts of projects in the framework of their lending activities.

Promotion of responsible corporate behaviour

The private sector plays a vital role in generating economic growth and in ensuring the sustainability of that growth. Therefore, the way private enterprises behave and are governed is important for sustainable development. OECD countries have launched several initiatives to promote responsible corporate behaviour in line with the sustainable development agenda. Among these instruments are the OECD Principles of Corporate Governance, the OECD Guidelines for Multinational Enterprises, and the OECD Bribery Convention.

The OECD Principles of Corporate Governance outline the core elements of a good corporate governance regime. They advocate that the rights of shareholders, including minority and foreign shareholders, be protected, and that the markets for corporate control be allowed to function in an efficient and transparent manner. They recognise the role that stakeholders play in contributing to the sustainability of financially sound enterprises, and that factors such as business ethics and corporate awareness of environmental and societal concerns affect a company's reputation and long-term success. In 2000, the OECD Principles were included as one of the 12 core sets of standards for financial stability compiled by the Financial Stability Forum. The OECD and the World Bank agreed to co-operate on their implementation and created a series of regional Roundtables in Latin America, Asia and Russia to this end. The World Bank is proceeding with a series of country assessments, using the OECD Principles as a conceptual basis.

The OECD Guidelines for Multinational Enterprises provide a set of recommendations for responsible corporate behaviour (consistent with existing legislation) that both complements and reinforces efforts by the private sector. These voluntary Guidelines — specifically aimed at the behaviour of Multinational Enterprises — provide a government-backed set of principals and standards of good corporate behaviour, and help to

level the playing field between competitors in the international market place. Issues covered in the recently revised Guidelines include: disclosure and transparency (updated to encourage social and environmental accountability); employment (now covering all internationally recognised core labour standards), and environment (encouraging MNEs to raise their environmental performance through improved internal environmental management and better contingency planning for environmental impacts). A new recommendation on human rights and new chapters on combating corruption and on consumer protection were also added.

Though the role of firms is vital in the fight against bribery, governments also have an important role to play. *The OECD Convention on Combating Bribery* addresses bribery of foreign public officials in international business transactions. The Convention requires countries to establish the criminal offence of bribing a foreign public official, and to have in place adequate sanctions and reliable means for detection and enforcement. The aim is to eliminate the "supply" of bribes to foreign officials, with each country taking responsibility for the activities of its own companies. The new chapter on combating corruption in the OECD Guidelines for MNEs, and the disclosure and transparency chapter in the OECD Corporate Governance Principles, together provide a framework discouraging firms from engaging in acts of bribery.

Firm-level responses

Multinational enterprises have attempted to respond to public concerns regarding sustainable development by issuing policy statements — or codes of conduct — which set forth their commitments in various areas of business ethics and legal compliance. Management systems have also been designed to stimulate compliance with these commitments and a number of standardised management systems have emerged. More recently, steps have been taken to formulate standards providing guidance for business reporting on non-financial performance. Enterprises have not acted alone in developing these initiatives, but have co-operated with labour unions, NGOs and governments.

Corporate codes of conduct cover a broad range of issues that span the three pillars (economic, social and environment) of the sustainable development agenda (OECD, 2001*a*). Examples of those issues are environmental management, human rights, labour standards, the fight against corruption, consumer protection, information disclosure, competition, and science and technology. "Compliance with law" is the most common commitment made in the codes, and environment and labour relations are the issues most often covered. Still, significant divergences exist among companies in the nature of commitments they make, even in narrowly defined business ethics contexts (e.g. commitments on core labour standards in the branded apparel industry). Governments can promote increased corporate responsibility by encouraging the use of environmental and social *codes of conduct* by the private sector, ensuring a supportive regulatory framework and promoting the awareness and effective implementation of the OECD *Guidelines for Multinational Enterprises*.

Management systems have been developed by firms to implement the strategies and commitments found in corporate codes of conduct. In particular, many firms are introducing *environmental management systems* (EMSs). An effective EMS identifies and controls risks related to the environment, and increases cost-savings through more efficient use of resources and energy. Since the implementation of an EMS requires considerable know-how, international standards have been developed to formalise this procedure. The most common standardised EMSs are the Eco-Management and Audit Scheme (EMAS), the EU supported management system and certification scheme introduced in 1993, and ISO 14001, an international environmental management standard published in 1996. The past few years have seen a rapid growth in the number of certified firms. As regards labour relations, standardised management systems have become available, of which Social Accountability 8000 (SA8000) — focusing on child labour, forced labour, health and safety, and free association and collective bargaining — is a well-known example.

Environmental performance reporting is used by an increasing number of firms to report the results of their efforts to the public. Companies are facing ever-greater pressure to publish a thorough report on their environmental performance, including quantitative information going back several years and references to

negative experiences. In economies where environmental management practices have been widespread, the demand for high-quality environmental reports is mounting. Sill, environmental performance reporting is relatively uncommon, and firms with a high environmental impact differ markedly in how they publish their information and the type of data they include (OECD, 2001*a*). Unlike other areas of business reporting, there are few widely accepted standards to help firms decide what information should be included in their environmental performance report. To help address this problem, the Global Reporting Initiative, supported by major businesses, NGOs and the United Nations, has developed standards for business reporting in the area of sustainable development.

These private initiatives often complement the government-orchestrated initiatives described above. Recent trends in regulatory or public enforcement strategy have tended to integrate these private initiatives, a move that may eventually lead to greater consensus among businesses and other parts of civil society about the scope and nature of commitments governing business conduct. Achieving consensus on the management and reporting practices needed to support these commitments is equally essential. These initiatives represent important steps in the ongoing process of developing a framework for promoting appropriate conduct in international business.

Conclusions

Driven by increases in trade and international investment flows and by changes in government policies — liberalisation, regulatory reform and privatisation — national economies have become increasingly integrated into one global economy, with the exception of a number of LDCs. For both developed and developing countries the internationalisation of economic activities poses opportunities and challenges for sustainable development.

This chapter has shown that both trade and international investment stimulate competition, improve resource allocation, and facilitate the international distribution of technology. Countries with open trade and investment regimes have generally experienced higher growth rates than those countries that did not. Though some have feared that recognition of these benefits might lead to a race to the bottom in environmental and social standards, e.g. in order to attract more FDI, their concerns have in general proven to be unfounded. At the same time, economic growth has increased pressure on the environment through scale effects, which can only partly be offset through more efficient use of resources (e.g. due to better technology). While economic growth has increased overall world prosperity, inequality between and within both developed and developing countries has increased. Though trade and investment are not the root causes of environmental and social problems — which in general result from market failures and inadequate policy frameworks — they can, under certain circumstances, amplify and accelerate these difficulties.

Liberalisation of trade and international investment has been a major contributor to economic growth and hence one of the cornerstone policies in promoting sustainable development, but it is not sufficient: sound social and environmental policies, both at the national and international level, are necessary as well. However, policy makers need to ensure that social and environmental policies do not become disguised or unjustified protectionist measures. Policies should be developed in such a manner that they best capture the benefits of trade and investment liberalisation, while mitigating the associated costs.

Market- and information-based environmental policy approaches— such as eco-labelling and the removal of environmentally damaging subsidies — deal with environmental or social externalities at the place where they originate. In addition, governments have stimulated more sustainable production at both the national and international level through *inter alia* green public purchasing and environmental impact assessments of projects and policies. This includes assessment of trade liberalisation initiatives that allow authorities to pinpoint environmental and social pressure points with a view to identifying needs for mitigating or enhancing measures. At the multilateral, regional, and bilateral level, fora that deal with trade and investment issues are increasingly recognising linkages with environmental and social issues. And MEAs using trade measures have enhanced co-operation with the WTO to explain the purpose and extent

of such measures. Within the OECD, several instruments — among which the OECD Guidelines for Multinational Enterprises — provide a benchmark to stimulate corporate behaviour more in line with the goals of sustainability. Firms are also responding to pressure from the public-at-large and civil society. This is manifested in the increasing use of corporate codes through which firms commit themselves to improve their social or environmental performance or both.

A number of factors affecting sustainable development can be enhanced. *First*, policy coherence between trade and investment agreements and social and environmental agreements must be increased to avoid potential conflicts between regimes and to reduce uncertainty. *Second*, in order to formulate appropriate policies, countries should pursue the development and application of more robust methodologies to assess the environmental and social impacts of liberalised international trade and investment. Similarly, they should develop and apply methodologies to assess the trade and investment impacts of environmental and social policies, so as to avoid creating hidden barriers to trade and investment. Carrying out such reviews can promote policy coherence and help to identify alternative policies for addressing concerns and ensuring appropriate follow-up.

Third, though average tariff barriers in non-OECD countries are higher than those found in OECD member states, OECD countries' trade barriers remain high in sectors of export interest to developing countries. Therefore, continued liberalisation of remaining barriers to trade and investment flows will benefit developed and developing countries, including through a reduction in poverty. *Fourth*, one approach to limit the potential conflicts between precautionary measures and trade disciplines is to base their use on scientific risk assessment. International agreement regarding the implementation of precautionary measures would further help ensure the integration and mutual compatibility of environmental and trade policies. Governments should also endeavour to develop international agreement defining under which circumstances the use of PPM-based environmental policy instruments could be accommodated within the multilateral trading system. *Fifth*, governments should promote increased corporate responsibility by developing regulatory frameworks that encourage good corporate behaviour in the areas of corporate governance, bribery and corruption, and environmental and social responsibility. *Sixth*, though high labour and environmental standards may be desirable in terms of sustainable development, these are likely to be more costly for developing countries to reach. OECD countries should assist developing countries in attaining the goals of sustainable development by, among other things, providing assistance for capacity building.

Finally, both the preparation of policies and the decision-making process need to be transparent and involve all relevant stakeholders — which may include NGOs, the business community, trade unions, and government officials of affected countries. This will allow for the formulation of effective national and international policies that enable trade and investment to work for sustainable development.

NOTES

1. By comparing a region's rate of growth with the world average, those regions that have not maintained their share of world trade can be identified.

2. The ratio of foreign direct investment stock to GDP is around 20% for countries like Colombia and Venezuela, and especially high in a number of countries such as Chile (40%), Malaysia (67%) and Singapore (86%), which may be compared with the world average of 14% (UNCTAD, 2000).

3. See chapter 9 of this report.

4. This difficulty arises due to several problems in the measurement of FDI statistics. For example, not all M&As qualify as FDI (UNCTAD, 2000).

5. This includes all 30 OECD Member countries, as well as Argentina, Brazil, and Chile. The OECD encourages non-members to adhere to this Declaration, which includes the Guidelines for Multinational Enterprises.

6. Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

7. Brazil, Argentina, Paraguay and Uruguay.

8. The Southern African Development Community comprises 14 countries: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia, Zimbabwe, and Swaziland.

9. Available empirical evidence suggests that privatisation has had a positive effect on the profitability and performance of privatised industries, and that liberalisation has been beneficial for efficiency and consumer welfare in reforming countries.

10. The wages paid in the manufacturing industry by foreign affiliates of MNEs reflect the higher labour productivity and are higher than those paid by national firms; see OECD (1998).

11. See World Bank (2000*a*). Low-income countries are defined as those countries with a GDP per capita in 1999 of less than USD 755.

12. Chapter V of the Guidelines encourages the adoption of technologies and operating procedures that reflect the highest environmental standards available to the enterprise.

13. For example, see Mabey and McNally (1999), Oman (1999) and Nordstrom and Vaughan (1999).

14. For example, it may be more efficient to run a single set of environmental practices worldwide than to scale back environmental practices at a single overseas location. Also, the high visibility of MNEs can make them particularly attractive targets for local enforcement officials, and the ensuing legal difficulties encourages MNEs to be especially conscious of their potential environmental liabilities overseas.

15. For example, see the Rio Declaration on Environment and Development, the Convention on Climate Change, the Convention on Biological Diversity, the Montreal Protocol on Substances that Deplete the Ozone Layer, and the Protocol on Biosafety. The Treaty Establishing the European Community (The EC Treaty) states that Community policy on the environment shall be "based on the precautionary principle", among others.

16. This distinction is crucial for analytical purposes because core and non-core labour standards are expected to have different, and often opposite, effects on economic outcomes.

17. See Sachs and Warner (1995). A critical review is provided in Rodriguez and Rodrik (1999).

18. Methodologies for the environmental assessment of trade agreements have been developed by the OECD and are currently being refined.

19. For example, foreign suppliers, particularly from developing countries, may experience market access problems due to lack of timely and transparent information and practical difficulties, such as arranging for recycling or take-back of packaging and materials.

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Chapter 9.

STRATEGIES FOR NON-MEMBER COUNTRIES

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STRATEGIES FOR NON-MEMBER COUNTRIES

Introduction

Ensuring sustainable development in the 21st century will require the active participation of all members of the international community. With 80% of the world's population, the developing countries will assume central importance. Their role in preserving peace and stability, and maintaining the viability of global commons such as the earth's atmosphere and biological resources, will be more significant than ever before.

Over the past decades, economic weight has started to shift from OECD to non-OECD countries, and this trend will continue in the future. OECD analysis shows that the non-OECD share in the world GDP could increase from about 40% in 1995 to more than 60% by 2020. Non-OECD share of world trade could rise from one-third to one half in the same period. The gap in living standards for those countries participating in the world economy could narrow significantly: in the non-OECD area real GDP per capita could rise by 270%, while in the OECD this figure might be limited to 80% (OECD, 1997). Developing countries will also account for virtually all of the anticipated increase in the world's population, from 5 billion in 1990 to about 7.5 billion in 2015. This increase over 25 years is more than twice the current population size of OECD countries.

With growing economic interdependence at the global level, the socio-economic prospects of OECD countries will be ever more tightly linked to that of developing and transition countries. Non-member countries will play a critical role in preserving peace and stability, expanding the global economy, combating poverty and achieving sustainable environmental and population balances. Large and populous non-members of OECD such as Brazil, China, India and Indonesia, for example, are likely to have an increasing influence at the global level (Table 9.1).

Table 9.1. **Eight countries with critical global weight**

	Share of world population	Share of gross world product	Share of world carbon emissions	Share of world forest area	Share of world flowering plant species
	% 1996	% 1994	% 1995	% 1990	% 1990[a]
United States	5	26	23	6	8
Russian Federation	3	2	7	21	9
Japan	2	17	5	0.7	2
Germany	1	8	4	0.3	1
China	21	2	13	4	12
India	17	1	4	2	6
Indonesia	4	0.7	1	3	8
Brazil	3	2	1	16	22
TOTAL	56	59	58	53	-

Notes: a) Based on a total of 250 000 known species. Total could not be calculated due to overlap in species among countries.
Source: Flavin, C. (1997), "The Legacy of Rio", i*n State of the World 1997*, Worldwatch Institute/W.W, Norton Co. New York.

OECD, developing, and transition countries have common responsibilities in relation to the protection of critical global public goods such as the climate, biological diversity and stratospheric ozone. Historically, OECD countries are responsible for most of the pressures on key natural resources. In the future, the major

emerging economies will exert increasing pressures. Actions by OECD countries alone to resolve major global environmental problems, therefore, will be increasingly ineffective unless non-member countries are involved.

Notwithstanding these common challenges, the issues facing developing and transition countries in their pursuit of sustainable development are significantly different from those facing OECD countries. OECD countries face problems linked to ageing of their population and to resource and pollution intensive patterns of consumption, while many developing countries have to deal with issues such as rapid population growth, food security and desertification, as well as destabilising health trends like the spread of HIV/AIDS.

In confronting these trends, developing countries face both the challenges and opportunities created by globalisation. On the one hand, increased trade and investment linkages foster more efficient resource use and the transfer of capital, technology, and know-how, thereby increasing welfare. On the other hand, in the absence of appropriate environmental policies and a corresponding capacity to monitor and enforce them, the economic growth made possible by globalisation may overtax the environment's capacity to absorb the negative externalities generated by economic activity in the form of pollution and waste. There are also concerns that the economic gains from globalisation will not be shared equitably within and between countries.

The important increase in private financial flows (from USD 50 billion in 1990 to USD 250 billion in 1999) has been largely concentrated in a few developing countries and sectors. The smaller and least developed countries still attract little of these flows. Moreover, private resources generally do not flow to some key sectors of priority need, such as health and education. Private flows may fluctuate widely and quickly, and even turn negative in time of financial crises. Despite the important increase of private capital flows to developing countries, official development assistance (ODA) will remain crucial in many development areas, particularly the large number of very poor countries (see Chapter 8).

For OECD countries, the rationale for helping developing and transition countries is based not only on moral arguments, but also on those of self-interest. Increased prosperity in the developing countries expands markets for the goods and services of the industrialised countries. Increased human security reduces pressures for migration and accompanying social and environmental stresses. Political stability and social cohesion diminish the risks of war, terrorism and crime that inevitably spill over into other countries. Other contemporary problems ranging from drugs trafficking to epidemic diseases also respect no borders. Everyone is made less secure by the poverty and misery that exist in the world. It is therefore a matter of special concern to OECD countries that many countries, especially in Sub-Saharan Africa, have been increasingly marginalised from the global system and suffer continuing deterioration of already impoverished living standards. It is crucial that OECD countries co-operate with and support developing countries in their efforts towards sustainable development. This will require an effort to increase the volume and effectiveness of ODA flowing from the OECD to developing countries.

The key challenge for developing countries is to establish a strong policy and institutional framework that will help them to attract increased trade and investment and to ensure that these flows benefit their societies and promote sustainable forms of development. Many countries will only be able to achieve this goal with external assistance.

This chapter highlights some of the key challenges faced by developing countries in their efforts towards sustainable development and the role that development co-operation can play. The first two sections outline the key principles and objectives of official development assistance, and the critical success factors for shaping effective sustainable development strategies. The subsequent sections highlight some of the critical issues facing developing countries and transition economies and how development co-operation efforts can help address them.

Many issues of critical relevance to sustainable development, ranging from water management, sustainable agricultural development, population growth, the fight against HIV/AIDS and the "digital divide"

are not covered in this chapter. The issues discussed in this chapter are meant to exemplify how developing countries are different from the OECD and what sort of development assistance OECD countries need to provide to enable them to achieve more sustainable development.

Partnerships for sustainable development: key objectives and principles

The OECD Development Assistance Committee's Strategy for development co-operation

Over the years, the understanding of development and development co-operation has undergone fundamental changes. It has expanded to take more fully into account how markets, societies and governance interact and evolve. The central importance of human and social capital in these development processes has also received more recognition, as has the natural resource base on which sustainable economic activity depends. Thus, most development partners now recognise that sustainable development can only be achieved through integrated strategies that incorporate key economic, social, environmental and political elements by bringing together all facets of development (macroeconomic, financial, structural, social, and human) in a long-term, holistic, and strategic way (Box 9.1).

Box 9.1. The past 50 years: achievements and the role of development co-operation

Development progress over recent decades has been unprecedented in human history. Life expectancy in the developing countries has risen by more than twenty years (from 41 to 62 years); the percentage of the population with access to clean water has doubled (from 35% to 70%); adult literacy has risen from less than half the population to about two-thirds, and food production and consumption have increased at a rate about 20% faster than population growth. These achievements result from sustained efforts by the people and governments of developing countries to help themselves. But international co-operation has clearly contributed:

- The dramatic fall in infant and child mortality has been supported by a major international campaign to increase child survival, led by the World Health Organization and the United Nations Children's Fund and supported by many bilateral donors.
- International development agencies have sponsored research, education and immunisation programmes to control smallpox (now eliminated), polio (eliminated in almost all countries), diphtheria, and measles and have introduced simple and effective ways to combat infant diarrhoea, river blindness and guinea worm disease.
- The "green revolution" that has contributed so much to the 20% increase in calorie consumption (and an accompanying decline in malnutrition) was given substantial impetus from international support for agricultural research, development of new crop varieties, extension services, irrigation and assistance to production and marketing, as well as development co-operation in support of sound agricultural and other economic policies.

Development co-operation has helped expand access to family planning and related education that have resulted in sharp falls in fertility rates and in desired family size in many developing countries. Contraceptive use in developing countries has risen from 10% of couples in 1960 to 50% in the 1990s. It has also contributed significantly to qualitative progress in the areas of economic management, social policies, the rule of law and human rights.

Source : OECD (1996), *Shaping the 21st Century: The Role of Development Co-operation,* Paris.

Experiences with development co-operation — both successes and failures — have also yielded important insights as to what works and how best to achieve results. Partnerships have accordingly become more complex. While earlier efforts almost inevitably involved working with central government, development co-operation actors are now working with many more partners to meet demands for greater efficiency, and respond to more pluralistic and decentralised political systems. These partnerships recognise the importance of a dynamic private sector, local ownership and participation by civil society. At the same time, co-operation is a collaborative effort whose underlying principle is not to do things *for* developing countries and their people, but to help them strengthen their own capacity. Drawing on this experience, the Development Assistance Committee (DAC) at the OECD has set out a strategic vision for future co-operation with developing country partners (OECD, 1996).

Focusing around shared goals and monitoring progress

Based on the series of United Nations conferences addressing critical development issues over the 1990s, the community of donor countries — through the DAC — formulated seven development goals to provide benchmarks against which to measure future progress. These goals, which capture the various dimensions of sustainable development, reflect the broad consensus of the international community. (See Box 1.1, Chapter 1).

A collaborative effort involving the OECD, the UN, the World Bank, the IMF and representatives from developing countries and civil society set out to define specific statistical indicators to monitor developing countries' progress towards these goals. The results of this exercise, which built on the work conducted by the UN in connection with the Common Country Assessments, were published in the first-ever joint UN/OECD/IMF/World Bank report, *A Better World for All: Progress Towards the International Development Goals.* Subsequently, the PARIS21 Consortium — a network of some 250 governments, international organisations, professional bodies and academic institutions worldwide — was established to further strengthen statistical capabilities, especially in poor developing countries. Efforts are also underway to define indicators in areas such as governance and the implementation of sustainable development strategies, which are not readily amenable to quantitative monitoring.

The OECD/DAC *Shaping the 21st Century Strategy* provides a framework for co-operation with developing countries, based on the principle of partnership around shared goals. This is based on the recognition that true partnership implies obligations on both sides.

Democratic accountability, the protection of human rights, and the rule of law

Developing countries' obligations include fostering accountable government and the rule of law; maintaining stable and co-operative relations with neighbours; a commitment to basic objectives of social development, and increased participation, including gender equality. Social and political tensions are inevitable in the process of socio-economic development. Although economic decline can be a potential source of conflict, economic growth alone does not prevent or resolve violent conflict, and may sometimes intensify tensions within society. Sustainable development must therefore establish institutions capable of managing socio-political tension and avoiding their escalation into violence — good governance is a cornerstone of all development efforts.

Broadly defined, governance is "the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences" (UNDP, 1997). It can be seen as "the manner in which power is exercised in the management of a country's economic and social resources" (World Bank, 1992). This implies predictable, open and transparent policy-making, a professional bureaucracy, an executive arm accountable for its actions, and strong civil society participation in public affairs. Good governance requires that all these actors be bound by the rule of law. Areas where donors provide support include constitutional and judicial reforms, the training of civil servants and many others (OECD, 1995*a* and OECD, 1998).[1]

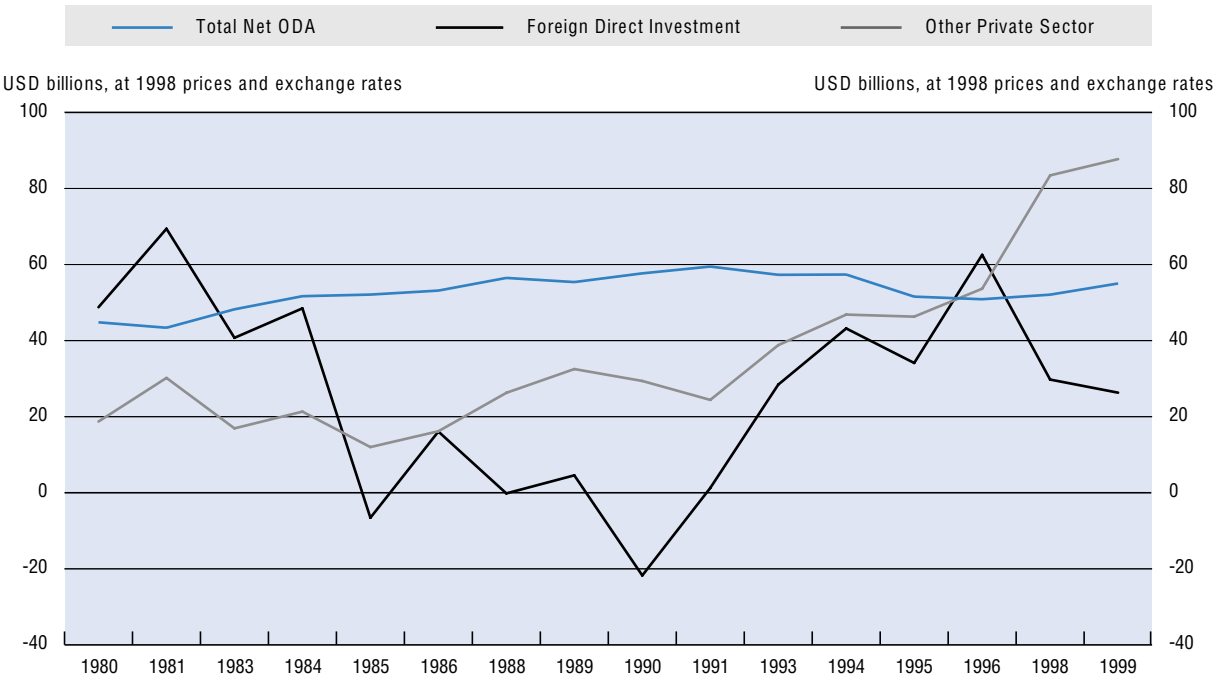
Adequate, well co-ordinated support and a conducive policy environment

Apart from the poorest developing countries, where official development assistance accounts for up to 15% of GDP, the bulk of financial resources for development comes from domestic sources, and increasingly from the private sector. For most developing countries ODA flows account for about 0.5% of GDP, with external private flows together accounting for about 2% on average.[2] For developing countries taken as a whole, foreign direct investment (FDI) has in recent years represented the largest source of external finance. While ODA flows are stable, international bank and bond lending are often larger but more volatile. Figure 9.1 provides an overview of these trends.

It is well established that in the absence of a supportive policy and institutional framework, the impact of external support is limited. Most of the policies required to mobilise domestic finance are equally effective in attracting external funds and notably FDI. Development co-operation efforts are therefore geared towards assisting developing countries establish the necessary policy frameworks, as well as the human and institutional capacities to mobilise resources for development. This includes identifying critical policy or institutional bottlenecks to the mobilisation of public and private resources for development. Policy dialogue between donors and recipients on these issues, notably in relation to sectors such as energy, transport or agriculture, provides unique opportunities to promote the integration of sustainable development concerns into long-term policies and plans.

Private flows are highly concentrated in a limited number of countries and sectors. The smaller and less- developed countries still attract negligible external private flows (Figure 9.2). Moreover, private resources generally do not flow directly to "unprofitable" sectors such as health and education. For many countries, the continued availability of concessional resources will continue to be critical while they build the capacity to create and mobilise domestic resources and attract private capital flows. However, only four

Figure 9.1. **Selected long-term flows from OECD to developing countries, 1980-99**



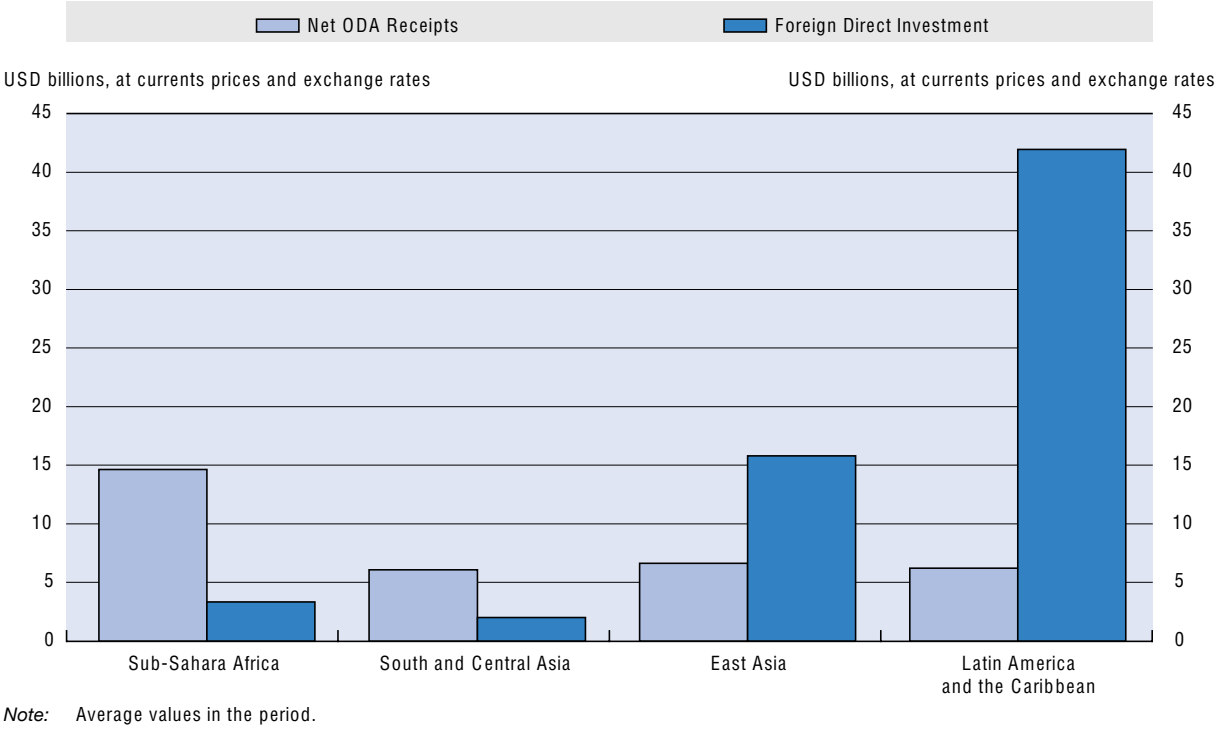
Note: ODA figures exclude forgiveness of non-ODA debt for the years 1990 to 1992.
Source: OECD, DAC Statistics.

of the DAC's 23 Member countries consistently meet the widely accepted volume target of 0.7% of GNP established by the United Nations in 1970 as an appropriate level for official development assistance. Enlisting the support of rapidly developing countries would generate additional resources for development.

Further efforts are needed to increase the volume and effectiveness of aid. In addition, donors have a responsibility for co-ordinating their contributions and support in the area of policy reform, harmonising their procedures, and helping strengthen partners' capacity to tackle their development challenges. A wide range of mechanisms, including "Round Tables" and "Consultative Groups", hosted respectively by the United Nations and the World Bank, have been established for this purpose. The Environmental Action Programme (EAP) Task Force and Project Preparation Committee, set up within the Environment for Europe process, illustrates the value of such co-ordination efforts. Ongoing efforts to further integrate economic, social, and environmental policies within coherent long-term development plans are discussed below.

The globalisation of trade, investment, and other linkages, and the growing role of developing countries in the international economic system, have raised the potential impact of OECD policies on developing countries and vice versa. By working towards greater coherence of their policies with global sustainable development objectives, OECD Members can significantly ease the challenges facing developing countries. For example, alleviating unsustainable burdens of debt for the poorest countries and reducing tariffs are critical.

Figure 9.2. **Net ODA receipts and foreign direct investment in selected regions, 1997-99**



Note: Average values in the period.
Source: OECD, DAC Statistics

Shaping effective sustainable development strategies

National strategies for sustainable development: a Rio commitment

At the 1992 UN Conference on Environment and Development, in Rio de Janeiro, governments committed to "adopt national strategies for sustainable development which should build upon and harmonise the various

sectoral, economic, social and environmental policies and plans that are operating in the country. …. Its goals should be to ensure socially responsible economic development for the benefit of future generations". (Agenda 21 Action Plan). The OECD's *Shaping the 21st Century Strategy* committed donor agencies to supporting developing countries in this area.

In 1997, the Special Session of the UN General Assembly — which met to review progress since the 1992 Summit —noted the continued deterioration in the state of the global environment under the combined pressures of unsustainable production and consumption patterns and population growth. This assessment led governments to set a target date of 2002 for introducing national sustainable development strategies.

Translating commitment into action

OECD and developing countries' governments have responded in a variety of ways to the Rio Declaration and Agenda 21. Some have prepared National "Agenda 21 Plans" setting out a "vision" for the future — usually for a generation ahead. Others have developed comprehensive "national environmental action plans" (NEAPs), often with World Bank support, building on existing national conservation strategies (NCSs) and national forestry action plans (NFAPs). But these plans have focused on environment and resource issues and have not been designed to address the economic and social dimensions of sustainable development. More recently there has been a trend towards development of sub-national strategies. Examples include province or district-level environmental action plans and "Local Agendas 21" plans, usually at the city level.

Key prerequisites in shaping sustainable development strategies

The experiences of the past decade have provided much better understanding of strategies for sustainable development — what works, what doesn't, and why. There is now broad agreement about the main prerequisites for shaping successful strategies. These include a shared vision of objectives; high level political commitment; participative planning and decision-making mechanisms; clear quantitative objectives and effective monitoring systems (OECD, 2001*a*) (See Chapter 4). Experience in the transition economies in central and eastern Europe shows that democratisation and improved governance can support progress in the social, economic and environmental spheres (Box 9.2)(OECD, 1999*b*).

Building a shared vision of progress. Development strategies first need to build a shared vision of future development options, paying specific attention to the impacts on disadvantaged groups, who are often under-represented in political processes. This may include seeking "pro-poor" growth options, (for example by favouring labour-intensive development) and addressing persistent inequalities with respect to access to land, water and other critical resources.

Securing high level political commitment. The formulation and implementation of an effective strategy requires strong leadership. When difficult political choices must be made, in the face of institutional inertia and resistance from established lobbies, the commitment from the head of state and senior ministers, as well as the more influential government departments such as the Finance and Planning Ministries, is critical.

Participative policy-making and planning processes. Many countries have well-functioning domestic planning processes at the sectoral level, regional or local levels. Typically, however, these systems do not provide sufficient scope for affected people to participate in the examination of the trade-offs between different policy options. Consultative processes should therefore include government agencies, local authorities, parliamentarians, as well as representatives of private sector and civil society groups (e.g. trade unions, NGOs) and marginalised groups, which in some countries include people living in remote regions and minority ethnic groups. Overcoming mistrust among these different stakeholders is often a key challenge While there are constraints of time and resources, broader participation can be helpful in fostering a more informed debate, identifying realistic development options, bringing sensitive but critical issues into the open and reducing the influence of vested interests.

Box 9.2. **Political, economic and environmental reforms are mutually supportive: evidence from economies in transition in Central and Eastern Europe and the Newly Independent States**[3]

Experience in the Central and Eastern European Countries (CEECs) and New Independent States (NIS) over the last 10 years shows that economic, political and environmental reforms can be mutually supportive and reinforcing. Democratic reforms have brought to the surface public demands for environmental improvement, which has translated into new, more effective environmental policies and institutions. Economic reforms have helped generate resources for investment in cleaner, more efficient technologies; reduced the share of pollution-intensive, heavy industries. These factors have led to a "decoupling" of pollution levels from economic output in advanced reform countries (e.g. reductions in emissions of key air pollutants have been greater than decreases in output). Countries that have been the most effective in developing national policies and institutions have also been the most effective in attracting donor support.

In the countries where the pace of economic and political reform has been slower, environmental improvement has also lagged. Pollution levels and resource consumption have declined less than output. Lack of incentives for the efficient operation of enterprises, and opportunities to profit from distortionary fiscal and monetary policies, have hindered the implementation of "win-win" strategies such as energy efficiency and cleaner production.

However, while economic and political reforms facilitate environmental improvement, they are seldom sufficient. The development of environmental policies and institutions adapted to democratic, market-based societies has also proved essential. Thus, the pace of environmental progress has been conditioned by the effectiveness in establishing effective systems of governance at national and sub-national levels.

Source: OECD (1999*b*), *Environment in the Transition to a Market Economy. Progress in Central and Eastern Europe and the New Independent States*, Paris.

Quite often, new cross-sectoral co-ordination mechanisms are also needed to overcome the tendency of government ministries and departments to focus only on their sectoral interests and constituencies. Special efforts are also needed to bridge the frequently observed divide between governmental agencies operating at different levels. At the same time, the institutional weaknesses facing many government agencies must be recognised.

Box 9.3. **Effectiveness of sustainable development strategies**

To be effective sustainable development strategies have to:

- Be an integral part of overall government objectives and "owned" by the sectoral ministries and agencies responsible for the implementation of national development plans.
- Identify long-term constraints, trade-offs and opportunities.
- Provide an opportunity for an informed debate amongst stakeholders.
- Find ways to address conflicts amongst stakeholders in a peaceful manner.
- Promote the gradual integration of existing strategic planning processes.
- Define priority objectives and ways to monitor progress.

Donor support should:

- Help identify areas where external assistance is required.
- Provide a framework within which external contributions can be co-ordinated.

Setting objectives that are realistic and easy-to-monitor. Realistic priority setting is a key element of strategy development. It is most effective when the political and the analytical dimensions of this activity are brought together. Arriving at agreed priorities is an iterative process which starts from broad policy orientations and becomes increasingly more specific. Priority setting is most effective when it results in SMART objectives — i.e. objectives which are Specific, Measurable, Agreed, Realistic, and Time-bound. Analytical tools which assess the costs and financing options of different strategies can promote greater realism in planning (OECD and Danish Environmental Protection Agency, 2000*a* and *b*).[4] Assessing the actual impact of policies and strategies also requires a capacity to monitor socio-economic and ecological conditions and needs at national and local levels (Box 9.3).

New international initiatives

Several recent international initiatives offer opportunities to put the principles of strategic planning for sustainable development into practice. The Comprehensive Development Framework (CDF), proposed by the World Bank in 1999; the Poverty Reduction Strategy Papers (PRSPs), a new approach to co-operation with developing countries endorsed by IMF/Word Bank later that year; and the "National Visions" being developed by some countries are all follow the principles and objectives outlined in the DAC *Shaping the 21st Century Strategy* document.

Box 9.4. Examples of sustainable development strategies

Ghana's "Vision 2020"

Launched in 1994, "Vision 2020" sets out a strategy that would allow Ghana to become a middle-income country by 2020. Co-ordinated by the National Development Planning Commission (NDPC), it combines a framework of policies, strategies and targets, and a new approach to planning that integrates social, economic, political, technological and environmental dimensions. "Vision 2020" — the result of extensive consultation and collaboration with a wide range of stakeholders over four years — enjoys high-level political support and a growing recognition within government and civil society as Ghana's key framework for the future. Ghana's challenge today is that of implementation, strengthening capacity (particularly at the district level), establishing effective co-ordination, as well as monitoring, evaluating and measuring outcomes and impacts.

Bolivia's "Agenda 21"

Bolivia's Agenda 21 programme is based on the recognition that economic growth, full social participation and the sustainable management of natural resources are all essential to eradicating poverty. In 1993, a Ministry of Sustainable Development and Planning was created covering planning, sub-national development, environment and indigenous people. The Ministry is committed to mainstreaming the environment and sound use of natural resources into all government policies. Policy reforms in support of the program include measures to increase popular participation in decision making and implementation; and a decentralised system of planning and legislation which allows 20% of budgets to be allocated to local sustainable development plans. The Bolivian experience highlights the importance of high-level commitment to change, democratic governance and civil society participation.

China's "Agenda 21"

In 1992 China began to recognise that the social and environmental impacts of industrialisation and economic growth (above 10%) could not be ignored. China used a centralised approach to the preparation of its plans for sustainable development but also created new partnerships between central and local government, science and academia. A national Agenda 21 programme — prepared by the State Planning Commission and involving specialists from 57 commissions and ministries — was approved by the State Council in 1994. The principles of the strategy were introduced into the plan for 1996-2000. Over 30 municipalities and autonomous regions are now preparing sub-national strategies.

The CDF, which is being tested in a number of countries, emphasises the need for a holistic approach to development, and highlights the interdependence of the social, economic, environmental, governance and financial elements of development. The PRSP approach, which falls within the CDF framework, aims to strengthen the link between debt relief and poverty reduction (OECD, 2001*b*).[5] Thus, the "Poverty Reduction Strategies" prepared by national authorities should serve as the basis for financial support by the Bretton Woods institutions. A key principle of this approach is that poverty reduction strategies "...should be country-driven, be developed transparently with broad participation of elected institutions, stakeholders including civil society, key donors and regional development banks, and have a clear link with the agreed international development goals".[6] Other international and bilateral development agencies are also encouraged to use the PRSPs to guide their support.

The success of these initiatives will hinge on donors and partners' adherence to their respective commitments. For donors, this implies refraining from directing the initiatives, and ensuring genuine ownership by partners. For developing country partners, the challenge is to establish genuine participatory mechanisms to mobilise all actors around long term development and poverty reduction strategies. The long-term social and environmental consequences of poverty reduction strategies will require rigorous assessment, in order to identify potentially consequences, building in appropriate response measures from the outset (Box 9.2). The action plans formulated in response to the Desertification, Climate Change and Biodiversity Conventions should be fully integrated in these efforts. Of course, the active involvement of ministries and agencies responsible for social affairs as well as environment and natural resource management will be critical.[7]

Sustainable development and poverty reduction

Poverty-environment linkages

Most environmental degradation is related to the consumption patterns of middle and upper income groups worldwide and to the large-scale, increasingly globalised, production systems that meet (and shape) their needs. The poor consume too little — in terms of water, food or energy — to make a major contribution to environmental pollution and waste. However, urban centres provide a vivid illustration of how the poor experience a proportionately greater share of the negative side- effects of industrial growth, as in the case of exposure to pollution. At the global level, a similar pattern can be observed. The least developed countries are the most vulnerable to the impact of climate change while they contribute the least.

Nonetheless, the poor do contribute to environmental degradation, for example when landless farmers convert forests to agriculture. This often results from land ownership and demographic patterns that confine poor people to low-potential, marginal areas, without access to financial markets, finance or technology. Irrespective of its cause, environmental degradation also affects the poor disproportionately, threatening livelihoods, worsening health and increasing vulnerability to disasters (through destruction of homesteads and natural resource base, but also displacement and violent conflict).

The rural poor, and notably the landless, depend directly on surrounding ecosystems -forests, wetlands and coastal fisheries — to meet their needs for food, fuel, fodder and medicinal plants, and so are therefore directly threatened by resource degradation. Deforestation directly undermines the livelihoods of forest-dwellers — often indigenous groups — who are among the most marginalised. Similarly, the degradation of coastal areas and wetlands threatens the lives of large populations dependent on these resources.

Recent World Bank estimates suggest that premature death and illness due to major environmental health risks accounts for one-fifth of the total burden of disease in the developing world. This is comparable to malnutrition (15%) and larger than all other preventable risk factors and of causes of disease. (The World Bank, 2000). The poor, particularly women and children, are most affected. Most of the burden of diarrhoeal disease is caused by contamination of water and food caused by poor or non-existent sanitation systems and inadequate hygiene, compounded by unreliable and unsafe domestic water supply. Indoor air pollution,

from cooking and heating with biomass fuels in poorly ventilated dwellings, contributes to acute respiratory infections that kill some four million infants and children a year and decreases the overall health and life expectancy of millions more women and children. In many newly and rapidly industrialising regions of the world, urban populations bear the brunt of the environmental health problems associated with industrial growth.

The frequency and magnitude of natural disasters such as floods, storms, droughts and landslides, seems to have increased over the past 40 years, and their impact has clearly risen dramatically (UNEP, 2000*a*). Poor people are the main victims of natural disasters, because a growing proportion of them live and work in more vulnerable places — and do not generally have access to adequate protection or insurance. Global climate change is expected to increase both the magnitude and impact of natural disasters.

Two major threats: desertification and biodiversity loss

Desertification, the degradation of drylands through loss of vegetative cover and topsoil, is the combined result of climate variability, overcultivation, overgrazing, deforestation, and poor irrigation practices. Seventy percent of the world's drylands (excluding hyper-arid deserts), or some 3,600 million hectares, are estimated to be degraded. Over 250 million people are directly affected. In addition, about one billion people in over one hundred countries are at risk. These people include many of the world's poorest, most marginalised, and politically weakest citizens. Africa is the most affected continent (UNEP, 2000*b*).

Long considered a technical issue, desertification is now considered to be inextricably linked to social, cultural, economic and political issues. Poverty and desertification constitute a vicious circle linking deteriorating natural resources to deteriorating livelihoods as people find themselves forced to encroach further on fragile soils, sparse vegetation and limited water resources to meet their basic needs for food, shelter and livelihoods.

Desertification has a critical impact on food production. Providing a nutritionally adequate diet for the world's growing population will require tripling food production over the next 50 years, a goal that will be difficult to achieve if desertification is not stopped and reversed. Malnutrition, starvation, and famine may result.

The United Nations Convention to Combat Desertification is a response to this threat. It emphasises the socio-economic dimensions at both micro- and macro-economic levels of desertification processes and the necessity of engaging affected communities and non-governmental organisations (NGOs) in the design and effective implementation of measures to combat land degradation.

The convention calls upon affected countries to prepare and implement national action programmes (NAP) to combat desertification, in the context of national policies for sustainable development. These include the establishment of early warning systems and mechanism for assisting environmentally displaced persons; drought contingency plans; the provision of food storage and marketing facilities in rural areas; the promotion of alternative livelihood projects to provide incomes in drought-prone areas; and the development of sustainable irrigation programmes for crops and livestock.

Biological diversity is also directly threatened by desertification and land degradation. As agricultural productivity decreases on existing farms, pressures increase to convert more natural ecosystems to agricultural uses, thereby destroying the habitats of animals and plants. This is a critical concern for food supplies, as almost all the globally important cereal grains originate from drylands. The loss of the genetic forebears of these critical food plants could impair our ability to adapt their genome to accommodate a changing environment. Land degradation, biodiversity loss and climate change are linked in many other ways (UNEP *et al.,* 1998 and World Resources Institute *et al.,* 2000) (see Chapter 11).

Reconciling the conservation of biodiversity with poverty reduction raises difficult issues. Biodiversity often has important direct use value for poor communities, in the form of food, fodder, firewood and

traditional medicinal products, which require tradeoffs between use and conservation. Many of the benefits from conserving biodiversity — such as the preservation of species variety, the prevention of soil erosion and the absorption of atmospheric carbon—are indirect and accrue at national, regional or global levels and to future generations. From the perspective of local populations, immediate benefits from converting biodiverse ecosystems to monocrop agriculture or pasture often exceed costs. To be successful, strategies to protect biodiversity must acknowledge such trade-offs and provide direct incentives for conservation by local users. This can include creating or enhancing markets for biodiversity services. In Costa Rica, for example, water tariffs provide for the need to compensate hillside forest managers for the watershed maintenance services they provide (Castro, 2001). The Convention on Biodiversity recognises this and emphasises the need to maximise the direct social and economic benefits from the protection and sustainable use of biodiversity and their equitable distribution. Continued support from developed countries, including through the Global Environment Facility (GEF),[8] is essential to compensate local users for the global externalities resulting from their contribution to global biodiversity preservation.

Combating poverty while enhancing natural resource management: key policies and strategies

Strengthening access of the poor to resources. Poverty reduction and sustainable resource management can go hand in hand. Policies to maintain the integrity of key natural resources can directly contribute to improving the well-being and long-term economic opportunities of the poor. While the specific policy measures required depend on location-specific environmental and social factors, success hinges on creating conditions whereby the communities that rely on these resources for their livelihoods have a clear stake in their long-term sustainable management.

Specific efforts are generally needed to protect the rights of the poor to access to critical resources such as land, forests, water, pastures, fishing grounds. This often requires clarifying and giving legal recognition to traditional communal resource rights in order to encourage protection and sustainable use; and paying specific attention to the constraints faced by women, who are often denied tenure rights. The provision of formal rights of access to land, water and other critical resources — whether communal or individual rights — must be buttressed by legal enforcement and protection. The poor are generally in a weak position to resist intrusion by more powerful groups. Thus, competent authorities should be willing to intervene, for example to exclude commercial operators from encroaching communal fishing waters, or to help forest users prevent the intrusion of large-scale commercial loggers in community-managed forests (Box 9.5). In this regard, governance issues, in particular political empowerment of the poor, assume a central importance.

Box 9.5. **Stopping environmentally damaging activities by the non-poor in Sri Lanka**

A project in Sri Lanka sought to protect biodiversity in the natural sanctuary of Rittigala and to increase livelihoods for households near the sanctuary. Collective management initiatives were started by the local Buddhist priest to limit open access to the forest and medicinal plants. While these initiatives had some success with respect to local households, they had little effect in stopping illegal logging by non-poor 'outsiders'. With donor assistance, links between the neighbouring villages and the Department of Wildlife were developed so that the villagers could request the Department of Wildlife to take action against illegal logging.

Source: Department for International Development, *Achieving Sustainability. Poverty Elimination and the Environment,* United Kingdom.

Prioritise investments in fragile areas, and foster the diffusion of appropriate cropping methods. Efforts to stimulate agricultural production usually target high productivity areas. In many countries, however, the scarcity of productive land, the pace of degradation of forest and other ecologically fragile lands, and the scale of watershed degradation (with severe impacts on downstream facilities[9]) call for special attention to the management of ecologically fragile lands. This implies devising appropriate land tenure instruments,

encouraging investment in land conserving techniques (e.g. contour farming), infrastructure (e.g. terracing) and crops (e.g. perennial tree crops and agroforestry systems), in order to safeguard their long-term productivity. In some cases, the priority may be to protect resources on which the poor depend from the indirect impacts of development, such as pollution from industrial or agricultural effluents.

The transition to sustainable management of fragile lands also requires improved access to specialised know-how, finance and produce markets, including assistance to identify market opportunities for high-value biodiversity products (e.g. medicinal plants). Such efforts are often part of broader community-based development schemes aimed at improving living conditions for communities in marginal areas through the provision of health, education and other basic services.

Redirect resources to the poor. In many cases, poverty reduction will ultimately involve some redistribution of resources — or rights of access to resources — toward poorer sectors of society. This requires political commitment at the highest level. Although direct land redistribution is seldom politically feasible, a wide range of fiscal measures — such as property taxes discouraging speculative land holdings — can foster a more equitable distribution of land and agricultural intensification in highly productive areas, thereby reducing pressure to settle marginal lands and forests. Reforming environmentally damaging subsidies that mainly benefit the non-poor (e.g. on energy and water for large-scale irrigated areas, or on activities such as cattle ranching, large-scale fishing and others) can also help mobilise resources for investments directed towards the poor.

Support off-farm rural livelihood diversification. The livelihood options available to poor women and men in rural areas include, the use of natural resources. A wide variety of small-scale or micro enterprises geared towards meeting local demand — for semi-processed food products, household goods, farm implements and a variety of services — provide important employment opportunities for rural households. Expanding the scope for those activities, which are generally highly labour intensive, can help combat resource degradation by offering alternative work opportunities for rural communities. This requires tackling factors restricting the growth of rural enterprises, namely, lack of infrastructure (such as roads) and lack of access to credit. Improving education, transport and communications may have greater impact on expanding income opportunities for the landless poor than investments aimed at increasing agricultural production as such. Supporting off-farm diversification may in some circumstances be the most effective way to reduce reliance on ecologically fragile lands.

Empowering poor people and communities. Strengthening participation by poor women and men in the preparation and implementation of national and local land use plans is key to identifying the social and environmental values of resources which may otherwise be perceived as under-utilised. Programmes to convert wetlands to irrigated agriculture, for example, often fail to consider their impact on communities relying on them for livelihood. Similarly, transport development plans may overlook their impact on neighbouring forests.

The role of development co-operation

Support for sustainable poverty reduction needs to be country-specific and follow DAC partnership principles. Partner countries should be encouraged to formulate and implement strategies and policies as outlined above. DAC members can provide support through programmes or projects in the context of integrated national strategies for poverty reduction and sustainable development. Depending on circumstances, useful approaches might include support to area development programs addressing the multiple dimensions of sustainable poverty reduction; institutional capacity building for improving rural markets and financial systems; and food-for-work programs to protect the poor from the impact of natural disasters or economic crises while developing needed infrastructure. Securing the natural resource bases on which poor people depend to meet basic human needs must be a central part of all these strategies.

Support to international agricultural research is also of major importance. Such support focuses on improved seeds and farming systems and on the needs and constraints of poor farmers in ecologically fragile

or drought-prone areas often neglected by private firms. Future support should build on the ongoing efforts of the Consultative Group on International Agricultural Research (CGIAR), co-sponsored by the Food and Agricultural Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP), the International Bank for Reconstruction and Development (IBRD), and its network of agricultural research centres. Development co-operation has a special responsibility for co-ordinating interventions and developing modalities of assistance adapted to the multi-sectoral nature of efforts to combat rural poverty. The Convention to Combat Desertification, which emphasises the need to rationalise the use of available financial resources in order to improve their effectiveness, has established a Global Mechanism to assist this effort. This includes facilitating the integration of desertification issues within national poverty reduction strategies.

Managing rapid urbanisation

Key trends

Urbanisation — one of the most significant demographic and social changes in the 20th century — will likely continue into the 21st century, mainly in developing countries.[10] By 2000, close to half the world's people lived in urban centres (2.9 billion out of a total of 6.1 billion). Developing countries already have an urban population more than twice that of Europe, North America and Japan combined. They have most of the world's largest cities and, in many of them, the urban poor already outnumber the rural poor. In many countries, policies biased towards urban investors and consumers have played an important role in fuelling urban growth.

The urban poor live in the worst locations, and often in hazardous zones, such as the vicinity of heavily travelled roads, rail tracks or around waste dumps. Population concentration and economic activities in urban centres also generate large volumes of industrial and household waste, as well as high levels of pollution. Most urban centres have inadequate waste-management provisions. In such places, industrial and household waste streams are released without any form of treatment. Large volumes of solid wastes accumulate in open spaces and streets, clogging drains, attracting disease vectors (rats, mosquitoes, flies) and polluting water bodies. Solid wastes that are collected often end up in open dumps, leading to methane generation and air pollution from uncontrolled burning. Unregulated disposal of hazardous industrial wastes such as solvents and heavy metal compounds results in many deaths and serious injuries. Air borne pollution is also severe. Common harmful pollutants include sulphur dioxide and suspended particulate matter from coal burning, and to lead, oxides of nitrogen and suspended particulates from transport-related sources.

Although urban centres may seem physically isolated from the natural environment, their sustainability actually depends heavily on access to a wide variety of natural resources and products that originate outside their boundaries. These include fresh water, agricultural products, energy and raw materials. Having depleted or degraded local sources, many cities must procure water from increasingly distant sources, diverting it from agriculture. In many cases, excessive exploitation of ground water has caused serious problems of subsidence. In coastal cities, over-pumped local aquifers invite saltwater intrusion. Waste and pollution generated in urban centres often find their way to surrounding regions, contaminating soil, groundwater and even coastal fisheries. Thus, without adequate infrastructure, regulation and management capacity — to manage wastes and regulate industrial pollution — urban environments can create a multiplicity of biological and chemical hazards both within city limits and beyond.

Urbanisation: benefits and trade-offs

Cities act as hubs for economic, financial and information flows and account for a high share of national production and income. Urban centres provide important markets for rural producers thus spurring rural economies. They also offer opportunities for the rural poor to diversify their sources of livelihood through seasonal migration, and provide havens from adverse climatic events such as drought. Urban and rural economies are mutually dependent in many other ways, and cannot be considered in isolation from each

other. Furthermore, dynamic cities often play an important role in spurring economic growth at the regional or national levels (OECD, 2001*d*).

Many specialised services and facilities essential to modern economies, e.g. information technology, financial intermediation, warehousing and trading, require a critical mass of economic activity present only in urban centres. Similarly, important social, educational or cultural facilities (such as specialised hospitals, universities, theatres and sports stadium) are viable only in cities, although they are generally designed to serve a broader rural hinterland. Cities' built environment, including religious monuments and culturally important sites, also gives visible form to important social and cultural values.

The concentration of population in urban centres lowers the average cost of providing basic infrastructure and services, including water, sanitation and garbage collection. It enhances the financial viability of public transportation thus facilitating mobility for low-income groups while reducing the need for private cars. It also increases the viability of such facilities as neighbourhood schools and clinics that can be reached by cycle or public transport. Similarly, the concentration of industries makes collective waste management facilities viable — even for small-scale enterprises — and increases the scope for recovering and recycling valuable resources — materials like paper, glass, aluminium cans, scrap metal, rags and many others — otherwise lost in urban waste streams.

The ability of cities to attract investment in high value-added services and manufacturing depends on factors such as access to markets, services and skilled labour, and the various benefits of industrial aggregation. But quality of life, which is directly related to effective environmental management, has become an increasingly important factor in business location decisions. Cities that cannot cope with increasing congestion and general environmental deterioration often cannot sustain inward investment and economic growth. Conversely, by allocating a share of the revenues from a growing tax base to improved environmental infrastructure and management, successful cities can generate a virtuous circle of investment and growth. The efficiency gains from urban concentration can help increase the resource efficiency of production and help de-link economic growth from increased resource use and waste generation (Box 9.6).

Box 9.6. **Curitiba: an urban success story**

The city of Curitiba, in southern Brazil, has pursued a set of wide-ranging environmental and urban planning policies since the 1960s. This has included using a mix of economic and regulatory instruments, integrated land-use and transport planning, integrated recreational and environmental management, and linked recycling and social development policies. Curitiba has enjoyed one of the highest rates of economic growth in Latin America, while gaining global recognition as an environmentally friendly city.

Source: OECD (2001), *Shaping the Urban Environment in the 21st Century*, Paris, forthcoming.

Managing urban growth: policies and strategies

Meeting the needs of the present generation implies satisfying the demand of urban dwellers for improved sanitary conditions and health. Safeguarding the ability of future generations to meet their own needs, on the other hand, implies ensuring that meeting urban demands — for water, food, space, raw materials and natural sinks for waste disposal — does not cause irreversible harm to neighbouring and global ecosystems.

Sound urban environmental management requires meeting these trade-offs head on, and framing urban development strategies within the broader context of national sustainable development strategies. This poses special challenges because city authorities are not accountable to constituencies beyond their boundaries.

When strategic measures are taken sufficiently early, urban planning can have far-reaching implications for future growth patterns. Uncontrolled urban development, generally leading to low-density urban sprawl, consumes valuable agricultural land and effectively "locks" industries and households in energy-intensive production and consumption patterns. Once established, these patterns are very costly to reverse, many options for sound land use having been foreclosed. The consequences of such sprawl include increased costs of infrastructure and service provision, as well as congestion and its associated pollution. For the many developing countries at an early stage of urbanisation, early planning measures will have a high pay-off.

Strategic land use planning — integrating industrial, residential and transport-related land use planning — entails forecasting future growth trends; identifying likely constraints and opportunities, and negotiating appropriate responses with affected communities and enterprises. Relevant measures include: reserving areas for low-income housing development, to avoid confining low-income groups to the urban periphery; encouraging a mix of residential developments, employment, leisure, health care and education; confining certain industrial activities to specially designated areas and away from vulnerable waterways; integrating transport and land use planning; using green spaces to prevent development in dangerous areas such as unstable hill slopes, and many others. Strategic urban planning can considerably lower the cost of providing public infrastructure by reducing, among other things, lengths of roads, gas and water pipes, and electricity lines.

Planning measures and other policies can influence both firm and consumer behaviour. These include regulatory standards on pollution and waste generation backed by active enforcement efforts and a willingness to punish violators. Full-cost pricing of industrial inputs such as energy and water is also a key means of encouraging efficient resource use. Demand-side management aims to reduce the need for major capital investments in supply infrastructure. Such measures are often beyond the scope of urban authorities and must involve national level economic planning authorities. They call for collaboration between agencies and ministries in a wide range of sectors, and at different levels of government

The social and cultural dimensions of urban planning need to be recognised. Cities often gather together groups with different ethnic origins, customs and modes of living. Communities with a long urban tradition, for example, may be much better aware of the health benefits of careful waste management than newly settled migrants. These differences in attitudes, which translate into different values, greatly influence the scope for and effectiveness of different policies and planning measures.

Public pressure plays a key role in building the necessary political will to enact and enforce pollution regulation, and to overcome resistance to change. Raising public awareness of the health hazards from pollution and of the role industries have in tackling this challenge is a critical first step. Women are often at the forefront in mobilising public opinion on these issues, largely reflecting concern for the health of their children and the cost they bear in caring for the sick. Therefore, assistance for urban planning should include outreach to the poor, and to women in particular.

The challenges posed by informal settlements — established spontaneously and often illegally — must be tackled as early as possible, either to avoid large numbers of people settling in dangerous areas or to minimise the costs of "retrofitting" a sound land use plan on a suitable but haphazardly settled area. A small investment in facilitating more appropriate settlement patterns can avoid subsequent resettlements, for example to allow the construction of road or sewerage infrastructure, yielding considerable long-run savings. Granting formal recognition to unauthorised settlements raises difficult legal issues. Resolving disputes between illegal squatters and lawful owners also requires lengthy negotiations and litigation. Where shanty towns are established in hazardous areas, however, there may be no alternative to resettlement.

In many developing countries, the combination of population growth, rapid urbanisation and poor management of urban services have resulted in serious infrastructure deficiencies. The water and sanitation sectors, typically managed by municipal or district water companies owned by local authorities, provide a clear illustration. Poor management practices and inadequate operation and maintenance of distribution systems have resulted in a serious deterioration of existing infrastructure. Tariff levels, considerably below

cost-recovery levels, have promoted overuse and wastage, further constraining water utilities' ability to extend their networks to service more users. Thus, the provision of piped water benefits the relatively well-off groups while the poor- who must procure water from vendors- pay the highest prices. Similar problems affect the energy and transport sectors.

Meanwhile, declining government budgets are widening the gap between needs and availability of funds for investments in urban infrastructure.[11] The private sector is therefore increasingly considered as an essential source of capital, management know-how and technologies for urban infrastructure and services. Between 1990 and 1997 infrastructure investments with private participation in developing countries increased from about USD 16 billion to USD 120 billion (World Bank, 1999). Private investment now makes up about 15% to 20% of total infrastructure investment in developing countries. An important share of this investment was in water services.

Options for mobilising private sector investment in urban infrastructure include concession arrangements, joint ventures, Build-Operate-Transfer (BOT) schemes and others, each entailing different divisions of ownership and management responsibility between the public and private sectors. Involving private sector in public infrastructure requires a shift on the part of the responsible authorities from direct provision of infrastructure and services towards the regulation of privately or publicly owned utilities. This includes making provisions for public accountability, transparency, the protection of consumers against the potential for abuse of monopoly positions and ensuring that increasing tariffs to cost recovery levels are socially acceptable (Box 9.7).

Raising public awareness of the cost of establishing and maintaining infrastructure is also a key issue. In many cases, controversies have arisen over such issues as replacing public with private monopolies or

Box 9.7. **Private sector participation in the provision of urban water and wastewater services: key lessons from experience**

- Water is both a basic human need and an economic good. Policy-makers must take full account of the economic, social and environmental dimensions of decisions affecting water supply and sanitation.
- There is a demand for expanded access to water services, and users are often willing and able to pay for services. The poorest households, who have no access to services, suffer disproportionately from infrastructure deficiencies.
- Water fees are often too low to support major private investments. Political will to increase water prices to cost-recovery levels, while making appropriate provision for poor and vulnerable households, are prerequisites for private sector participation. Increased tariffs should be linked as closely as possible to improvements in system performance.
- Private involvement does not relieve the government of its responsibilities to ensure that basic rights to water are met. Governments remain responsible for ensuring the efficient delivery of water and sanitation services, and involving the private sector is one way of doing so. When governments decide to involve private firms, they also need to build up their own capacity to negotiate with those investors and regulate and monitor their performance of those investors.
- Water networks are long-term and risky investments; clarity and predictability of the legal and regulatory provisions governing the investment are a prerequisite for private investment. Up-front transaction costs, project specific risks and country specific risks — are often too high, and can prove dissuasive for private investors. Governments must be willing to recognise and address these issues.

Source: OECD, (2000*a*), *Global Trends in Urban Water Supply and Waste Water Financing and Management: Changing Roles for the Public and Private Sectors*, Paris.

raising prices for services and others. Experience suggests, however, that the key issue is not private *versus* public but rather what is the best means for delivering water services to all efficiently and effectively. Key lessons learned in relation to the water sector are outlined below.

The role of development co-operation

Although most of the world's poor still live in rural areas, assisting developing and transition countries to address urban management problems and to make the most of dynamic urban-rural growth linkages can contribute significantly to reducing poverty and making development more sustainable. This can contribute directly to meeting the development goals outlined in the OECD/DAC's Shaping the 21st Century Strategy, the UN-sponsored Agenda 21 and the Habitat Agenda. In many countries, furthermore, trends towards democratisation and decentralisation are opening new opportunities for successful co-operation with donors, based on widely accepted principles of good urban governance.

Most OECD-DAC Members have considerable experience in supporting urban environmental improvement. Some key lessons from this experience include the following:[12]

- *Projects can combine environmental improvement with poverty reduction and enhanced governance.* As a safe and healthy environment is a widely shared goal, environmental interventions are often a good vehicle for starting local dialogues and city consultations, and can provide a good entry point to improve governance. This often requires micro-level interventions in partnership with local stakeholders, as well as a long-term perspective.

- *Broad-based stakeholder participation is essential.* City and municipal authorities, citizens, community-based organisations, NGOs and the private sector, as well as national governments and sectoral agencies at various levels, all have key roles to play. Stakeholder participation is necessary to mobilise local resources, and ensure the sustainability of urban improvement strategies. Local governments play an important role in mobilising and facilitating community initiatives.

- *Management capacity, not capital, is often the main bottleneck.* Projects, which focus directly on improving capacity, have the biggest potential pay-off. This includes supporting urban authorities to develop their capacity for strategic and participatory planning, formulating policies conducive to efficient production and consumption, managing infrastructure, and monitoring and enforcing industrial and transport pollution standards. Investment in infrastructure such as water treatment plants, drainage systems, and power supply systems must be based on local initiative and tailored to local conditions.

- *Improving the management of existing infrastructure is a priority.* Priority areas include reducing leaks in water-supply systems, and developing pricing systems that encourage consumers and businesses to use resources efficiently. The resulting financial savings can facilitate the extension of basic services to poor communities. Mobilising private investment often helps in this regard, and ODA can help to facilitate this process.

- *Changing the attitudes and perceptions of people and organisations.* Effective programmes of public information, education and communication are essential to support environmental improvement initiatives.

- *The interests of poorer stakeholders groups must be specifically considered:* Within rapidly changing institutional contexts — which often include a greater emphasis on cost recovery, demand management and privatisation — there are risks that the interests of the poor may not be adequately reflected in policy reforms. NGOs can play a key advocacy role for the poor.

- *Sound urban management requires looking beyond the city limits.* Urban authorities collaborating with their counterparts in neighbouring jurisdictions, can avoid the transfer of environmental costs generated by cities to other ecosystems, and extend the benefits of urban growth to neighbouring regions.

Helping developing countries avail of the opportunities arising from increased international investment and trade: policy and institutional challenges

This section complements Chapter 8 by focussing on developing countries and the areas where assistance from OECD countries can help ensure that increased openness to trade and investment is to the benefit of developing countries.

Increasing openness and integration of the world economy is creating huge wealth and has the potential to make possible a massive reduction in poverty across the world. But it also entails a number of risks, especially for developing countries. While increased trade and investment do not themselves cause increased poverty or environmental degradation, they can exacerbate existing weaknesses in regulatory capacities or inequities in resource endowments

Risks from increased openness to trade and investment: accelerated natural resource degradation

On the one hand, openness to trade can raise the value of natural resources thus reinforcing incentives to manage them efficiently and on a sustainable basis. On the other hand, when property rights are not clearly defined, and regulations governing natural resources extraction weak or poorly enforced, the increased demand for natural resources resulting from openness to trade can accelerate unsustainable resource use patterns (See Box 8.3, Chapter 8). When access to natural resources is highly inequitable, the benefits from trade tend to accrue disproportionately to privileged sections of society.

Foreign Direct Investment can accelerate the transfer of modern technologies and production methods, leading to improved efficiency in resources use, and reduced pollution and waste. On the other hand, it can foster the migration of industries which no longer meet applicable environmental standards to countries where standards are lower or unenforced. Overall, it is unclear whether FDI has led to the transfer of polluting industrial processes from the OECD to developing countries. Existing empirical data and studies, though not conclusive, do not suggest a transfer of dirty technologies at the aggregate level. However, aggregate data masks significant differences across industrial sectors and countries (OECD, 1999*a*). Some of the most socially and environmentally critical industry sectors, such as extractive industries, would need to be studied in greater detail in order to reach firm conclusions.

Risks from openness to capital markets

Greater openness to international capital markets may make developing economies more vulnerable to external shocks. The decade of the 1990s witnessed a major increase in the level of international capital flows to developing countries. Factors accounting for this include deregulation, regional integration, and advanced information technology. While this has provided much needed capital to some developing countries, it has also led to increasing volatility of financial flows, and wider financial crises (OECD, 2001*b*).

The role of Development Co-operation: key areas for capacity development

The ability of developing countries to make the most of the opportunities from increased trade and investment, and minimise the associated risks outlined above, hinges on the effectiveness of their environmental and social policies and institutions. Although these are the responsibility of developing countries, donors can contribute. Many developing countries and economies in transition need support for capacity development at all levels to ensure that appropriate policy and institutional frameworks are in place. Relevant policy areas include environmental impact assessment procedures (see Chapter 8), technology co-operation (see Chapter 6) land use policies and fiscal policies. Capacity development in the environment (CDE) — the process by which capacity in environment and appropriate institutional structures is enhanced — is recognised as an essential element for implementing the conclusions of the UN Conference on Environment and Development (UNCED, 1992). Capacity development for trade is also an important area where development co-operation can play a role.

Capacity to define resource tenure rights

In many developing countries, resource tenure rights — the terms and conditions on which resources can be held, used and transacted — are poorly defined and weakly enforced. This leads to conflicting claims and insecurity for users, often fuelling social tensions and conflicts. Different types of resources, such as land, water, pastures, fishing or hunting grounds or forests - call for different tenurial arrangements. While cultural traditions will determine whether tenure rights are held in common or by individuals, improving security of tenure over resources is essential. Resource users need such security to make sound management decisions and undertake the costly investments in know-how and infrastructure necessary for long-term resource productivity.

Capacity to establish regulatory and fiscal regimes tailored to local conditions

Fiscal regimes can significantly affect the way resources are used. For instance, in many countries plantation timber enjoys tax advantages compared with naturally harvested timber. These advantages encourage the conversion of still viable natural forests to mono-crop plantations. Similarly, subsidies distort the investment decisions of local and foreign producers alike. As a general rule, market based instruments targeting the undesirable by-products of economic activities (negative externalities) are more effective in fostering environmentally and sound behaviour than restrictions or bans (see Chapter 5). However, local conditions and prevailing regulatory and enforcement capacity determine the feasibility of policy instruments. Emission taxes, for example, require sophisticated monitoring equipment and high administrative capacities. As a result, many governments apply less sophisticated measures such as product taxes with a less direct relationship between pollution levels and tax rates.

Similarly, when the negative environmental consequences of macroeconomic adjustment policies cannot be effectively addressed through economic instruments, policy makers have to resort to "second-best solutions" such as quantitative restrictions. For example, in the case of increased demand for log exports following an exchange rate depreciation, quantitative restrictions on log exports have been viewed as necessary measures, at least until an effective regulatory framework has been put in place to prevent logging from exceeding a sustainable rate. There are also instances where subsidies may have positive environmental impacts — given prevailing regulatory and enforcement capacities. For example, when fuel wood can be readily obtained from open-access forests, the removal of subsidies on household fuels can actually accelerate forest depletion.[13]

Capacity to enforce rules and standards

The administrative systems responsible for monitoring and enforcement often lack the necessary human and financial resources to perform their tasks. Establishing well-equipped monitoring systems; setting and enforcing sanctions that eliminate economic incentives for non-compliance; and providing technical training to inspectors is a priority. Environmental permits and standards are two regulatory tools that developing countries can use to strengthen their environmental policy framework.

Capacity development for trade

Capacity development for trade is another important area where development co-operation can play a role. For example, OECD countries can assist developing countries in assessing the impact of trade liberalisation measures. OECD methodologies can be used by developing countries to design measures to alleviate adjustment impacts of trade liberalisation, and OECD countries can share their own experience in carrying out such assessments. The OECD methodologies include practical guidance on how to carry out an environmental review of trade measures and provide a detailed checklist of potential environmental effects that need to be considered in such a review (OECD, 2000*b*).

Developing countries are often constrained in their ability to participate as full-fledged partners in the negotiation and implementation of international agreements. Donors can also play a role in this regard by

supporting countries' capacity to analyse the implications of agreements being negotiated, formulate their position and participate to informal meetings and events which often have an important impact on the outcome of negotiations.

The Development Assistance Committee has promoted member support to capacity development for trade negotiations by developing a set of guidelines in this area. These are designed to enhance co-ordination and implementation on the ground, while assuring that trade capacity building is demand-led and locally owned. Another effort to promote co-ordination is the Integrated Framework for Trade-Related Technical Assistance. The recently launched UNCTAD/UNEP Capacity Building Task Force on Trade, Environment and Development also provides a framework to respond to these capacity building needs (UNEP/UNCTAD, 2001).

Fostering greater policy coherence in OECD countries

The process of globalisation requires OECD governments, more than ever before, to take account of the broader development objectives in all policies and external relationships. In a world where there is no longer a clear distinction between domestic and international affairs, effective development co-operation programmes alone will not adequately reduce poverty. Development objectives need to be integrated throughout the full range of government departments not only in developing countries but also in OECD countries. Trade, agricultural and fisheries policies are examples of areas where further efforts are needed.

The international trade regime is characterised by several constraints, which limit access of especially processed products from developing nations to markets in OECD countries. First, are tariff rates with peaks for products in which developing countries are most competitive (even though the average level of tariffs has been reduced substantially). Second, is tariff escalation, with increasing rates for processed goods, which impede industrial exports from developing countries. Third, are non-tariff barriers such as product standards and regulations, non-transparent government procurement (such as aid tying, application of rules-of-origin, anti-dumping action), and subsidy discrimination. Often, intrinsic incoherence of the preferential trade regimes have been to the detriment of developing countries, because they can exclude sensitive products in sectors where poor countries have a competitive advantage (e.g., textiles, agriculture).

Improving policy coherence in OECD countries could have an overwhelming effect on developing countries. Estimates by the secretariats of OECD and the World Bank indicate that OECD tariffs and subsidies for agriculture and manufactured goods may cause annual losses to the developing countries on the same order of magnitude as their total ODA receipts. Adding the impact of non-tariff barriers, protection of services and intellectual property rights, the total static cost impact of OECD protection on developing countries may be over three times the amount of ODA, and the dynamic effects even larger.

National export credit agencies (ECAs) play an increasingly important role in providing capital for source country investors seeking new opportunities abroad and their customers. Total annual commitments of export credit agencies have been at a constantly high level during the last decade (USD 46 billion in 1986, USD 48 billion in 1998 roughly at the level of official development assistance during the same period. While not a widespread practice among ECAs in the past, an increasing number of countries have now established or are currently establishing environmental guidelines drawing on related experience in International Financial Institutions. In order to support this trend, the OECD Working Party on Export Credits and Credit Guarantees (ECG) has agreed on an Action Statement on Export Credits and the Environment, and on a Work-Plan. In this context, the ECG is currently negotiating an Agreement on Common Approaches on Export Credits and the Environment, which is scheduled for completion in 2001.

Conclusions

Sustainable development is an objective for developing and transition economies, as much as for OECD countries. However, the nature of the development challenge for each set of countries is quite

different. For example, rampant poverty, rapid population growth, food insecurity, desertification, and the scourge of HIV/AIDS are urgent issues for many of the poorest countries. Not only are these problems different from those facing OECD countries, but they must be addressed with weak institutions and systems of governance, and low levels of human, financial and physical capital.

From a global perspective, it is essential that OECD countries engage with developing countries more fully in the effort to address sustainable development. In a changing world, old distinctions between "North" and "South", as well as between "East" and "West", are becoming blurred. Issues can no longer be divided into "domestic" and "international" spheres. Risks of social disintegration and exclusion affect all countries, as do opportunities to benefit from participation in a growing global economic system. Increased human security would reduce pressures for migration and accompanying social and environmental stresses. Political stability and social cohesion diminish the risks of war, terrorism and crime that inevitably spill over into other countries.

As the balance of economic weight shifts from OECD to non-OECD countries, all countries will need to play a role in ensuring the integrity of global economic, environmental and social systems, according to the principle of common but differentiated responsibilities. Sustainable development expands the community of interests and values necessary to manage global issues.

Increased global trade and investment provide important opportunities for accelerating economic growth, and reducing poverty. Provided effective policies and institutions are in place, trade and investment liberalisation, combined with the wider diffusion of modern technologies and know-how, have the potential to lift large populations out of poverty. Moreover, a number of emerging markets and transition economies are moving in this direction.

However, globalisation will not deliver its potential benefits if it works for only a few. Indeed, many countries, notably the least developed, are increasingly marginalised as the process of globalisation passes them by. Technologies, capital and know-how only flow to countries where the fundamental conditions to attract and effectively use these flows are present. At present, many developing and transition countries have not managed to establish the policy and institutional frameworks required to attract these flows. Thus, there is the risk of a two-track world developing, where some countries and regions progress while others fall farther behind. Development co-operation has an important role to play in helping countries build their capacity to take full advantage of the opportunities afforded by globalisation

Building on past experience, a new approach to development cooperation has emerged, embodied in the DAC strategy for the 21st century. The strategy provides a framework for cooperation with developing countries, based on the principle of partnership around shared goals. Achieving the International Development Goals (IDGs) set out in the DAC Strategy — increased resources for development cooperation, to be more effectively deployed and better coordinated — would mean a major stride towards sustainable development. It is somewhat paradoxical that as global wealth has increased in recent years, development assistance flows have remained stable or declined. Only four countries consistently achieve the target of 0.7% of GDP. Moreover, it is clear that private flows can not substitute for development assistance: the two have different objectives, work in different ways and generally flow to different groups of countries.

For many developing countries there will be important trade-offs between national priorities such as reducing poverty and protecting global public goods, such as atmosphere. Developing effective burden-sharing arrangements that reflect "common but differentiated responsibilities" (e.g. for climate-related or biodiversity issues) should play an important role in helping to reconcile such trade-offs. Beyond that, there is considerable scope for win-win policies targeting local and global environmental problems. Efforts to improve health by controlling air pollution, through support of cleaner, more efficient technologies, can contribute to reducing greenhouse gas emissions. Similarly, efforts to combat land degradation and to reduce vulnerability to climate change (e.g. by preventing deforestation) can improve food security for affected local communities while also helping preserve global biodiversity.

One of the International Development Goals, derived from a commitment made at the 1992 UN Conference on Environment and Development (UNCED) concerns the elaboration of sustainable development strategies, focused on national priorities. National sustainable development strategies provide a framework for building coherent, long-term approaches to tackle the tradeoffs involved in achieving sustainable development. While the focus of these strategies varies widely, poverty reduction remains a central objective for many of the poorest countries. Important insights have been gained on the key principles underlying successful strategies and how to support developing countries in implementing such strategies.

Development cooperation is one of the main instruments at the disposal of OECD countries to help the poorest counties. However, a variety of other policies, notably trade and investment, have important impacts in developing countries. There is therefore growing recognition of the need for greater policy coherence.

The current conjuncture for confronting these challenges is promising. There is now broad global commitment to halving the proportion of people living in extreme poverty by 2015. Developing countries are establishing and implementing strategies to achieve this goal, with the support of the international development community. It is equally clear that sustainable use of natural resources is a precondition for poverty reduction efforts to have a lasting impact. The development community is putting together a co-ordinated and focused response to these challenges. The time is right to seize the opportunities at hand: rising political will to tackle poverty, economic prosperity in OECD countries, the potential benefits of technological advances in telecommunications, information and the life sciences. It is essential to deliver on promises, convictions and goals, and to follow through with commitment, resources and well-founded efforts on the ground.

NOTES

1. The *DAC Guidelines on Participatory Development and Good Governance* provide a framework for donor assistance in these areas. The *DAC Guidelines on Conflict, Peace and Development* focus on the special needs of countries in or recovering from conflicts.

2. This includes foreign direct investment, bank lending, bonds and portfolio investment.

3. The CEECs are: Albania, Bosnia And Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, FYR of Macedonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Yugoslavia. The NIS are: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russian Federation, Tadjikistan, Turkmenistan, Ukraine, Uzbekistan.

4. "Environmental Finance Strategies in the Urban Water Sector in the NIS", OECD (forthcoming), provides one such example.

5. The PRSP initiative is linked to the Heavily Indebted Poor Countries Debt Initiative (HIPC) and the World Bank's Poverty Reduction Support Credit.

6. *Development Committee Communiqué*, September 27, 1999.

7. The World Summit on Sustainable Development in South Africa in June 2002 will provide an opportunity to take stock of progress achieved.

8. The Global Environment Facility was established to forge international cooperation and finance actions to address four critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, ozone depletion, and the problem of land degradation.

9. Soil erosion and siltation affects downstream roads, irrigation, water supply and hydropower generation infrastructure and sometimes coastal fisheries. The economic value of these impacts often dwarfs the value of the timber extracted or crops produced in upland watersheds.

10. The terms "city" and urban centre" – often used interchangeable – are generally understood to refer to densely settled, non-agricultural areas, but there is no general agreement about how to define them. While most countries define settlements with 20,000 or more inhabitants as "urban" there is far less agreement on the classification of smaller settlements. This greatly limits the accuracy of international comparisons.

11. It is estimated that developing countries spend about USD 250 billion a year on new and rehabilitated infrastructure, about 30% of which for water. 90% of this amount is taken from tax revenues or intermediated by governments through foreign financing (both concessional and non-concessional funds from multilateral and bilateral sources).

12. This section draws from a comprehensive review of DAC Members' initiatives in the area of urban environment, conducted by the DAC Working Party on Development Co-operation and Environment.

13. The IMF has recognised the need to take these realities into account when recommending fiscal reforms to its clients.

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Section IV

CROSS-SECTORAL ISSUES

Chapter 10.

NATURAL RESOURCE MANAGEMENT

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Chapter 10.

NATURAL RESOURCE MANAGEMENT

Introduction

Natural resources are the foundation for human life and underpin sustainable development. They provide the raw materials for meeting basic human needs: food and water, clothing and shelter, medicine, tools, energy and communication. They also provide recreational and other non-consumptive services for increasing numbers of people. Beyond these human needs, natural resources play an important role in providing the food, habitat, and reproductive bases for virtually all living resources, and in meeting ecosystem functions like carbon and nitrogen fixation, water catchment and temperature buffering. Owing to increasing demands for natural resources, some resources are being depleted, although this is occurring mainly on a local basis. And as a consequence of increased exploitation, many resources may be degraded, while pollution and waste from their use may increase. The exploitation of one resource can also have adverse impacts on another, such as when the runoff from a mine degrades water quality. The threat of resource depletion is offset to some extent by resource-saving technology. Resource substitution is also helpful, since some natural resources (e.g. petroleum and forests) can be used to meet several needs, and most needs can be met by more than one natural resource. Nevertheless, resource depletion, degradation, and pollution may very well increase in the absence of appropriate legislation and policies.

The extraction of commercially exploited natural resources contributes to varying shares of GDP in OECD economies. These shares range from 0.2% in Japan to 15% in Norway for non-renewable resources, and from 0.1% in Italy to 7.7% in Iceland for renewable resources. However, the value of natural resources does not depend solely on the immediate commercial return from their exploitation, but also on environmental, recreational and other services they provide.

Managing a portfolio of natural resources is complex. Resources differ in their physical characteristics, abundance, and value to different members of society. Optimising the stream of benefits they provide is further complicated by inter-temporal trade-offs, interactions between different resources, uncertainties about future demand and supply and the environmental impacts of their exploitation. Managing the transition to more sustainable practices requires careful consideration of labour and other social adjustment issues.

This chapter sets out some of the key facts about major types of natural resources, and discusses their management in OECD countries. It also discusses some of the policy challenges related to natural resource management, including ownership and access rights, resource degradation, the provision of ecosystem services and the management of natural assets. Finally, it provides a brief summary of the policy issues at stake and the policy actions that could improve the management of natural resources.

Natural resources: characteristics and ownership

The economic, social and non-use values of a natural resource vary over time due to technological developments, as well as to changes in public priorities, market prices and costs. Distinguishing resources according to their salient characteristics can help in designing appropriate management policies.

Characteristics

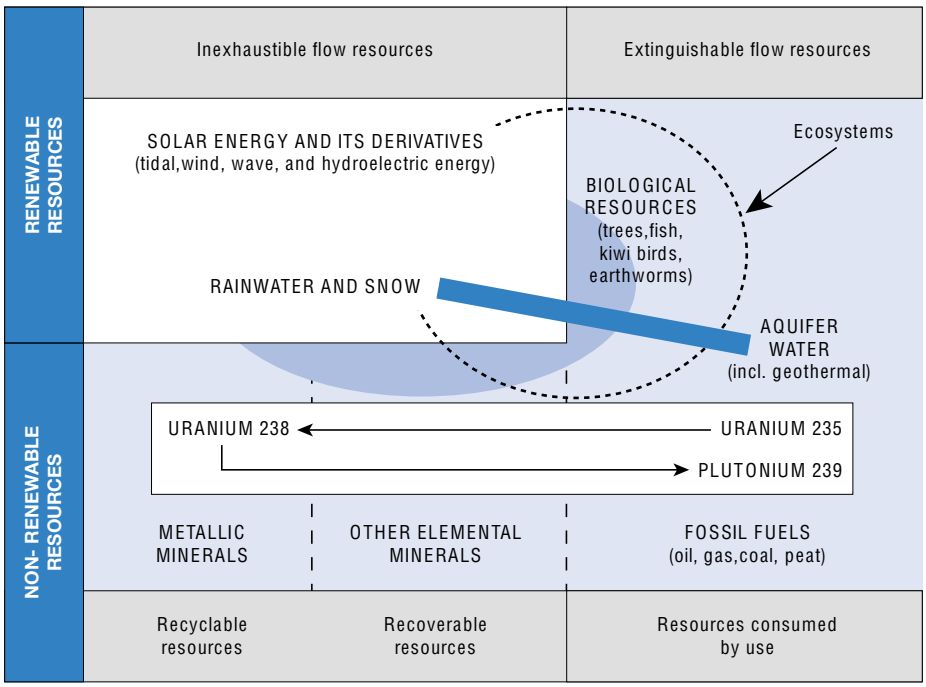
Natural resources[1] are those parts of the earth's biological and mineral endowment from which society, directly or indirectly, derives value. Energy from the sun and its derivatives (e.g. wind power) are sometimes included, as well as the earth's atmosphere and the spectrum of radio-wave frequencies.

Figure 10.1 distinguishes two major categories, non-renewable and renewable resources. *Non-renewable* resources (i.e. minerals, mineraloids and rocks) are stocks with a more or less finite initial endowment that are depleted over time. They may be further divided into *(i)* materials from which metals are extracted; *(ii)* materials used for their intrinsic chemical or fertiliser properties; *(iii)* materials used for their special or aggregate physical properties (e.g. building materials and gemstones); and *(iv)* materials used as sources of energy (Harris and Skinner, 1982). Concerns about future supply (limitations) usually focus on the first and fourth categories. Yet many materials can be recycled. The inherent nature of the materials will generally dictate the potential for recycling and the number of recycling cycles. Technological improvements, collection systems and appropriate price signals are factors that can promote recycling and reduce the need to draw on virgin resources.

Renewable resources can be classified as flow resources that are, or can be, naturally replenished within a sufficiently short time-span, thus providing for an indefinite stream of benefits. They can be further divided into those that can be reduced or removed through human activity if not managed sustainably (e.g. biological resources, the atmosphere) and those that cannot (e.g. tides). Many biological resources are mobile, unlike other resources, and this complicates their management.

Some natural resources do not fit neatly into any one particular category. Soil, for example, is a composite of minerals, organic compounds, and living and decaying organisms — neither wholly mineral nor wholly biological. An ecosystem is an assemblage of organisms, mineral nutrients, atmospheric gases, and an influx of solar energy and water, all interacting as a functional unit. An ecosystem can also be regarded as

Figure 10.1. **A classification of natural resources based on their physical characteristics**



Source: Based on Rees (1985), *Natural Resources - Allocation, Economics and Policy*, first edition, Methuen, London and New York.

a natural resource, though of a much different kind than any of its constituent parts. Ecosystems maintain the balance of nature; they rarely have distinct geographical boundaries, and are constantly exchanging materials and energy with adjacent ecosystems and the abiotic environment.

Ownership and access

Resources are also distinguished by ownership regimes. At one extreme are open-access management regimes, which provide no means of excluding users from the resource. A notable example is high-seas fisheries that are not regulated by regional fisheries management organisations. At the other extreme is private ownership, in which rights to resource exploitation are clearly defined, as in the case of forested lands in the United States and Scandinavia. For example, in Finland private persons own about 62% of the forested area, the government 24%, forest industries 9% and others 4%. For other OECD countries private ownership varies from 7% in Canada and 23% in Greece to 60% in the USA and 91% in Portugal. Common-property regimes occupy an intermediate position, and can take a variety of forms. Access is restricted, but by means of conventions, norms and rules, not through ownership per se. Water resources often fall within this category. In theory, different ownership regimes can be applied to one resource. But in practice the characteristics of the resource itself (location, mobility, separability), information shortfalls, distributional impacts, and transaction costs often constrain the practicable choice of ownership regime.

Natural resource management regimes vary across resources, time and area. Governments have always played a key role in determining access to natural resources. The nature and degree of government control over commercially valuable natural resources varies among resources, nations, and sub-national units. In most OECD countries, the majority of agricultural land, apart from semi-arid rangeland, is privately owned. (Issues relating to the management of agricultural land are covered in Chapter 14.) A significant share of the forested area is also privately owned, though most governments own large tracts which they lease to private logging companies. Even on privately owned forested land some countries (e.g. the Nordic countries) allow public access rights to recreational activities and to the gathering of berries and mushrooms. Rights to mineral, oil and natural gas deposits, even those underlying private land, are generally held by governments, which then grant licences to companies who wish to exploit them. Mineral rights can be privately held in the United States, but even there the State and federal governments control significant mineral and hydrocarbon resources. Water rights range from purely public to purely private, typically being more elaborately defined in areas with low rainfall. Rights to catch fish in marine waters generally belong to nations and are allocated by governments, but in some countries and for some fish they have been assigned to individuals, usually as a proportion of an annually determined Total Allowable Catch (TAC).

Over the last century, governments have also become owners of large areas of land and water managed or set aside as *nature reserves*, or for *recreation and other uses*, where the mining or harvesting of natural resources is limited or forbidden. Access to these parks and nature reserves varies widely, ranging from free and unlimited entry to fee-for-access.

Government involvement in the harvesting of natural resources is less common and declining. Today in OECD countries, private individuals and companies carry out most farming, logging, fishing and mining. The main exceptions are in energy (see Chapter 12) and water. Because of the large scale of investments required, or the strategic nature of the resource, many governments at the beginning of the 20th century formed state-owned enterprises to develop energy resources (including hydroelectricity), large-scale irrigation and plantation forests. In recent years, many of these enterprises have been sold to private investors. However, most governments continue to regulate access to resources under their control (through licences, permits, and other means) and in some cases determine total production levels (e.g. fisheries TACs).

Natural resources and sustainable development

A necessary condition for sustainable development is the preservation and enhancement of the overall capital base of societies for current and future generations. Natural resources form a key part of natural

capital, and provide raw materials and environmental services that are necessary to develop man-made, human and social capital. Two features that distinguish natural resources from other sorts of capital are:

- If depleted or degraded natural resources cannot always be replaced or restored.

- Natural resources form an integral part of larger ecosystems. Natural resource depletion and degradation can lead to environmental degradation and reduced ecosystem services.

Natural resource depletion: scarcity, technological change and recycling

There has been a longstanding debate about whether natural resources are becoming scarce. There are several methods of measuring scarcity (Box 10.1) including unit costs of production, real prices of commodities and resource rents. Prices provide a valuable indicator of scarcity but they are not perfect indicators of future trends and need to be interpreted alongside other information, in particular when non-market values and uncertainties relating to technological or policy change are significant.

Scarcity is influenced by changes such as technologies, substitution and recycling. There is considerable scope for substitution among materials produced from natural resources. What matters from the sustainability perspective is not whether a particular natural resource will be available indefinitely but rather whether human ingenuity can keep combining man-made, natural, human and social capital in ways that enable both human and ecosystem needs to be met. New technologies, substitution, recycling, afforestation and changing consumer preferences can reduce pressures on natural resources and ecosystems and enable resource use to be decoupled to some extent from economic growth. New technologies provide a "backstop" against resource scarcity even when they are not economic in the short term.

Box 10.1. **Measures of natural resource scarcity**

In competitive markets resource rents are discounted and included in an asset's value. If there is a market for the natural resource *per se*, e.g. oil reserves and mineral deposits, the market price should reflect the natural resource rent. Rising rents, in turn, would be an indicator of scarcity. However, the asset value of the natural resource is often difficult to disentangle from the value of the man-made capital needed to produce commodities from the natural resource. Oil companies own oil reserves and production equipment, and mining companies hold mineral rights and own mining equipment. Thus, there are two problems with the measurement of rent as an indicator of scarcity.

First, rents are measured by the difference between natural resource price and the marginal extraction costs, but data on the latter are difficult to obtain. Second, the use of rent as a scarcity measure assumes that firms are following optimal extraction plans, and that they are fully informed about future prices and extraction costs. But this condition is not always fulfilled. Moreover, private resource owners often have no incentive to take into account the effects on other producers and consumers of their use of a natural resource, nor do they always produce sufficient public goods (e.g. biodiversity).

Unit extraction costs have been used as an indicator of scarcity on the basis that as low-cost, high-quality resources are depleted, exploitation tends to shift towards higher-cost and lower-quality resources. However, observed trends in unit extraction costs also reflect technological change, resource substitution and improved knowledge about resource deposits.

Trends in real prices of natural resources are a well-established indicator of scarcity, but this indicator also has its problems. Producer cartels can raise prices even if supplies are not scarce (as in the case of petroleum), and government intervention can influence prices. Moreover, prices, rents and costs do not always fully reflect the environmental impacts of natural resource exploitation.

Non-renewable resources

Non-renewable resources include metalic ores and fossil fuels — rocks, mineraloids and compressed gases containing hydrocarbon compounds (and associated impurities) — such as petroleum and coal. The speed at which ores and other mineral resources are depleted depends on their nature, technology, changes in price and demand patterns. Demand is driven by population, income growth and price changes. Demand for resources is also influenced by activities in other markets. For example, trends in construction activity affect the demand for metals. At one end of the spectrum many metallic minerals, once extracted and transformed into a relatively pure state, have the potential to be reprocessed again and again. At the other end of the spectrum fossil fuels cease to exist once consumed.

Overall, metals production has risen relatively slowly during the last two decades, with significant differences between commodities and time periods. For example, world steel production grew about 15% between 1980 and 1998, aluminium and copper production grew more than 50%, while lead and zinc production was relatively static during the same period. A significant amount of the input to metal manufacture comes from recycled materials: over 40% for steel, over 30% for aluminium, nearly 50% for lead and 15% for copper (Henstock, 1996). Recycling considerably reduces the energy required in metal manufacture (Box 10.2).

New materials and related product technologies that save metals are constantly being developed, such as optical fibres and communication by wireless telephones to replace telephone systems using copper wire. Closer to the mining end, new ore-processing technologies, such as froth flotation and electrowinning, are substantially improving resource recovery rates and reducing energy consumption.

Box 10.2. Recycling

The main recycled waste streams are glass, paper, metals, plastics, rubber, textiles and organic waste. Recycling can help reduce waste streams and disruptions to natural landscapes, and moderate pressure on virgin stocks of natural resources. For example, recycling of primary wood fibres helps to conserve habitats for wild species, and reduced mineral extraction reduces the environmental impact of overburden. There can also be important environmental benefits downstream. For instance, the US Bureau of Industrial Recycling has estimated that energy savings from recycling can be considerable: aluminium (95%), copper (85%), iron and steel (74%), lead (65%), zinc (60%), paper (64%) and plastics (80%). However, the environmental implications are not always beneficial. For instance, as the percentage of waste-paper input in paper manufacturing increases, the oxygen demand of effluents from the manufacturing process rises, exacerbating competition for oxygen in the recipient water source.

Technological change has improved recycling and utilisation rates by:

- Improvements in the production process, e.g. a shift from basis-oxygen to electric-arc furnaces in steel-making.
- Changes in products, e.g. the development of medium-density and high-density fibreboards.
- Changes in recovery technologies, e.g. the use of electrowinning technologies in copper production.

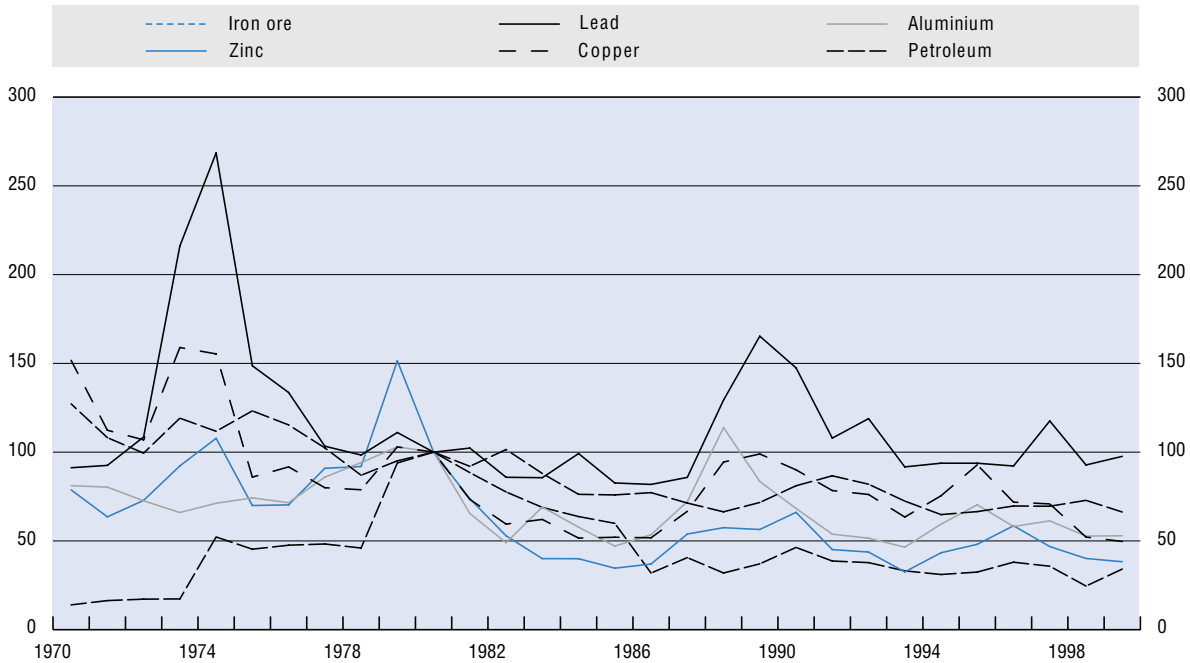
However, some technological changes may inhibit recycling. For instance, the increased use of composite materials has increased the recovery cost of certain materials.

With the exception of zinc, the prices of metals and minerals have not risen in real terms since 1970 (Figure 10.2). While there was around a five-fold increase in the real price of petroleum during the 1970s, it fell during the 1980s, and since then has fluctuated around the average level for the 1970s. Regarding

metals, the large number of producers and users, as well as the openness and international character of global metal markets, tends to ensure well-functioning markets and pricing mechanisms. While minerals continue to be depleted in a physical sense, price trends indicate that long-term scarcity is currently not an issue that markets have been particularly concerned about.

Figure 10.2. **Real prices for selected minerals and metals**

Index 1980=100



Source: IMF and OECD.

Uranium provides fuel for nuclear energy, which represents some 25% of the electricity supply in OECD countries. Known conventional uranium resources exploitable at costs lower than USD 40/kgU, around 1.25 million tonnes, are equivalent to some 20 years of consumption at current levels; known conventional resources exploitable at costs lower than USD 130/kgU represent more than 60 years of annual consumption. Although current uranium prices do not provide an incentive for the exploration and development of new uranium mines, the potential for extending the lifetime of uranium resources is large. Beyond known resources, there are large speculative and unconventional resources, including uranium contained in phosphates and sea water, representing more than 4 billion tonnes. Furthermore, recycling of fissile materials and the development of thorium reactors offer additional opportunities to broaden the resource base for nuclear energy.

Concerning fossil fuels, the International Energy Agency's *World Energy Outlook 2000* (IEA, 2001) views the world's petroleum-resources from conventional deposits as not being depleted until after 2050. Oil produced from unconventional sources (tar sands, extra-heavy crude oil, oil synthesised from coal and liquid fuel produced from plant matter) will gradually increase in importance, but will still account for less than 4% of total supply. For most deposits a sustained rise in the price of crude oil to USD 25 to 30 per barrel (in constant 1990 dollars) will be required before significant new exploitation of resources take place. Cumulative production of *natural gas* to date has exhausted only around 11% of total resources. Recoverable resources of gas from unconventional sources is also thought to be significant. No supply problems affecting *coal* are expected to occur before 2020, if ever. Concerns over coal's high carbon content and CO_2 emissions are already leading to declining consumption in some developed countries. Coal's abundance and relatively

cheap price still makes it the fuel of choice in other countries — particularly developing ones — which is one reason why CO_2 emissions have been rising rapidly in China and India.

Water

Over the past fifty years, the doubling of the global population, combined with generally increasing per capita demand, has resulted in approximately a four-fold increase in global *water* abstractions (but much less in OECD countries). However, global water withdrawals still represent only 8% of annually renewed water resources. None of the major regions of the world are currently suffering from high water stress (greater than 40% usage) at an aggregate level. Several OECD countries have stabilised or reduced per capita (and total) water abstractions since the late 1980s, suggesting that per capita water use can be decoupled from growth.

While there is ample water available in aggregate to meet current and future human requirements, 47 countries are classified as suffering medium-high or high water stress, and 17 of these countries already extract more water annually — mainly from groundwater aquifers — than is replenished through natural water cycles. Water quality remains poor in many areas of both developing and developed countries.

Technology improvements such as more efficient irrigation systems and reduced pipe leakage are contributing to increased efficiency in water use, and reduced environmental pressures. However, there is scope for improvement. For example, only about one-third of the water withdrawn for irrigation purposes actually reaches the crop. Although drip irrigation has increased 28-fold since the mid-1970s it is still employed in less than 1% of the world's irrigated areas, and primarily in OECD countries.

Renewable resources

Forests and fisheries are important commercial renewable resources and biodiversity has increasingly been seen as a key resource in its own right. Depletion and degradation of renewable resources varies according to biological characteristics, climate, demand and resource exploitation methods and rates. For some renewable resource-based products, long-term price stability (shown in Figure 10.3) suggest that their supply is not becoming scarce. However, there might have been a change during the 1990s that warrants further investigation.

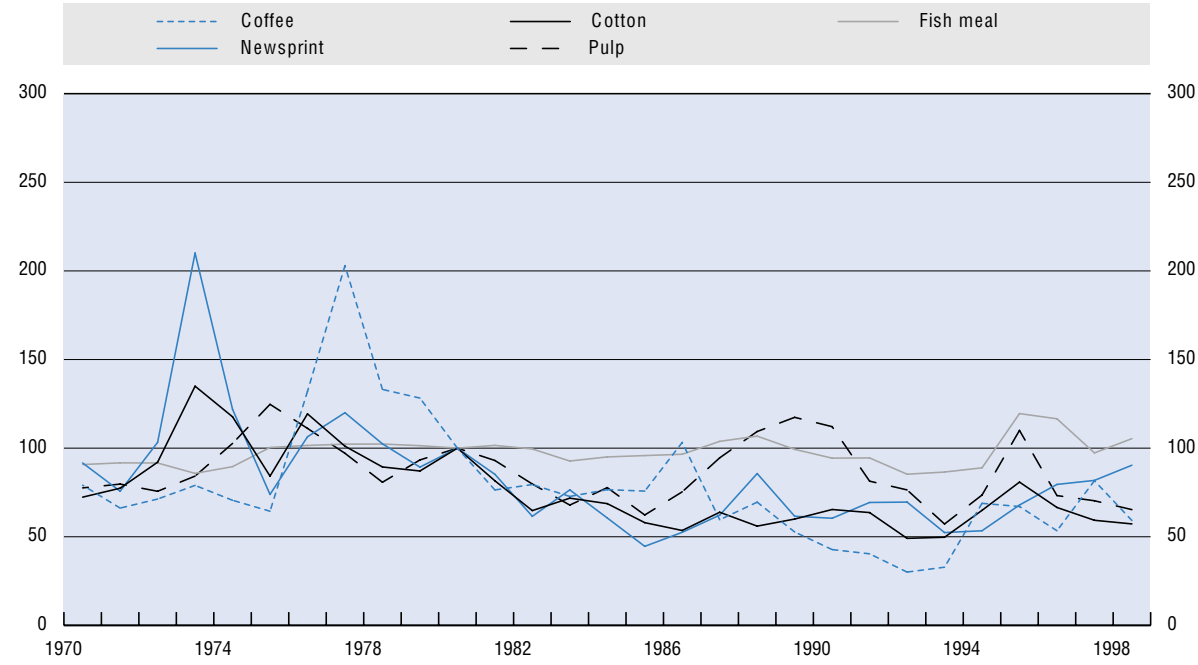
Consumption of the main *forest* products rose by about 50% between 1970 and 1990 (both in the OECD and rest of the world). Owing to technological improvements that increased the efficiency of forestry production and wood processing during this period, roundwood removals rose by only two-thirds as much as wood consumption. OECD demand for the main forest products is expected to weaken over the next few decades, as population levels stabilise and waste-paper recycling increases. In developing countries, however, increased population and income are expected to drive increases in demand for industrial wood products.

Since the 1980s, less wood has been harvested each year in Canada, Europe, the United States and the former USSR than has been replaced through new growth (Figure 10.4). Overall, OECD countries are currently harvesting only about 55-60% of the annual growth of their forests. The share of plantations has been increasing rapidly since the 1960s and this trend is likely to continue. Since 1970, real prices for pulp and newsprint have been relatively stable (allowing for cyclical variations) or slightly downwards (Figure 10.3). It appears unlikely that there will be any global decline in the supply of commercially harvested wood in the foreseeable future, although local scarcities may arise.

World production from marine capture fisheries reached a record of 93.6 million tonnes in 1997, and fell to 86.3 million tonnes the following year (Panel A, Figure 10.5). OECD production peaked at 34.5 million tonnes in 1988, and was down to 26.8 million tonnes ten years later. The United Nations Food and Agriculture Organisation (FAO) reported that for 1996, 49% of major fish stocks were fully exploited, and 24% were over-exploited. Over-exploited marine fish stocks are recovering in some areas, but will not return to levels

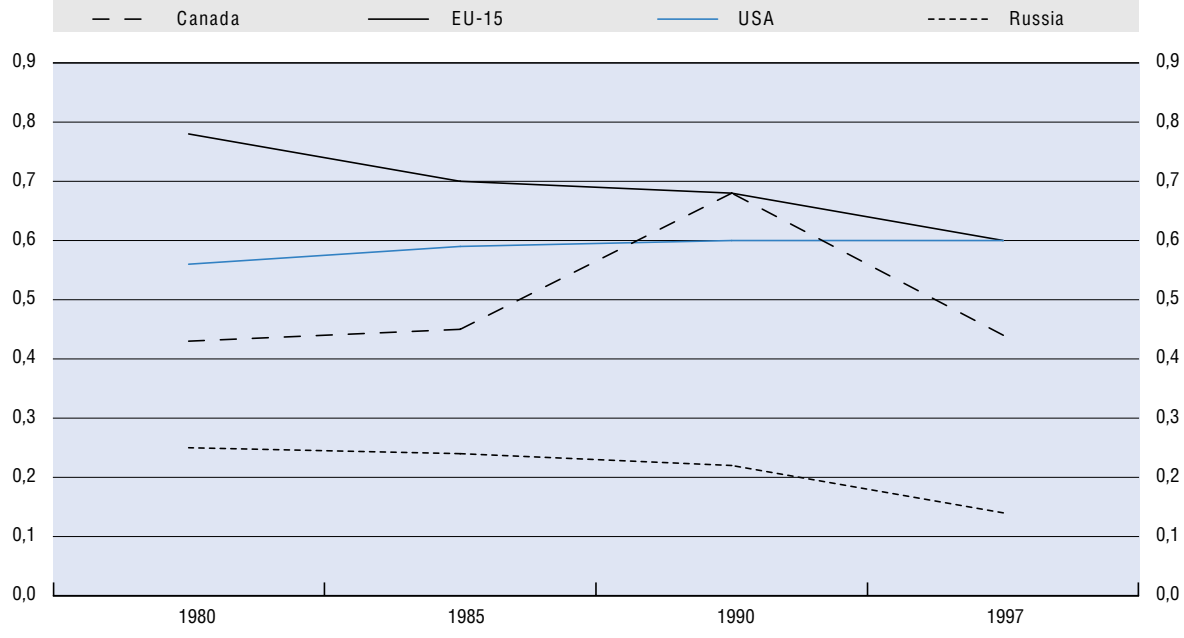
Figure 10.3. **Real prices of selected commodities**

Index 1980=100



Source: IMF and OECD.

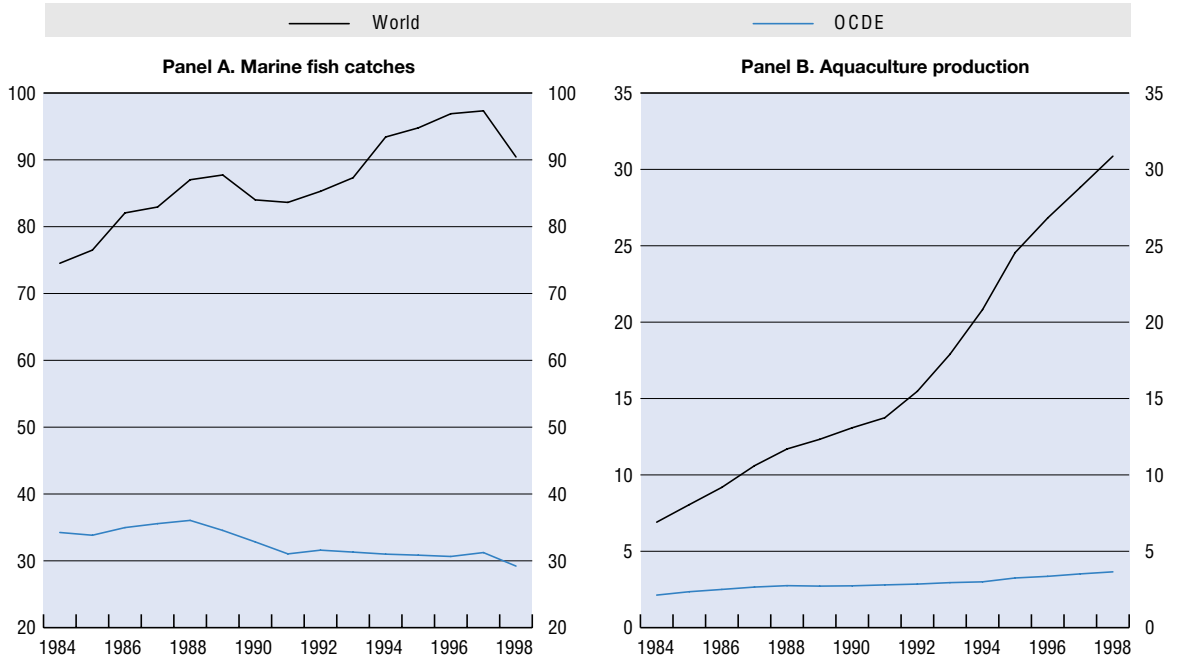
Figure 10.4. **Trends in wood growing stock, 1980s and 1990s**



Source: OECD (1999), *OECD Environmental Data, Compendium 1999*, Paris.

consistent with their single-species maximum sustainable yield without some reduction in fishing activity and capacity. There is still potential for biological and economic improvement of marine fisheries because some fish stocks are currently over-fished or under-utilised. The FAO has estimated that marine fisheries production could potentially reach 125 million tonnes compared with the 1990-94 average of 83 million tonnes. Better management and development of under-utilised fisheries would contribute 8 and 35 million tonnes respectively.

Figure 10.5. **World fish production**



Source: FAO Fishery Statistical Databases, www.fao.org/fi/statist/FISOFT/FISHPLUS.asp

By contrast, world fish farming has witnessed an average annual growth rate of more than 10% over the years 1984-1998 (Panel B, Figure 10.6). From 1984 to 1998 total world aquaculture production of fish more than quadrupled (from 6.9 to 30.9 million tonnes). It accounted for 26% of the volume of total world fisheries production in 1998. In OECD countries it grew less than in the rest of the world, from 2.1 million tonnes in 1984 to 3.7 million tonnes in 1998. There is potential for further expansion of aquaculture, but environmental problems and conflicts with other coastal zone users (tourism and traditional fisheries especially), together with scarcity of marine feed, could slow down future expansion. For land-based aquaculture, competition for land and water will probably be the limiting factor.

While *biodiversity* may be viewed as renewable, extinction of some species remains a real threat. In other cases (e.g. unique ecosystems) biological resources may be classed as exhaustible. On average, 3% of known species in OECD countries are endangered or vulnerable to extinction. For invertebrates, the percentage of known species endangered or vulnerable is below 3%, but for mammals and amphibians the ratio is above 20%. These averages obscure significant variations between countries in terms of numbers of species and the nature of the threats, but measuring biodiversity is complex (Box 10.3). Major threats to the deterioration in biodiversity include population pressure and pollution.

Technological advances continue to bring down the costs of extracting useable *renewable energy* from the sun's rays, waves and winds, although most of these technologies are not yet economically competitive except in some special applications or circumstances. Technological progress is also expected to improve the efficiency of energy consumption.

Box 10.3. **Measuring biodiversity**

The assessment of biodiversity raises a number of conceptual and empirical issues. Different methods of measuring biodiversity can yield different results. Compiling the total number of species (or threatened species) may not provide information on broader aspects of biodiversity, such as ecosystem health. On the other hand, indicators at the ecosystem level obscure problems relating to specific species. The aggregation of variables such as ecosystem quality and size in a natural capital index that takes species into account can provide comparable pictures among countries but it provides no information on specific threatened species and ecosystems.

There is a shortage of appropriate and consistent physical, biological and socio-economic data relating to biodiversity. In addition, the impact of growing numbers of humans on the planet's ecosystems may be overstated, while that of other factors — like human settlement patterns, poverty and technological change — cannot easily be predicted and assessed. Benefits associated with biodiversity, which have quite different local and global components, are often unclear and diffuse. Until more accurate methodologies are available, policy-makers interested in biodiversity trends have to rely on expert educated guesses.

Environmental impacts of natural resource use and resource degradation

Environmental impacts of natural resource use and resource degradation pose two significant challenges to sustainable development: *(i)* impacts of pollution and waste, which are the main challenge posed by the exploitation of non-renewable resources; and *(ii)* unsustainable practices, which threaten the reproduction capacity and productivity of renewable resources and related environmental services.

Although a relatively small part of the land in OECD countries is mined directly at any one time, *mining* has a number of environmental effects, both at operational sites and beyond them. These effects include air and water pollution, waste and pressures on biodiversity and habitats. Waste from *uranium* mining and milling activities are radioactive at a relatively low level but occupy large areas around the mines since the grades of uranium ores, like the ores of many other metals, are low (typically around 1%).

The environmental effects of *oil and gas* exploitation include pollution at extraction sites and during transportation, and disturbance of habitat. Major environmental damage from pollution during transportation is rare, but can be locally severe (see Chapter 13). The impacts of carbon dioxide emitted during the use of fossil fuels are discussed in Chapter 7.

While global *water* resources are potentially sufficient to meet current and projected demand, there are severe differences in the distribution of water across and within countries. Moreover, maintening high levels of water quality cannot be assured. Many areas are already subjected to environmental and health-related problems related to *water* pollution — contaminated drinking water (e.g. excess levels of nitrates, persistent organic pollutants, and heavy metals), eutrophication, and acidification. The situation is most serious in the developing countries, especially in areas undergoing rapid urbanisation, but there are problems in OECD countries too. Inappropriate water management practices also exacerbate soil erosion in many regions, and lead to waterlogging or salinisation of the soils through the excessive application of irrigation water. Overdrawing groundwater resources can result in various undesirable (and usually long-term) environmental consequences: subsidence, desertification, salinisation (including sea-water intrusion), wetland destruction and build-up of heavy metals.

Well-managed *forests* — including natural forests, semi-natural forests and plantations — improve water and soil quality by filtering airborne pollutants and enriching the soil. They regulate water flows and help to prevent soil erosion. They act as carbon sinks and temperature buffers, mitigating the effects of climate change. Forests can promote biodiversity by providing habitat for sylvan animals and plants. While forests are not over-harvested in aggregate, in some areas forests are being degraded by pollution, species

diversity is being reduced, and inappropriate clear-felling is contributing to increased soil erosion. Increasing the proportion of forest products harvested from commercial plantations may reduce pressure on natural forests. *Plantation* ecosystems are simpler than natural forests, and the wildlife is likely to be less varied, but plantation forests provide a number of environmental services including watershed protection, erosion and flood control. In New Zealand the combination of a proven fast-growing plantation species (*radiata* pine), combined with the removal of agricultural subsidies and controls on land use, has resulted in a reduction in deforestation and an expansion of new plantation forests — financed entirely by the private sector. However, natural forests and semi-natural forests are still dominant in most OECD countries.

Marine ecosystems provide wildlife habitat, maintain biodiversity, and dilute and treat wastes. In addition to effects on commercial *fish* stocks, the environmental impacts of marine fishing include by-catches (marine mammals, birds and non-commercial fish species), damage to the ocean floor, and waste and pollution. As marine fish catches have increased there has been a change in the composition of the catch towards a higher share of lower-valued species, generally those further down the food chain. Such species may also serve as important feed for marine predators such as sea birds, large fish, seals, whales and sharks; it is therefore necessary to ensure that the TACs for feed species take account of the needs of other species in marine ecosystems, as well as the impacts of predators on their feed species. The use of fishing techniques (e.g. sea turtle excluders and bird-saving devices) that reduce the by-catch of highly valued non-marketed species provides another example of the trade-off between use and non-use values of different species in marine ecosystems.

Aquaculture production can relieve pressures on marine fisheries. The main environmental costs are sedimentation and water pollution. There are also negative impacts on wild fisheries from their use as sources of seed and feed inputs for fish farms, and from the introduction of exotic species.

Resource values

A variety of values are associated with natural resources (see Chapter 2). The use-values of natural resources — i.e. as inputs into the production of economic goods and services — are generally captured in commercial markets. However, unlike other goods and services, their exploitation can affect future resource availability and hence the welfare of future generations.

Most non-use values of natural resources are not reflected in markets (Daly, 1996). Ecosystem functions that indirectly support and protect economic activity elsewhere include carbon and nitrogen fixation, flood-control and temperature buffering. Often their values cannot be appropriated by individual owners, and their consumption by one individual does not reduce their value to others. These public good characteristics mean that these services do not normally command a market value commensurate with their total value to society.

Most non-renewable resources (e.g. iron ore, oil and coal deposits) are mainly valued for the materials, energy or services that can be derived from them. These include the present value, if positive, of any additional revenues that could be earned by postponing production. For these resources, existence values tend to be nil or close to nil. Nevertheless, valuation of such resources is not straightforward (Box 10.4).

For most other resources, determination of their value to society is more complex. For example, fish (such as herring) have a market value as a food for humans, but also a value as food for other fish (such as cod) or marine mammals (such as killer whales). Some marine mammals in turn prey on other marine mammals. Many people derive option, bequest or existence value from mammals and fish. The existence value that people ascribe to some resources, such as penguins or geysers, is highest if the resources remain in their natural state. In the case of many ecosystems, the whole is worth more than the sum of the parts.

Individuals differ in the values they attach to the same natural resources. An urban dweller may feel that all wolves living in the wild should be protected; sheep ranchers may have very different opinions. Before the late 1800s, beaches were places to store small boats; today they are the centrepieces of billion-

Box 10.4. **The price of a non-renewable natural resource**

The price of a non-renewable resource such as oil has two components: the cost of extraction and distribution (including a return on invested capital), and a form of economic rent called *resource rent* (also referred to in the literature as *scarcity rent*, *Hotelling rent*, or *user cost*). Resource rent exists when consumers are willing to pay more for resources in limited supply than what it costs to produce them, *and* producers expect the future price of the *in-situ* resource to rise by at least the normal rate of interest. If producer countries would provide oil at the cost of production, this rent would accrue to consumers, or to governments through taxes. The distribution of economic rent can be controversial. However, from the point of global efficiency it does not really matter whether the rent accrues to producers, governments or to consumers, if each party spends or invests with equal efficiency.

What does matter for economic efficiency, is how a resource is allocated over time and how its price develops. Over time, the use of the resource should shift into more and more higher-value uses as supply declines. The simplest economic models of natural resource extraction predict that the real price of a depletable resource should rise gradually over time. In fact the price of many natural resources is falling because progress in technologies for exploration and extraction has increased recoverable reserves. This alters any estimation of "efficient prices".

In practice, the price of a natural asset is not necessarily determined by cost considerations. For example, oil prices are set in international markets partly by co-ordinating oligopolists who try to maximise their profits by restricting supply. Public campaigns, restrictions on the use of oil, taxes and other measures contribute to lowering the absolute level of demand, as well as making it more sensitive to changes in supply.

dollar tourist developments. The first example illustrates problems in reconciling competing demands concerning resources (wolves) for which there may be no markets. The second example shows the difficulty of predicting values of resources (beaches) due to changing tastes and incomes.

The total value to society of natural resources includes the different use, option, bequest and existence values of all individuals, and also reflect the values of ecosystem services. In practice, the value of flood prevention and soil retention could be assessed through their effects on commercial production and land values; but problems of estimating other unpriced natural resource values means that it is difficult to achieve consensus about the optimal amount of these services or who should pay for them (Box 10.5). Nevertheless, these valuation concepts are useful for thinking about priorities and how certain policies might affect total welfare.

Box 10.5. **Methods for valuing externalities**

Economists have developed various methodologies — hedonic valuation, travel cost, contingent valuation, among others — to estimate values of environmental benefits and costs that can be used in setting policy priorities and environmental standards. While in theory all values can be captured by the use of such methods, in practice it is exceedingly difficult to measure non-use values, such as the intrinsic value of whole ecosystems. In addition, when dealing with environmental irreversibilities (such as species extinction) and fundamental uncertainties (such as the extent of sea level rise from global warming) valuation is inherently problematic. Nonetheless, regulatory authorities are implicitly "valuing" resources whenever they prioritise funds to be spent on the protection of the environment or set environmental standards.

Natural resource management policy issues

The fundamental objective of the sustainable management of natural resources is to contribute to enhancing welfare through maximising the net benefits from resource use within the context of economic

development. That means taking into account commercial and non-commercial use, on-site and off-site effects, and the balance between use by current and future generations.[2] The challenges for natural resource management policy fall into two related categories: minimising resource degradation and addressing discrepancies between public and private returns from resources. The latter means ensuring that resources are used or preserved as efficiently as possible through "internalising the externalities" of natural resources and providing the right price signals and incentives.

Despite the fact that there has been hardly any evidence of overall scarcity in the supply of natural resources, optimising the rate at which local resources are depleted and minimising resource degradation are important issues. Natural resources differ in the degree to which their depletion or degradation is reversible, and maximising the net benefits of their use over time is not straightforward. The optimal depletion rate also differs across countries and over time due to different resource characteristics. The type of natural resource management and the level at which it is implemented (international, regional, national or local) may therefore vary between resources.

For *non-renewable* or exhaustible resources (minerals, fossil fuels and aquifer water), the main policy question is the optimal rate at which the remaining stock should be depleted. The answer to this question, in turn, depends on the uniqueness of the resource (i.e. what substitutes are available and at what cost), the opportunity cost of capital, expectations about prices, government taxes and regulations, and technological developments. Assessment is complicated by the existence of environmental and social externalities, which need to be taken into account.

For *renewable* resources, a central policy question is the choice between depleting them now, leaving them unharvested in a natural state, or pursuing intermediate strategies. Historically, virgin stocks of natural resources, such as timber and fish, have been initially exploited at rates exceeding maximum sustainable yield. This approach can lead to reduced annual yields for many years thereafter. Such a strategy can make sense from a commercial standpoint, but its environmental effects can be severe. Today, some fisheries management plans impose temporary reductions in harvesting levels in order to allow stocks to recover to a level where they will support a higher annual yield. The best of these plans anticipate the environmental, economic and social impacts of such transitional arrangements and include targeted measures to deal with them (see OECD, 2000).

In concrete terms, policy can have a role in relation to the sustainable development of natural resources by:

- Facilitating the development of property rights and markets.

- Removing subsidies that hamper sustainable resource use.

- Reducing resource degradation and enhancing the provision of environmental services.

- Improving the management of publicly owned natural resources.

- Reducing pollution by natural-resource-based industries.

- Dealing with information shortfalls.

- Addressing distributive implications of natural resource management policies.

Development of property rights and markets

Clearly defined, comprehensively assigned, secure and transferable property and use rights are a necessary condition for the efficient allocation of resources (including ecological resources) among competing uses. Clearly-defined rights are also necessary to indicate who bears responsibility for the environmental

consequences of resource use: who should be held to account for resource degradation and pollution, and who should be rewarded for resource enhancement and the provision of environmental services. The establishment of property rights for natural resources gives the owners of rights an incentive to optimise the exploitation of resources for different uses through time (OECD, 1999). In principle, tradable property rights will be allocated to the most efficient resource users, leading to optimum productivity of the resource. However, in the absence of complete property rights a particular attribute of a resource (e.g. an environmental service it provides) may not be developed or protected, leading to over-use of the unprotected resource attribute. In other cases, individuals may have an incentive to exploit a resource as much as possible in the short term before others exploit it. This often leads to greater-than-optimal rates of exploitation, as continues to occur in some fisheries, common pastures and forests.

A number of factors can impede the establishment of effective property rights:

- Negotiating effective access rights is especially difficult in large or dispersed groups, where there are information shortfalls and asymmetries. High transaction costs are often indications of such problems, and may be difficult to overcome.

- It is not easy to establish rights to resources that cannot be clearly defined (e.g. biodiversity) or where property rights are difficult to enforce (e.g. commercial fisheries, especially where the fish stock migrates over large areas).

- The establishment of access rights can lead to problems when rights are concentrated in the hands of a single owner or a small group of colluding parties. Equity and distributive conflicts can also be significant.

Access to *fisheries* resources was traditionally managed in "open" regimes, where no individual fisherman has the right to exclude other producers from harvesting any part of the resource. From an individual fisherman's perspective, leaving fish to grow and reproduce risks losing the fish to other fishermen or predators. Competition drives stocks below the optimum levels (i.e. the stock size that would yield the maximum returns from the resource). Fishermen thus impose an external cost on each other (and other potential users of the resource) in the form of lower future benefits. It is widely recognised that many fish stocks are over-exploited and that corrective measures are needed to ensure long-term sustainability of the fisheries sector.

To correct over-harvesting, governments have restricted access rights by setting up marine reserves, imposing input controls (e.g. licences that place a limit on the numbers of vessels that can participate in a fishery), output controls (e.g. individual fishing quotas), and technical measures (e.g. mesh-size restrictions). Typically, several different interventions are used in combination. Licenses to limit the entry of new vessels, and rights-based management systems (such as individual tradable quotas used in conjunction with technical measures), have improved the productivity, economic performance and sustainability of a number of fisheries. Changing institutional arrangements can also enhance a proprietary interest in the resource. Involving fishermen in decision-making processes (co-management) often yields promising results. The uptake of individual transferable quotas (ITQs) has been limited in part because their introduction can lead to a rationalisation of fishing activities (fewer fishers and vessels are needed to harvest a given quantity of fish) and a concentration of landings in the largest ports. Other reasons for their limited uptake include difficulties in establishing the institutional framework for ITQs, administrative problems, and fear of discarding less valuable fish. Governments have often eased the transition to ITQ-based systems by awarding quota rights to existing participants, overlooking the claims of the rest of society (OECD, 1997).

Fish are a mobile resource and most extend their habitat beyond national territorial waters. The international community has acknowledged the need for international action to preserve living marine resources by adopting various arrangements that provide a legal and institutional context for responsible fisheries. Among these, the United Nations Convention on the Law of the Sea (UNCLOS) signed in 1982 codified the 200-mile exclusive economic zones (EEZs) that had been introduced unilaterally by a number

of countries in the late 1970s. In 1995, states were encouraged to adopt two international agreements: the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (the "Compliance Agreement"); and the Agreement on Straddling Stocks and Highly Migratory Fish Stocks. Neither Agreement has yet received a sufficient number of ratifications to enter into force. The 1995 FAO Code of Conduct for Responsible Fisheries provides an important impetus for a move to responsible and sustainable fisheries.

At the international level, disputes over shared freshwater resources have arisen with increasing frequency in recent years, especially in conditions of low water availability, threatening political and environmental security. Two-thirds of the world's major catchment areas straddle national boundaries. Over 2 000 treaties and other administrative arrangements have been drawn up relating to the management of these common basins, and a substantial body of international law has developed around the issue. In many areas, however, mechanisms for resolving water-based conflicts are either non-existent or inadequate. Even within individual countries, tensions can develop between sectors or regions over scarce resources. One notable trend in recent years has been increasing competition between rural and urban water users. Such tension seem set to increase in the future.

Tradable permits for water abstraction and water pollution provide a promising approach to these problems. Several OECD countries have successfully introduced trading in water-use rights. The most active trading has taken place in the agriculture sector, where it has been facilitated by longstanding institutional stability, and for water supply emergencies. Tradable pollution rights are more complex, and examples are confined to specific pollutants such as salt, and organic and nutrient pollution. Water trading can affect many people other than buyers and sellers, such as recreational fishers. This means that the overall implications of trading schemes are complex and have to be carefully tailored to local conditions. More generally, water-trading schemes require substantial information, strong management institutions and consideration of equity issues. Lessons could be learned from the experiences of Australia, New Zealand and the United States in this area.

Removal of subsidies that have been shown to hamper sustainable resource use

Subsidising natural resource use can undermine sustainability in three respects:

- Excess productive capacity and effort are encouraged by those subsidies that lower production costs, reduce risks, or increase output prices. Higher levels of output in the short-term often come at the expense of production in later periods, distorting activity in favour of current production, resulting in too much environmental damage and not enough environmental benefit (public goods).

- The efficiency of resource allocation within the economy is reduced.

- Users receive distorted signals regarding scarcity, retarding the development of resource-conserving technologies, products and practices.

There is a long history of governments subsidising natural-resource-based industries. The OECD regularly measures support to agriculture (see Chapter 14), fishing, and coal mining, and has examined support to water consumption. Rates of support for some forest products, minerals and energy products (besides coal) are also high in some countries. While some of these support measures may include conditions intended to limit damage or ensure the proper use of natural resources, others do not. Taking into account both the positive and negative environmental and social effects of natural resource use calls for coherent resource management policies, which include a range of economic, regulatory and co-operative measures.

Subsidies that provide incentives for excessive natural resource use take many forms: direct monetary transfers, tax preferences, subsidised provision (under-pricing) of resources, and preferential rights to resource use. Examples are grants and tax incentives for land clearing. In certain ecosystems major adverse environmental impacts may occur through the provision of public services. For example, the economic

and social benefits of roads may be offset by the costs of fragmented habitat and environmental degradation. Under-priced water favours excessive rates of water abstraction thereby increasing pressures on fragile aquatic ecosystems. While roads and water are often described as socially important public goods, wealthy people often benefit more from them than do the poor, who also suffer more from adverse environmental impacts.

The removal of those subsidies that interfere with the sustainable development of natural resources will increase economic efficiency and can improve environmental and social outcomes. Table 5.3 in Chapter 5 provides some estimates of support levels in the OECD to several natural-resource-based industries. It should be stressed that these subsidy estimates do not distinguish between those that are harmful from those that are beneficial to sustainable development.

Mining of *minerals* is not generally subsidised, but the industry benefits from tax incentives for investment, depreciation or both. Incentives applied to petroleum products, such as subsidies or tax rebates on diesel fuel used in farming or fishing, can have important indirect effects on other natural resource industries, however.

In 1997, OECD countries spent USD 6.3 billion in government financial transfers to the fishing industry (OECD, 2000). Most *fisheries* assistance (for OECD countries, 77% of transfers in 1997) is spent on infrastructure and on activities that are essential for ensuring the sustainable use of fish stocks and the aquatic ecosystem, such as fisheries management, research and enforcement. The remainder was spent on support in the form of direct payments and cost-reducing transfers (e.g. modernisation grants, income support and tax exemptions). These transfers can encourage a build-up of capacity and an expansion of fishing activity. Direct payments and *ex-post* cost-reducing transfers (e.g. loan write-offs for vessel-owners who agree to quit operating in a particular fishery) are often used to reduce fishing capacity, but they can encourage the introduction of new technology and create spill-over effects in other fisheries. Possible negative effects of some kinds of transfers can be reduced or minimised when transfers policies and resource management policies are mutually supportive.

Historically, water has often been provided free or at less than full cost in OECD countries, (i.e. prices have not covered the costs of operation, maintenance and investment). This does not provide the right signals to bring about the efficient and sustainable use of water. Studies indicate that increasing water prices provide incentives for water conservation. Farmers react to changes in water prices, application costs and shortages, while householders also reduce consumption in response to increasing water prices. Comparison of OECD country level data show that household water consumption levels have fallen in those countries that have recently realised substantial increases in real domestic water charges. Industrial users are often even more responsive to changing water prices than households or agricultural users. OECD work has also shown that the adoption of water-conserving technologies depends crucially on what users are charged for the resource.

Reducing resource degradation and enhancing the provision of environmental services

Reducing resource degradation

Pollution, waste deposits, and inappropriate resource management practices have caused degradation of water and renewable resources. Examples of the former include the effects of effluents on water and fish, and the impact of air pollution on forests. The latter is illustrated by over-fishing, and logging without adequate allowance for biodiversity conservation. The under-provision of environmental services — such as habitat for biodiversity and environmental sinks — is largely due to their public-good characteristics, and to the imperfect development of markets and pricing mechanisms to provide incentives to supply enough of these services.

The main strategies adopted to deal with degradation have been regulation and instruments to enforce the polluter-pays-principle. Management practices have gradually improved, as the costs of sub-optimal management have become more apparent. Support for the provision of environmental services is more

recent and experience is more limited, but is important in some countries with respect to land-based activities such as forestry and agriculture. A range of regulatory, market based and voluntary instruments have been used (Box 10.6). Emphasis is switching to complement regulation with market-based mechanisms and voluntary, partnership-based arrangements.

Box 10.6. **Instruments for natural resource management**

Regulations play a key role in managing access to resources and enforcing the polluter-pays-principle, especially to prevent damage to human or ecosystem health. Examples include ambient standards for air and water quality, and waste disposal regulations. A precautionary approach needs to be considered in managing natural resources. In this respect, regulations are typically used to manage resources without established markets such as highly-diverse ecosystems, and to guard against uncertain impacts, such as those that could arise in association with a new technology. However, regulations are often costly to implement and enforce. And they can impose rigidities that do not reflect the diversity of situations and deter innovation or progress beyond regulated limits.

There is an increasing emphasis on market-based instruments, such as tradable permits, fees, charges and taxes for resource use or pollution. When appropriate, they are preferable to regulations because they maximise incentives and economic efficiency. Two types of market-based instruments are price rationing and quantity rationing. In the case of pollution control price rationing sets a charge for specific emissions without controlling total emissions. Comprehensive information on emissions is needed for implementation, and charges work best if there are relatively few polluters or pollution sites. Charges have been frequently used to handle point source air and water pollution. Quantity rationing involves establishing an overall quantity of emissions that are then allocated to producers, for example in a tradable rights scheme. Implementation requires establishment of the permit market and its rules, and monitoring trades to ensure the rules are maintained. Administration of the permit market can be expensive if there are a large number of traders, but the market may be inefficient and inequitable with a small number. Tradable permits have been used less often than charges, but they may prove more effective for dealing with non-point source pollution. Information requirements are the major constraints on both types of instrument.

Voluntary or negotiated agreements between an industry and government can provide a flexible framework for promoting better management. Examples range from the establishment of codes for environmental management, many of which are in accordance with the International Standards Organisation (ISO) 14001 framework, to project-specific agreements to provide infrastructure and training. Although voluntary agreements rarely produce major environmental improvements, and may be weakened by free riders, they can be a valuable complement to regulation and economic instruments. Examples include Canada's Accelerated Reduction/Elimination of Toxic Substances program and the US Environment Protection Agency's 33/50 initiative.

Largely as a result of public pressures, stricter controls have been imposed in most OECD countries on many of the larger sources of *freshwater* pollution, and many of the worst polluted water bodies are now being cleaned up (albeit often at fairly high cost). Non-point source pollution such as nutrient-laden run-off from agricultural land remains a problem (see Chapter 14). Baseline quality standards for inland waters (i.e. suitable for fishing and swimming) are not always met in OECD countries. Most countries have also had difficulty protecting groundwater quality, especially from non-point sources. Nitrate concentrations in excess of WHO drinking water guidelines are now widespread in some European and North American aquifers. Available evidence suggests that there will be a continued worsening of aquifer water quality in the future. Once groundwater sources are contaminated, they can be very difficult to clean up because the rate of inflow is usually very slow, and purification measures are often costly.

The 1990s have seen many policy changes with respect to *forests*. Countries have revised their forest laws to give more prominence to environmental outputs. More stringent controls have been placed on forest management practices and on the harvesting of natural forests.

Fishing practices have been modified to reduce the harm done to non-target species and to the marine ecosystem in general. For example, governments have recently prohibited the use of drift nets for harvesting certain species, and occasionally closed fisheries when species have been threatened.[3] Several governments have also strengthened monitoring, control and enforcement activities in their fisheries.

Measures to protect endangered wild *flora and fauna* have traditionally been regulation-based. Specific examples include restricting tourist-related activities on the coastal part of Laganos Bay in the Greek island of Zakynthos to protect the loggerhead turtle; imposing a ban on hunting the Asiatic Black Bear in Korea; and prohibiting agricultural activities in a newly-established national park in Austria. However, such measures can be effectively complemented and enhanced by market-based instruments (MBIs) in some areas. Managers of publicly owned zoological parks and nature reserves, for example, have found that many people are willing to pay an entry fee if they know the revenues will help towards the protection of endangered or threatened species and ecosystems. Other examples of MBIs affecting prices are visitor's fees in national parks, and taxes charged for groundwater abstractions, which have been imposed in the Netherlands in order to slow down changes in the local flora caused by falling groundwater tables. MBIs can also affect quantities or quality levels. Examples from OECD countries include individual transferable quotas for non-target marine species in New Zealand and Iceland, fisheries tradable development rights and "wetland banking" in the United States, and tradable hunting rights in the United States and Mexico.

Provision of environmental services

One of the biggest challenges for natural resource policy is incorporating non-commercial considerations, including non-use values such as biodiversity, into resource management decisions. Traditional water management policies partly ignored the ecosystem effects of regulating water flows. Forestry management did not take account of the role of forests in providing habitat and maintaining biodiversity. Fisheries management defined optimal harvesting rates for commercial species, sometimes without taking account of by-catches of mammals, birds and non-commercial species and other environmental impacts of fishing.

Traditional *water*-management practices, especially in arid and semi-arid areas, have often ignored the effects of regulating flows of previously untamed rivers on aquatic and associated wetland ecosystems, leading to the retreat or disappearance of unique ecosystems once dependent on larger and irregular water flows. That situation is changing. The Australian Water Reform Framework acknowledged "the environment as a legitimate user of water." In the United States, steps are being taken to restore some of the water flow to the Everglades, a unique wetland ecosystem threatened by agricultural pollution and urban development. In the 1980s, the Netherlands modified the design of its storm-surge barrier across the mouth of the Oosteschelde estuary so as to allow water to flow freely through the estuary except on the rare occasions when the barrier is in use.

Recently the emphasis of support for *forestry* has been shifting from commercial operations towards social and environmental objectives. A key policy issue is the appropriate level and type of intervention needed to optimise the supply of non-industrial forest services. In the 1990s most OECD countries adapted their forest legislation to include biodiversity conservation. Countries have also adopted criteria and indicators for sustainable forest management. Some countries have introduced area access or use regulations (e.g. hunting bans), but many countries have set-aside certain forested areas (e.g. those that contain particularly rich or endangered ecosystems), rather than regulate their use. Throughout the temperate world, there is a movement, driven by governments and environmental non-governmental organisations (NGOs), toward the certification of forests as meeting sustainable management standards. Countries have developed criteria and indicators of sustainable forest management, reflected in the Helsinki Process in Europe and the Montreal Process and Santiago Declaration for non-European temperate countries, including the United States and Canada.

Many OECD countries have introduced payments to compensate forest owners for income loss resulting from activities that protect biodiversity. In Finland, the Act on Financing Sustainable Forestry came into force in 1997 and several instruments are used to preserve biodiversity (Box 10.7). Other OECD countries have taken similar initiatives to manage their forests in a holistic way, incorporating all their functions, including

recreation, conservation of biologically diverse ecosystems and fibre supply. At the EU level, the *Natura 2000* Directive provides for payments to local stakeholders, including forest owners, although the level of compensation raises considerable debate. In New Zealand, some Maori tribes have been compensated for not harvesting wood in indigenous natural forests that they own. In the United States, constitutional provisions for compensation have not been implemented, but one-time payments are sometimes granted to forest owners under various contractual and easement programmes — many financed by non-governmental organisations and charitable trusts. Issues that arise with these initiatives are the need to separate commercial and non-commercial outputs, and to encourage private production by supporting the development of markets for non-commercial outputs.

Box 10.7. **Initiatives to preserve biodiversity in Finland**

Purchases of forest land by the State are mainly directed at old forests, the most important biotopes from an international perspective. The share of old forests in total forest land has decreased dramatically during the last century and now accounts for between 2-3% in the South and up to about 20% in some areas in the North. Since 1997, a considerable amount of private land has been purchased for nature conservation purposes. The funds for such purchases have almost doubled between 1996 and 1998 (from FIM 184-362 million a year), and most were dedicated to the acquisition of old-growth forests. Recent government initiatives pay special attention to the regulation of private forests, accompanied by subsidies to cover part of the costs and information on better forestry practices. The Forest Act defines particularly significant habitats in commercial forests where management has to be carried out in a way that retains their characteristics. Courts can penalise the violation of the law. To compensate for income losses due to protection costs, the Act on Financing of Sustainable Forestry provides funding to private forest owners. When landowners can demonstrate that environmental measures reduce the yield substantially they may ask for compensation. Losses exceeding 4% of the logging value or FIM 40 000 are compensated.

Consideration is being given in some countries to the further development and creation of markets that reward sustainable resource use, conservation and the provision of habitats and other biodiversity-enhancing activities. This involves industry financing of carbon-fixing afforestation programmes, through a global market of carbon rights — subject to such arrangements not being used by industry as a loophole to avoid CO_2 emission reduction.

Management of publicly owned natural resource based assets

Governments continue to be heavily involved in the management of some natural resource related infrastructure, especially for water, for which large investments are likely to be required in coming decades. In the OECD region, most countries have already achieved access rates to public water supplies in excess of 90%. Access rates to public sewage systems are much more variable. An estimated 59% of OECD populations had access to wastewater treatment in 1995, up from 51% in 1980.

Global investment in *water services* — excluding that undertaken directly by industry as part of establishment costs — is currently USD 70-80 billion a year (Table 10.1), the largest investor of which is government, contributing about USD 50 billion a year. The local private sector, ranging from small water vendors to private municipal and metropolitan utilities, contributes around USD 15 billion. International donors contribute a further USD 9 billion for water and sanitation services, and irrigation and drainage. The international private sector contributes about USD 4 billion a year.

Table 10.1 suggests that annual investments in water infrastructure will have to more than double, to USD 180 billion, over the next 25 years in order to meet future needs. Private firms are likely to be the main source of this finance, and local communities will need to contribute much in cash and in kind. Government will finance a smaller share in direct capital investment and maintenance costs for traditional water supply projects. This has the potential to free up public resources (and softer loans and grants) for water-related

Table 10.1. **Annual worldwide investment requirements for water resources**

Area	Billions of USD		Share (%)	
	1995	Estimate 2025	1995	Estimate 2025
Agriculture	30–35	30	43–50	17
Environment and industry	10–15	75	13–21	41
Water supply and sanitation	30	75	38–43	42
Total	70–80	180	100	100

Source: Cosgrove, William J. and Frank R. Rijsberman (2000), *World Water Vision: Making Water Everybody's Business*. London: Earthscan Publications for the World Water Council.

projects that supply public goods. These include flood management and environmental protection, which will take a larger share of overall investment. Resources could also be used for subsidies to low-income users to help defray the higher cost of their minimum water and sanitation needs. This explicit subsidy element accounts for the need for government cash flows to remain at current levels, making total cash requirements greater than direct investments shown in Table 10.1.

The more investments are made in water infrastructure, the more important the management of these facilities will become. Under the right conditions, the *private sector* can make a significant contribution to improved management of water utilities. As governments strive to reduce expenditure and to decentralise authority over local services, the role of the private sector in water infrastructure is likely to grow. It will be important to find appropriate avenues for exploiting this opportunity. The increasing *decentralisation* of management authority for water utilities is also placing stress on the capacity of the public sector itself to manage various components of these services. Even in the absence of private management, the public sector's management capacities are increasingly likely to come under scrutiny.

Greater involvement of water users, including private firms and communities, is a critical element of successful strategies for the sustainable management of water resources. Social instruments designed to modify water user behaviour to increase the efficiency of use and to conserve water (such as education, information, and partnership strategies) are needed to foster both user "ownership" and responsibility in water resources management. In a number of cases, governments have gone beyond simply a "public consultation" process in making water management decisions, and developed a broader multi-stakeholder process involving water users in the development and implementation of water management policies. In some cases, the full management of irrigation water systems has been transferred to water user associations, placing the responsibility for the sustainable use of water resources and the recovery of the costs of supply in the hands of the irrigation users.

While two-fifths of OECD forested land is privately owned, with large variations across countries, the long-term trend in many OECD countries has been an expansion of public forests as a result of acquisition and afforestation. That trend is being reversed, notably in the countries in transition. Publicly owned forests are normally obliged to provide a range of goods and services demanded by the public. Privatisation may increase efficiency in wood supply, but also some loss of public access to forests, and reduced supply of environmental services. Intermediate solutions are the transfer of forestry operations to the private sector, while leaving the land in public hands (as is done in Canada) or contracting the provision of environmental services to forest owners. In some countries (e.g. the Nordic area), public rights to certain forms of recreation, such as hiking and mushroom gathering, are kept when forests are privatised.

OECD experience attests to the importance of transparency, fairness in government dealings with landowners, and local community participation in the provision of forest services. Non-governmental organisations may assist in identifying priority areas for protection, and help secure public and private sector support for sustainable natural resource management. Facilitating public participation through disseminating information assists the implementation of regulations and incentives, and the development of new markets for forest services.

Reducing pollution by natural-resource-based industries

Degradation and pollution of natural resources by other activities is a much more significant issue in the sustainable development context than pollution (which is nevertheless important) from natural-resource-based industries (with the possible exception of intensive agriculture).

The minerals industry faces a broad range of regulatory requirements, especially aimed at controlling emissions into the environment and their impacts. Regulatory approaches are often effective in achieving environmental goals, but they are often costly and do not provide incentives for companies to move beyond strict compliance. The emphasis has shifted from centralised decision-making with detailed regulations towards the setting of clear standards and provision of information. Emission limit values and conditions will continue to be based on technology benchmarking — i.e. best available technology — whereas environmental quality targets can push further improvements both at the local and regional levels.

Most countries screen mining projects through environmental impact assessment processes. The effectiveness and efficiency of these procedures depend on the input of the developers, the degree of rigour applied in independent reviews of their proposals, the account of consultation with affected parties, and the effectiveness of enforcement of licence conditions.

OECD governments usually require extensive reclamation and rehabilitation of mine sites. Best practice requires mine closure and rehabilitation to be planned during the life of the mine, and carried out progressively as areas are worked out or as waste dumps become full. In Australia, Canada and the United States, performance bonds have provided an effective incentive for compliance with licence conditions and to ensure that adequate rehabilitation is carried out once mining operations cease. Fines are common for infringement of environmental regulations or licence conditions.

The use of *uranium* raises some very sensitive environmental issues at each step of the fuel cycle. Environmental impacts of uranium mining and milling activities are monitored, minimised and eventually mitigated. Assessments of current practices for licensed facilities in OECD countries have shown that the tailings (spillover effects) can be effectively managed over long periods with minimal long-term health and environmental impacts. Future uranium mines in OECD countries will undergo close environmental scrutiny before being allowed to operate.

The management and safe disposal of *nuclear waste* is a high priority in the context of sustainable development. Radioactive waste comprises small volumes that may be isolated from the biosphere at acceptable costs. Repositories for the disposal of short-lived radioactive waste are in operation in most OECD countries and in many non-member countries, and long-lived radioactive waste is currently being held in safe interim storage facilities. Long-lived nuclear waste remains toxic for a very long period — for several thousands of years in some cases — and has to be isolated from the biosphere as long as it is potentially harmful. For the long-term, geological disposal has been recognised by several OECD countries as a strategy responsive to this fundamental ethical and environmental problem.

Dealing with information shortfalls

Good and effective natural resource management policy requires sufficient and relevant information, particularly on:

- Stocks, flows and depletion of commercial resources.

- Technologies, recycling and substitution.

- Physical properties, values and demands for environmental services provided by natural resources (including the effects on services of reductions in resources), and links between resource exploitation and these services.

Information on commercial resources and their values is readily available but less is known about links between natural resource exploitation and ecosystems and the values of non-commercial outputs. In particular there is a great deal of *uncertainty* about the long-term environmental and economic impacts of natural resource degradation. Such shortfalls could lead to biases in favour of more (or less) rapid depletion, or incorrect assessments of the environmental implications of policies. In relation to fisheries, information on resource levels is not always readily available. Moreover, as a migrating living resource, the information that is available has a greater level of uncertainty than for other natural resources. Scientific knowledge regarding the complex interactions between harvesting, ocean conditions, and other stocks (predator and food sources) is improving but remains imperfect.

In the 1990s, OECD countries made considerable progress in providing information to the public on the expected environmental impacts of new technologies. For example, environmental data, indicators, state-of-the-environment reports and other types of reports, many accessible over the Internet, are now provided by many governments on a routine basis. Enterprises more commonly provide environmental information on a voluntary basis or as part of their obligations (e.g. Pollutants Release and Transfer Registers). Considerable research has been done on the links between natural resource exploitation, environmental services provided by natural resources and ecosystem productivity. But more is needed.

Concerning monitoring and enforcement, the pressure to improve environmental quality comes primarily from government regulators. Continuing practical difficulties have been experienced in providing information in the public domain, for example because of scattered sources of information, inadequate electronic communication infrastructure and confidentiality constraints.

The proliferation of NGOs has contributed to widening stakeholder involvement in conservation and sustainable resource use. Further, communities have increased their level of involvement, both deriving local benefits from conserving ecosystems or demanding conservation in general. Facilitating public participation through gathering and disseminating information not only assists in improving regulation and its enforcement but also in the development of new markets. Box 10.8 includes two illustrations of information provision issues.

Box 10.8. Two examples of information provision

Increasing consumer awareness of the safety and quality aspects of food in general, and fish in particular, have prompted several governments to set minimum quality standards for fish products and to encourage private industry to develop and adhere to quality control systems. A number of operators have schemes that seek to inform consumers on the origin of, and the methods used to produce and process, the products they purchase. In this regard, and complementing an early implementation of the FAO Code of Conduct for Responsible Fisheries, the development of marketing practices and improvement of consumer information can enhance the move to more responsible fisheries.

Current forest inventories essentially evaluate changes in stocks of timber. Closer monitoring of changes in forest area, including biodiversity and carbon sink indicators, could facilitate policy-making in the area of sustainable forest management. It raises some important issues, however. First, establishing parallel monitoring schemes (for timber and for the environment) would be expensive. Instead, it would be useful to expand the scope and reduce the periodicity between two forest inventories and adopt the concept of continuous national monitoring. Second, there is a need for harmonisation of monitoring methodologies being used by OECD countries.

Addressing distributive implications of natural resource management policies

Choices between conserving resources to preserve the capital base for future generations and consuming natural resources to benefit current generations invariably involve trade-offs and questions about how the

benefits are likely to be distributed within society. Will certain choices both reduce poverty and improve the distribution of wealth? Could the earth's ecosystem sustain the high pressure on natural resources that would result if all countries adopt lifestyles similar to those prevailing in most OECD countries? These are difficult questions, but their answers depend in part on the resource management decisions taken by OECD countries.

The distribution of resource rents

When resources are privately owned and traded, rents tend to become explicitly incorporated into the purchase price of property, be it a hectare of forest land or a quota for the right to catch fish. When the resources are vested in the state, rents tend to become implicitly incorporated in the value of resources, and government managers or political governing bodies must decide how to collect, spend or invest those rents.

Practices vary among countries and across different natural resources. In the case of privately owned agricultural and forested land, it is common for many governments to tax the market value of the property. Access fees are typically charged for publicly owned rangeland and forests, and royalties from non-state-owned producers of oil, gas and minerals. Examples of government attempts to capture resource rent from water users (especially farmers) are rare, as are attempts to levy resource rent taxes or auction off property-rights in fishing. While a few countries collect special fees to pay for government-provided services (such as monitoring and research costs), these are not directly related to the economic rent derived from the resource. Understanding the origin, valuation and expenditure of resource rents is an area in which further analysis would be useful (see Daly and Cobb, 1989; Roodman, 1998).

Transition to sustainable resource use

Much progress has been made in developing policy frameworks for the sustainable management of natural resources. Yet the actual transition to such policies — which is now overdue — is likely to give rise to adjustment and distributive problems, creating resistance to policy change. Because some natural-resource industries suffer from imbalances, such as excess capacity or over-exploitation, a major focus of current OECD work is on ways of "managing the transition". This is an area where the trade-offs between natural resource sustainability and social implications are most evident.

Managing the transition to the sustainable use of natural resources is complicated by the age of some of the industries involved, and the complex web of laws, traditions and property rights that have evolved along with them. Inappropriate incentives over time create expectations that are costly and painful to change. Many government financial transfers, including those provided through sector-specific policies, may have contributed to structural imbalances. Yet adjusting use levels may create short-term redundancies in capital and labour.

Around 40 million workers (including 32 million farmers) are directly employed in primary industries in OECD countries. Many of these workers have specialised skills, but often have low formal education: it is the workers with the best skills (highest opportunity costs) who are most adaptable and attracted to alternative activities. Moreover, because the activities of primary industries tend to be carried out in rural and remote areas, alternative employment opportunities for these workers may be limited. The transition to more responsible fisheries provides a salient example of a difficult process that can involve significant short-term costs in order to realise long-term gains. This underscores the importance of identifying the costs and gains of different transition strategies.[4] OECD work on agriculture (OECD, 1994) and fisheries (OECD, 2000) has stressed the importance of: training and other measures for redundant workers; ending policies that encourage young people to seek employment in industries that lack the resource base to sustain them; and developing new economic activities that build on enhancing local environmental amenities. Deploying displaced workers to environmental restoration projects (as is happening in fisheries and uranium mining) can sometimes help to ease adjustment problems and improve the environment.

Social issues are also being increasingly highlighted in the context of mining. While the development of new mines brings economic and social benefits, such as new jobs, its social impact on a small community

can be significant. It is a process that many mining companies realise needs to be carefully managed. Accordingly, some of them are developing approaches that take local and traditional values into account from the start of the mine-planning processes.

Conclusions

Warnings about shortages and limits of material stocks of natural resources have been recurrent throughout history. However, the increased demand for natural resources through time has been met by supply at real prices that have generally fallen or not increased over the long term — a characteristic of abundance, not scarcity. This has been due to improved productivity, technological developments, new sources of supply, availability of substitutes, and increased efficiency in resource-using production processes. The key driving forces have been technological progress and the information and incentives provided by markets.

But many ecosystems are currently under stress. There are pressures on the sink and purification capacity of the environment — i.e. in the possibility of disposing safely of the waste streams generated by the production and use of natural resources — and on the production capacity of renewable resources. The generally positive trends in the economic efficiency of natural resource use therefore have to be viewed in the wider context of sustainable development. Prices for the provision and use of resources have not always taken into account either the full cost of resources or environmental effects. Subsidies and under-pricing have caused market distortions, leading to over-use of some resources, inappropriate production practices, and ultimately detrimental effects on sustainability. Oligopolistic pricing has also distorted prices in markets for some natural resources. In either case, there is little incentive for the private sector to provide environmental services such as biodiversity that have the characteristics of public goods. And with the projected increase in population and income, there are fears that increased pressure on resources — in particular, freshwater in some locations — could lead to increases in prices, which could in turn hamper economic growth and aggravate social problems among the poorer groups in society.

In the case of water, though demand is being met in aggregate, there are regional and local problems: shortages, inadequate quality, threatened aquifer supplies, and slow uptake of resource saving. The supply of forest resources has kept pace with demand, but some fisheries resources are over-exploited. Environmental degradation from resource use poses a larger problem than resource scarcity. Some degradation arises from non-renewable resource exploitation but the major challenges are to prevent the degradation of renewable natural resources (water, forests, fisheries and biodiverse or unique ecosystems), and to maintain or enhance related environmental services.

Effective and clearly defined ownership and access rights are a pre-condition for efficient resource allocation and the creation and well-functioning markets. OECD countries have taken a range of national and international initiatives to improve management and to develop tradable rights and enforceable technical regulations to address over-fishing. Tradable rights are also being used to manage some water resources.

The emphasis in natural resource management policy is shifting today towards preventing resource degradation and maintaining non-commercial environmental services, especially those dependent on biologically diverse ecosystems. Some OECD countries have taken steps to recognise environmental uses of water. A range of market and partnership-based mechanisms to conserve biodiversity, sometimes at the local level, are being developed to complement regulations.

The distributive implications of resource management are becoming more significant as an issue in sustainable development and involve trade-offs between inter- and intra-generational equity. This is a key concern in the transition to sustainable resource usage.

The priority for policy-making is to facilitate the operation of well-functioning markets to ensure that natural resource providers and users face market signals that contribute to the sustainable management

of natural resources within an ecosystem framework. Good governance, particularly within those domestic and international institutions responsible for managing natural resources, is essential to ensure the best possible outcomes (see Chapter 4). Specific actions will of course need to be adapted as necessary to take into account the specific characteristics of different natural resources within each country. Those actions that policy-makers should consider include:

- *Addressing market failures and public goods*, through the establishment of clearly defined and enforceable property rights and institutional frameworks, so that resource providers and users are aware of their obligations to take account of the environmental effects on other sectors and resources of their actions (e.g. through greater application of the polluter-pays-principle, and the use of quotas in fisheries); encouraging the development of market-based approaches, such as tradable permits and licences; and finding ways to ensure the provision of public goods, such as biodiversity, at the appropriate level (local, national, international), through a mix of market instruments, regulation (including zoning and creation of nature reserves), and co-operative approaches.

- *Undertaking research on non-market natural resource values,* especially in cases where there is no incentive for private commercial enterprises to take account of the existence values of, for example, biodiversity; assessing the demand and costs of alternative supplies of natural-resource values; and encouraging research into technologies that enable more efficient and cleaner resource extraction and use, and lower the cost of recycling.

- *Phasing out those subsidies deemed to be harmful to the sustainable management of natural resources* — notably, domestic output and input subsidies, tax advantages, market-price support, under-pricing of natural resources that distort decisions on allocation, and practices that contribute to natural resource depletion and environmental degradation.

- *Improving policy transparency* through the provision of comparative and consistent information on: natural resource use, depletion and recycling, as well as the economic, environmental and social effects of these actions; the level, type and characteristics of subsidies and other policy instruments; the policy decision-making process (i.e. targeting, tailoring, sequencing, time horizon of policies) and institutions; the analysis, monitoring, assessment and flexibility of policy actions; and sharing experiences across countries to identify best policy practice.

To contribute to the design of appropriate actions, policy-makers should consider three sets of *indicators*:

- *Prices of key natural resources,* adjusted for inflation and the effects of under-pricing, oligopolistic pricing, subsidies, and externalities — as indicators of trends in the abundance or scarcity of natural resources. Projections of trends in prices under alternative scenarios would also be valuable, as "early warning" indicators of possible risks to resource availability. These indicators could be included in the *OECD Environmental Outlook* and other OECD publications.

- *Level and composition of subsidies*, both explicit and implicit (e.g., under-priced water) for natural resources (resulting from policies). As far as possible, these calculations should be undertaken on a timely basis to enable consistent cross-country and temporal comparisons; the calculation of the level and composition of support to agriculture in the OECD, which uses a well-established methodology, provides a useful framework and a starting point to measure and classify support measures as either harmful or helpful to sustainable natural resource management.

- *Rates of resource depletion, degradation and recycling,* in conjunction with real price trends, to draw attention to (actual and potential) risks to the supply and demand of specific natural resources, thereby indicating areas potentially requiring policy action. For some natural resources, where there is a large degree of uncertainty as to the supply/demand balance and possible severe negative effects from shortages, there is a need to establish scientifically designed reference levels that can be used to trigger precautionary action.

NOTES

1. Resources are found in nature (e.g. trees, fish, ore, petroleum), whereas materials are the usable substances produced from resources (e.g. wood or fibre, fish fillets or meal, metals or fertiliser, plastics or diesel fuel).

2. Discounting and intergenerational problems are extensively discussed in the economics literature; see, e.g. Portney and Weyatt (1999).

3. In addition, international co-operation is being used as an extension of individual countries' action. Examples include the UN Regional Seas Conventions (with 39 protocols) and the Arctic Council (which is comprised of Canada, Denmark, Finland, Germany, Greenland, Iceland, Norway, Russia, Sweden, the United Kingdom and the United States).

4. In fisheries, this work could be followed up by an analysis of the net benefits to fishers, and to society at large, of rebuilding depleted stocks.

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Chapter 11.

CLIMATE CHANGE

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Introduction

Global climate change will challenge sustainable development in the 21st century. In particular, changes in atmospheric temperature, sea levels, and precipitation patterns will impact on the natural environment, agricultural activities, human settlement and health, and will impose large direct and indirect economic costs on human populations. Rapid change in climate may also lead to irreversible changes in the natural environment and threaten vulnerable ecosystems, through habitat loss and the extinction of already endangered species (Watson 2000).

Climate change is inter-linked with other global, national and local environmental problems and development challenges. Global environmental links include loss of biodiversity, deforestation, stratospheric ozone loss, desertification and freshwater degradation, all of which are aggravated by climate change. Because these problems are linked through the same physical, chemical and biological processes, policies to respond to climate change could aggravate or improve other areas of concern (UNEP *et al.,* 1998). Population and economic growth — along with fossil-fuel production and use, land use, human settlement patterns and related infrastructure — are also linked to climate change. At the local level fossil fuel use, for example in road transport, leads to greenhouse gas emissions and lower local air quality, a significant human health concern in urban areas.

As with other policies for sustainable development, climate change policies have implications for global and domestic equity, within as well as between generations. The impacts and costs of climate change are likely to be unevenly distributed among major world regions and sectors. Assessments by the Intergovernmental Panel on Climate Change (IPCC) indicate that the majority of harmful effects will occur in developing countries where the ability to adapt is limited (IPCC 2001*b*). Although industrialised nations have caused the bulk of past emissions, most are not likely to suffer the worst impacts of climate change. The long time horizons, and the uncertainty surrounding possible climate futures, also present a particular dilemma to politicians and policy-makers. Governments are asked to provide leadership and take action that incurs costs today to reap global benefits for future generations. Inaction risks imposing significant costs on future generations and widening future economic disparities among developed and developing regions of the world.

Effective responses require, first, establishing sound and acceptable policy objectives to address climate change and, second, modifying economic incentives and other policies to take these objectives into account. The central challenge is to set objectives and design climate change policies to properly balance social benefits and costs, in the context of equity concerns and real-world constraints.[1] A mix of policies will be required to work across different time scales (near to long term), spatial scales (local, national/regional and global) and institutional actors (enterprises, governments and civil society) (Rayner and Malone 1998). The range of responses will need to encompass both mitigation and adaptation to climate change.

The nature of the problem

Scientific consensus attributes the enhanced greenhouse effect,[2] and much of observed global warming, to a human-induced increase in atmospheric concentrations of greenhouse gases (GHG) with radiative forcing

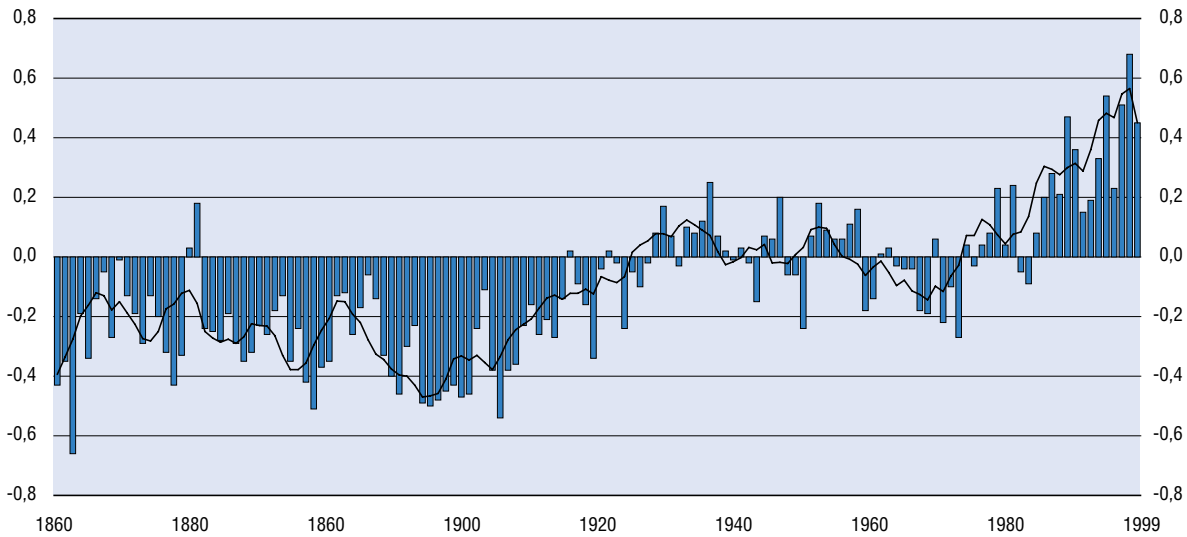
properties (IPCC 2001a). Changes in atmospheric concentrations of GHG are the result of increases in cumulative emissions. Emissions of carbon dioxide (CO_2), from fossil fuel combustion and land use change, presently contribute roughly 60% of the enhanced greenhouse effect, while methane (CH_4) accounts for 15-20%. This is due in part to differences in the atmospheric lifetimes of GHG. For example, methane is estimated to have an atmospheric life of only 12 years, whereas CO_2 survives much longer (50-200 years). Other long-lived gases include nitrous oxide (N_2O), with a lifetime of 120 years, halocarbons (HFC, PFC) and sulphur hexaflouride (SF_6), which have lifetimes ranging from several hundred to tens of thousands of years (IPCC 1996a and 2001*a*). Global warming effects also occur through changes in ozone concentrations in the upper and lower atmosphere and through aerosol emissions, which have a cooling effect.

Fossil fuel combustion is the largest source of man-made GHG emissions. It leads to increases in CO_2 and aerosol emissions, while coal, oil and gas production are also an important source of CH_4. Although properly managed land-use removes carbon from the atmosphere, certain land use changes, especially forestry and agriculture practices, accelerate the release of carbon stored in vegetation and in soils. Intensive agricultural production and waste management practices are the major sources of CH_4 and N_2O emissions, and industrial chemical use in consumer products and production processes release halocarbons (HFC, PFC) and sulphur hexaflouride (SF_6).[3] Overall, fossil-based energy use and production — linked to growth in population and economic activity — is the dominant source of GHG emissions.

Impacts and vulnerability

The potential for large impacts, mainly on future generations, places climate change high on policymaker's agendas. Recent evidence indicates that human-induced global warming is already occurring. Despite large variations from year to year, global mean temperature has risen significantly over the last hundred years. In the past century, the temperature rise was faster and lasted longer than at any period over the past thousand years. The 1990s decade was the warmest on record for the Northern Hemisphere (see Figure 11.1). A range of other indicators confirm global warming, including increased precipitation in the Northern Hemisphere, decreased snow and ice cover, sea level rise and ocean heat increase (The UK Met Office, 2000; IPCC 2001*a*). Evidence suggests that most of the global warming observed in the last fifty years can be attributed to human influence (IPCC 2001*a*).

Figure 11.1. **Annual anomalies in average near-surface temperatures, Northern Hemisphere, 1860-1999**



Note: Annual observations (bars) and ten-year moving average (line).
Source: The UK Meteorological Office (Hadley Centre)

Based on the range of climate sensitivities and of plausible ranges of GHG and sulphur dioxide emissions reported by the IPCC, climate models project that global mean surface temperature could increase by about 1.4 to 5.8 C° by 2100 (IPCC 2001*a*).[4] The projected rate of warming is much higher than observed changes in the 20th century and is likely to be higher than that experienced in the last ten thousand years. Precipitation is likely to increase, though projections vary by region (e.g. decreases in precipitation levels in subtropical areas), as do projections for related impacts such as increased frequency and severity of drought. A continued decline in glacier mass is also foreseen, as well as a continued decline in snow cover and sea ice, especially in the Northern Hemisphere. For the next 100 years, the scenarios also show a wide range of possible sea level rise, from 9 to 88 cm (IPCC 2001*a*).

The impacts of climate change will vary by region. Changes in temperature and water supply and quality will impact on agricultural production, human settlement and health, biodiversity and animal migratory patterns. Adverse impacts could partly be offset by some positive impacts, such as increased agricultural productivity in some regions of the Northern Hemisphere, and lower energy use due to warmer winter seasons. Even in the Northern Hemisphere, effects will be varied — forest productivity is expected to increase in northern Europe and decrease in southern Europe (University of East Anglia, 2000). Overall, studies show that some of the most adverse effects will be in developing countries, where populations are most vulnerable and least likely to easily adapt to climate change (IPCC 2001*b*).

Global agricultural production might not be significantly affected by global mean surface temperature changes of less than 2 degrees C°, but agricultural productivity is projected to decrease with greater warming. Crop yields and changes in productivity due to climate change will vary considerably across regions, with productivity projected to increase in middle to high latitudes — depending on crop type, growing season, changes in temperature regime, and seasonality of precipitation. However, in tropical and subtropical regions — where some crops are near their maximum temperature tolerance and where dryland, non-irrigated agriculture dominates — yields are likely to decrease for even small changes in climate. This is especially true in Africa and Latin America, where decreases in overall agricultural productivity of up to 30% are projected during the next century (Watson, 2000).

A number of other negative impacts on ecological and socio-economic systems may also emerge as a result of human induced global warming (Box 11.1). These include higher frequency and intensity of droughts, in particular in areas already suffering from low precipitation, such as central Asia, northern and southern Africa, the Middle East, the Mediterranean and Australia. Some developing countries located in arid and semi-arid areas are already experiencing high water stress and could be particularly vulnerable to increased drought or changes in precipitation patterns. Related problems of food security, water supply and quality, already difficult in some of these regions, could worsen (IPCC 1998 and 2001*b*). In countries

Box 11.1. **Desertification, biodiversity and climate change**

The links between global and local climate, natural habitats and land degradation are many, complex and varied. At the global level, deforestation, land degradation, and desertification contribute directly to increasing the concentration of CO_2 in the atmosphere, as they reduce vegetative cover and impair the water retention capacity of the soil, thus diminishing the ability of vegetation to store carbon. Deforestation and desertification have already caused a substantial release of soil and other terrestrial carbon to the atmosphere. At the local level, deforestation increases soil erosion, reducing fertility and agricultural productivity. Since forests are habitats to a large number of species, their degradation results in direct loss of biodiversity; in turn, land degradation can lead to desertification and is a major cause of food insecurity. Climate change is also expected to significantly affect the resilience and productivity of many ecosystems, which impact on both terrestrial and marine species. Even minor changes in key environmental variables such as temperature or salinity, for example, can greatly affect the abundance, diversity and distribution of fish populations. Many interactions between biological processes and climate could also initiate or reinforce drought in certain regions with significant socio-economic consequences (UNEP *et. al* 1998).

particularly dependent on climate sensitive natural resources, such as small island nations, human settlements and economic livelihoods will be threatened. Another impact of climate change in tropical, subtropical, and less well protected temperate zones is likely to be an increase in the geographic spread of vector borne diseases, including dengue fever and malaria (WHO 2000; IPCC 2001*b*).

The risk of unprecedented rates of change, as well as of irreversible or non-linear changes, could make it difficult or impossible to adopt successful adaptation strategies. In the case of ecosystems, species of flora and fauna already threatened by extinction face even greater risks with climate change, as they are unlikely to be able to adapt to rapid changes in temperature, habitat, or both. In addition to biodiversity and species extinction, other possible changes are: (*i)* a possible reorganisation of the thermohaline ocean circulation in the North Atlantic resulting in a more southerly course of the Gulf Stream, which would significantly affect the climate of western Europe; (*ii)* a possible reduction of upper level ocean cycling in the southern ocean; and (*iii)* a possible (but unlikely) rapid disintegration of part of the Antarctic ice sheet with dramatic consequences for the global sea level (IPCC 2001*b*).The risk of irreversible change calls for preventive measures.

Estimated costs of climate change

Costs of climate change are largely unknown, partly because the likely physical impacts of climate change are not easy to predict in sufficient regional and local detail. Even for the broadest of indicators such as global mean surface temperatures, there is quite a wide range of uncertainty attached to the IPCC projections. Temperature changes and, more importantly, changes in the quantity and distribution of precipitation will certainly have economic consequences, both positive and negative. However there are no robust estimates of the economic and social costs (IPCC 2001*b*).

Several studies have attempted to assess the impact of climate change on human welfare in quantitative terms. While the IPCC has focused to a large extent on describing physical impacts, studies range in their coverage of regions, and types of damages assessed. The most comprehensively covered topics are agricultural impacts, and the costs of sea level rise, yet estimates can vary widely (Yohe and Schlesinger, 1998, Darwin and Tol, 1999). In a recent example using two alternative data sets of direct cost estimates, uncertainty regarding the value of dryland lost to sea level rise led to a 17% difference in coastal protection, a 36% difference in the amount of land protected, and a 36% difference in direct costs globally (Darwin and Tol 1999).[5] Obtaining more accurate measures will depend on improved modelling capabilities and more certainty about valuation and costs.

Based on a survey of studies undertaken since the IPCC Second Assessment Report (SAR), Table 11.1 shows aggregate monetised impact estimates on current economy and population for a 1.5 to 2.5 C° temperature increase (Tol et. al 2000).[6] These studies indicate a greater vulnerability of developing countries to climate change. At lower levels of climate change, damages might be mixed across regions; for example, poorer countries are likely to be net losers, and richer countries might gain from moderate warming. At higher levels of change (more than 2-3 degrees C°), net damages occur in almost all regions (IPCC 2001*b*). Developing nations face greater vulnerability because of their reliance on agriculture, their lower tolerance to coastal and water resource changes, and lower financial, technical, and institutional capacity to adapt (causing higher health impacts, for example). While sustainable development might reduce this vulnerability, uncertainties about the rate of climate change and pattern of economic development in poorer countries raise questions about whether development could occur fast enough to make a difference. Very few studies have considered dynamic responses to steadily increasing GHG concentrations, and the implications of multiple stress factors. This issue was highlighted recently by IPCC as critical for further research (IPCC 2001*b*). In the absence of dynamic analyses, it is hard to determine whether certain impacts are in fact best mitigated or avoided through GHG emissions reduction or through other policies, such as improved health care or infrastructure development.

These estimates of the costs of moderate or low temperature change would, if taken at face value, suggest only modest damage for OECD countries. However, a number of reasons argue for a continuing commitment

Table 11.1. Estimates of the regional impacts of climate change

	First Generation Pearce *et al.*, 1996	Mendelsohn *et al.*, 1996.	Nordhaus / Boyer 2000	Tol[a] 1999
	2.5°C	2.5°C	2.5°C	1.0°C
North America	-1.5			3.4 (1.2)
- USA	-1.0 to -1.5	0.3	-0.5	
OECD Europe	-1.3			3.7 (2.2)
- EU	-1.4		-2.8	
OECD Pacific	-1.4 to -2.8			1.0 (1.1)
- Japan		-0.1	-0.5	
Eastern Europe and former USSR	0.3			2.0 (3.8)
- Eastern Europe			-0.7	
- former USSR	-0.7			
- Russia		11.1	0.7	
Middle East	-4.1		-2.0[b]	1.1 (2.2)
Latin America	-4.3			-0.1 (0.6)
- Brazil		-1.4		
South and Southeast Asia	-8.6			-1.7 (1.1)
- India		-2.0	-4.9	
China	-4.7 to -5.2	1.8	-0.2	2.1 (5.0)[c]
Africa	-8.7		-3.9	-4.1 (2.2)
World				
- output weighted [d]	-1.5 to -2.0	0.1	-1.5	2.3 (1.0)
- population weighted			-1.9	
- at world average prices [e]				-2.7 (0.8)
- equity weighted [f]				0.2 (1.3)

Note: Estimates are expressed as per cent of Gross Domestic Product. Positive numbers denote benefits, negative numbers denote costs. Estimates are incomplete and there is a considerable range of uncertainty around estimates. Tol's estimated standard deviations are lower bounds to the real uncertainty. Figures, other than Mendelsohn's, are expressed as impacts on a society with today's economic structure, population, laws, etc. Mendelsohn's estimates denote impact on a future economy;
(a) Figures in brackets denote standard deviations;
(b) High-income OPEC;
(c) China, Laos, North Korea, Vietnam, Mongolia. Various methods of weighting are employed:
(d) output weighting referring to GDP weights;
(e) world average prices referring to a valuation of health, agricultural productivity, etc. calculated globally, to avoid controversial regional assessments; and
(f) equity weighting calculated as damages before aggregation with the weight being world average income over regional average income.

Source: Tol et. al. 2000 "How Much Damage Will Climate Change Do? Recent Estimates," Research Unit Sustainability and Global Change SCG-2, Centre for Marine and Climate Research, Hamburg University, Hamburg.

to GHG emission mitigation by OECD countries. First among these is the potential for significantly higher costs associated with higher levels of climate change (e.g., at the high end of the range projected by IPCC of 6 degrees C°). Second, near term ancillary benefits are likely to be considerable, and should be taken into account. Nevertheless, high degrees of uncertainty remain, including a limited knowledge of the size of future physical impacts and insufficient recognition of welfare criteria. Regional and national assessments are beginning to provide better estimates of the costs of climate change and should help to inform decision-making.

It will take many years before consensus is reached on the likely size of the costs of climate change. In the near term, the focus of analysis should shift from single predictions, or extreme ranges of uncertainty, to more comprehensive risk assessment. As the Chairman of the IPCC pointed out at the Sixth Conference of the Parties in November 2000: "…if policy formulation waits until all scientific uncertainties are resolved, and carbon dioxide and other greenhouse gases are responsible for changing the earth's climate as projected by all climate models, the time to reverse the human-induced changes in climate and the resulting environmental damages would not be years or decades, but centuries to millennia, even if all emissions of greenhouse gases were terminated, which is clearly not practical" (Watson 2000).

International framework for co-operation

Effective action to address climate change will require a global coalition of different countries and actors. The UN Framework Convention on Climate Change (UNFCCC) establishes a framework for international

co-operation to respond to climate change. The explicit aim of the Convention is to stabilise atmospheric greenhouse gas concentrations so as to prevent dangerous climate change over the long term.[7] As a Framework agreement, the Convention does not legally bind Parties to reduce emissions to any particular level. It suggests, however, that industrialised countries should aim to return emissions to 1990 levels by the year 2000. It also obligates all participating countries to adopt mitigation policies, to adapt to climate change and to co-operate on related technology and knowledge transfer. Agreement and ratification of the Convention by 186 countries attests to international concern over global climate change.

The Climate Change Convention, which came into force in 1994, is one of several outcomes of the United Nations Conference on Environment and Development (UNCED) held in 1992. As with other international agreements emerging from UNCED (e.g. on biodiversity and desertification), the UNFCCC differentiates commitments to reflect "common but differentiated responsibilities and respective capabilities" of ratifying nations. These commitments recognise that all Parties have responsibilities to combat dangerous climate change, and yet provide that "developed country Parties should take the lead in combating climate change and its adverse effects." The Convention also calls on Parties to give full consideration to the "specific needs and special circumstances of developing country Parties especially those that are particularly vulnerable to climate change." Finally, the UNFCCC identifies the need to "protect the climate system for the benefit of future generations" and calls on Parties to "take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects" (UNFCCC, 1992).

The Kyoto Protocol, signed in 1997, sets out quantitative targets for industrialised countries (Box 11.2).[8] It also creates a robust institutional framework, which will broaden the range of policy options. Achievement of Kyoto emission reduction targets will only have a marginal effect on atmospheric GHG concentrations. However, this step is important to demonstrate the leadership of industrialised nations in addressing this issue. To achieve the more ambitious objective of the Convention — stabilisation of atmospheric GHG concentrations — the Protocol will have to be followed by other agreements that continue to reduce emissions over future commitment periods.

Box 11.2. Key features of the Kyoto Protocol

Parties agreed to the first protocol under the UNFCCC in Kyoto, Japan, in December 1997. The Protocol commits industrialised (Annex B[9]) countries to achieve at least a 5% reduction in their aggregate emissions for the period 2008-2012 compared to 1990 and establishes legally binding and differentiated emissions reduction targets in 2008-2012 compared to 1990. It also:

- provides flexibility to countries to achieve these targets across a "basket" of six greenhouse gases or groups of gases (CO_2, CH_4, N_2O, PFCs, HFCs; and SF_6), and calls for accounting for removal of CO_2 by sinks.

- allows for the use of a number of international market-based mechanisms to enhance cost effectiveness: *international emission trading* and *joint implementation* (JI), among industrialised countries, and a *clean development mechanism* (CDM), which allows investment in project-based emission reduction in developing countries;

- confirms obligations under the Convention to provide technical and financial assistance to developing countries to enable them to respond effectively to climate change.

Many of the specific rules required for the implementation of the Kyoto Protocol are still being developed. Once rules and modalities are defined, national ratification of the Protocol could proceed more quickly.[10] On-going negotiations aim both to clarify the Protocol and to implement all main provisions of the Convention. Key issues include the design of a compliance system, the creation of safeguards for compliance to the rules for the Kyoto mechanisms, the establishment of rules for the operation of the clean development mechanism (Box 11.3) and how to account for sinks. Negotiations need also to define and advance financial assistance and support for capacity building and technology transfer to developing and

transition countries. This could include, for example, compensation for developing countries that are particularly vulnerable to the impacts of climate change.

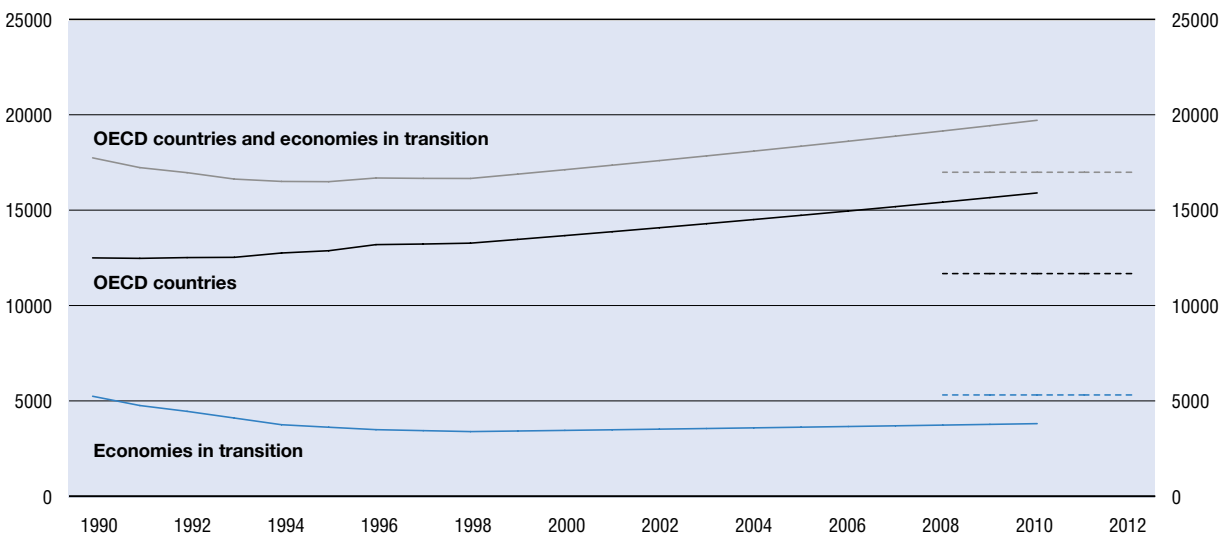
Box 11.3. The clean development mechanism

The objective of the Clean Development Mechanisms (CDM), as outlined under Article 12 of the Kyoto Protocol, is to help developing countries to achieve sustainable development while assisting industrialised countries in meeting their GHG emissions targets. The CDM increases incentives for industrialised countries to invest in developing countries, by allowing such foreign investments to "count" towards meeting their Kyoto commitments. Hence, the CDM could provide a valuable source of finance, technology transfer, management and technical expertise and could therefore contribute to sustainable development in developing countries. It also has the potential to engage developing countries to achieve project-based emission reductions in a cost-effective way. But the CDM will not, in itself, address impediments to foreign direct investment in host countries, notably those related to poor regulatory environments or macro-economic instability. Thus investment in CDM projects may flow most readily to countries where investment conditions are favourable. Simple, clear and transparent rules for the CDM will help ensure wide access to the CDM. A rule to fast-track small projects, many of which may be located in smaller and poorer countries, could help to ensure wide access to the CDM.

National implementation strategies

In parallel with efforts to clarify the Kyoto Protocol, industrialised countries are advancing mitigation policies and working towards achievement of the emission reduction targets set out under the agreement. Despite these efforts, emissions in most OECD countries have continued to rise since 1990. Compared with a business as usual scenario, Kyoto targets imply emission reductions of 20-30% for most OECD countries, should countries tackle the targets unilaterally (Figure 11.2). Slower growth or even declining emissions in economies in transition suggest, however, that the overall emission reductions required across industrialised

Figure 11.2. **Greenhouse gases emissions and Kyoto targets, industrialised countries**



Note: Emissions of CO_2, CH_4 and NO_2 (million tonnes CO_2 equivalent). Historical data up to 1998; projections to 2010. Dotted lines indicates targets foreseen in the Kyoto Protocol.
Source: UNFCCC 2000 inventory data for historical figures, OECD GREEN estimates for projections.

countries may be more modest (18%), although this will be affected by the uncertain pace of economic development in transition countries. Emission abatement of such magnitude is likely to require significant structural adjustments and cost.

The energy dimension

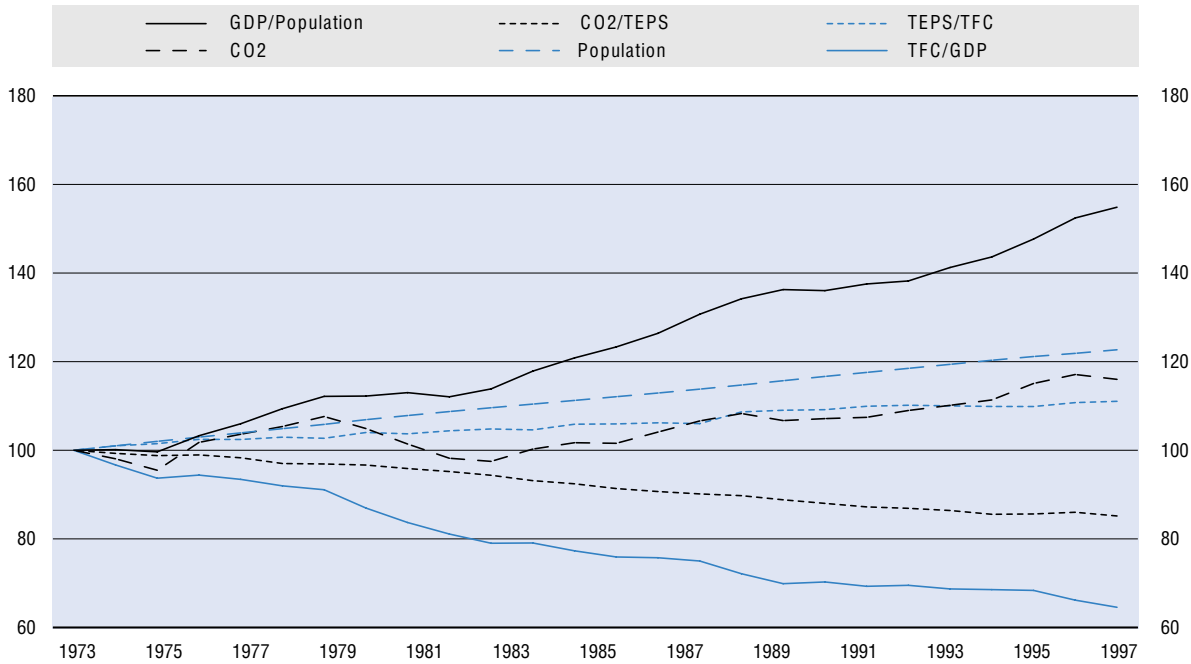
CO_2 emissions from energy accounts for roughly 75% of global emissions of GHG and for over 80% of the emissions from OECD countries (Newman *et al.*, 2001). Relationships between economic activity, energy use and CO_2 emissions are therefore key to achievement of Kyoto targets and to longer- term mitigation. Figure 11.3 highlights trends in CO_2 emissions and its relationship with economic activity (GDP), population, total primary energy supply (TPES) and total final energy consumption (TFC) in OECD countries.

For OECD countries, CO_2 emissions have almost kept pace with population growth. The total final energy intensity of the economy (TFC/GDP) has decreased by almost 22% since 1980, reflecting improved energy efficiency, structural changes in the economy, and fuel and technology changes in the power sector. These changes have been driven largely by improvements in technology, changes in energy prices and market reform policies. Energy intensity fell rapidly in OECD countries following the oil price rises of 1973/74 and 1979. While real oil prices have declined significantly in the last twenty years, increased taxation has moderated this fall for consumers in most countries. Future energy prices are difficult to predict, but will depend largely on OPEC arrangements and on the pace of energy market reforms (OECD 2001; IEA 2000). (Box 11.4 outlines some of the main historical trends.)

Figure 11.3 shows that OECD countries are also experiencing a slight decrease in the efficiency of converting energy from its primary form to final energy (TPES/TFC), mainly reflecting the increased share

Figure 11.3. **Contributions to changes in emissions of carbon dioxide in OECD countries, 1973-1998**

Indices 1973=100



Note: Based on "Kaya Identity" where CO_2 emissions = CO_2 intensity of primary energy supplies (CO_2/TPES) x energy conversion ratio (TPES/TFC) x final energy intensity of economic activity (TFC/GDP) x economic activity per capita (GDP/POP) x population (POP).

Source: IEA databases.

of electricity in final energy consumption. The relative efficiency of conversion from primary energy is still low, but this is offset somewhat by improvements in energy conversion technology. Improved technologies, especially combined cycle gas turbines and gas-fired co-generation, offer significant potential to further improve conversion efficiency in the production of electricity.

The technical and structural changes underlying these trends are difficult to disentangle. Statistics are often insufficiently detailed to separate the effects of technological change from those of structural change (IEA 1997*a*). However, the trends point to the importance of the scale of per capita income and population as main drivers of emissions and energy use.

Continuous improvements in the efficiency of final energy use (TFC/GDP) and primary energy conversion (TPES/TFC), as well as reductions in carbon intensity of primary energy supply (C/TPES), will be required to accelerate the de-carbonisation of energy production and use. Such technical innovation will be essential to break the link between the demand for economic services and products and GHG emissions. In electricity generation, this will mean shifting from more to less carbon intensive fuels, and eventually moving to low or zero-emission technologies (see Chapter. 12). Carbon capture and storage may also open up a variety of options — for example, allowing coal to be used in combination with hydrogen production and fuel cells, which would boost the efficiency of energy conversion while limiting emissions.[11] Fuel cells also have the potential to clean up the transport and residential sectors and industrial production. Such technological developments need to continue and accelerate to successfully de-couple economic development from growth in CO_2 emissions.

Box 11.4. **Higher energy prices drive energy efficiency and technical change**

Major price rises for energy in the 1970s led to significant reductions in energy demand. Since then prices for end users in OECD countries have fallen to around their pre-shock levels and have been relatively flat through the end of the 1990s. During this period of energy-price stability, GDP and energy use have moved closely together. Stability of energy use following lower energy prices in the 1980s, indicates that improvements in energy efficiency have tended to be "locked in" through infrastructure and permanent behavioural change. Recent OPEC decisions to reduce oil output have led to large rises in energy prices in 2000 but the duration of this price rise is uncertain, as it partly reflects cartel management rather than underlying market forces. Physical global supply shortages are not expected to influence prices significantly over the coming decades (IEA 2000*a*; OECD 2001).

National policy developments

Domestic policies necessary to reach the Kyoto emission targets are in early stages of development. Such policies will have to include a mix of instruments (See Chapters 5, 6, and 7). Market-based instruments and subsidy-reforms offer significant opportunity to improve cost effectiveness. Large opportunities exist to reform sector policies, especially in the agriculture, transport and energy sectors. For example, energy is heavily subsidised in many OECD countries and these subsidies harm the environment and the economy; energy subsidies are estimated at roughly USD 80 million per year, with the bulk of support for nuclear, coal and oil (de Moor 1997). OECD (1997) estimates that reform of energy subsidies could reduce CO_2 emissions from this sector by 1 to 8% in Member countries while improving economic performance. Energy subsidies are also important in non-OECD countries. IEA (1999) estimates that removing energy price subsidies in eight key non-OECD countries[12] could reduce global energy consumption by 3.5% and global CO_2 emissions by 4.6%, while increasing global GDP by almost 1%. To be successful, policy reforms will also need to address the social and political ramifications of removing harmful subsidies (OECD 1997).

Making greater use of economic instruments will improve the cost effectiveness of GHG mitigation. A number of countries have taken steps towards the introduction of a carbon tax.[13] As an alternative to a CO_2

tax, a system of domestic tradable permits is in many ways equivalent, and has similar efficiency properties (see Chapter 5). Domestic tradable systems could also be linked to international trading system foreseen in the Kyoto Protocol. Some countries are already experimenting with pilot systems and others are planning to implement domestic systems. One of the challenges for both carbon taxes and emission trading is how to deal with existing heavy emitters. Industry arguments about adverse effects on competitiveness have led countries to grant exemptions to some emitters, even though these exemptions tend to seriously weaken the link between higher prices and carbon emitted. While preferential treatment may be warranted in a transition phase, partly to overcome political resistance, these exemptions should be phased out rapidly to avoid reducing the incentive to abate.

Table 11.2. Examples of ancillary benefits of greenhouse gas mitigation, by sector

	Policy Objective	Ancillary Benefit (examples)
Electricity production	Fuel switching away from oil and coal to low or no emission sources.	Lower air emissions of SO_X and NO_X, improved water quality and eco-system preservation in freshwater bodies. Limits forest die-back related to acidic deposition and contributes to improved urban air quality.
Transport	Lower emission vehicles and demand side management.	Lowers congestion in cities and human health costs related to urban air pollution.
Agriculture	Minimise use of inorganic nitrogen and organic fertilisers.	Lowers nitrogen run-off from agricultural land, improving water quality.
Manufacturing	Prioritise investments in energy and materials efficiency.	Improve resource efficiency of industrial operations, long term and often short term financial savings accrue; lower energy related costs.

Other measures can be effective for dealing with market imperfections such as those that lead to under-investment in energy efficiency. Such policies are often targeted to a specific sector of the economy and may include regulatory policies for materials, buildings and products, green government procurement, research, information and public awareness programmes.[14] If used to complement economic instruments, these instruments can accelerate diffusion and development of technologies and encourage consumption of goods and services with lower carbon intensity. Voluntary agreements to reduce emissions — between governments on one side and enterprises, small consumers or farmers on the other —can also be effective to encourage "learning" about mitigation options (See Chapter 5). Policy in the near term can also provide funding, or incentives for research, development and demonstration to help bring forward cleaner technology (such as hydrogen fuel cells) and improved production processes (such as innovation in farming practices). Policy may also be instrumental to reduce barriers to the introduction of new technologies such as micro-generating technologies from clean energy sources. While such policies need to be carefully designed and administered to avoid creating long-run market distortions and trade barriers, if carefully crafted they can encourage investment and diffusion of new technologies and production processes (OECD 1999*b*).

Policies also need to take into account national circumstances. For example, they should aim to capture the range of ancillary benefits available from greenhouse gas mitigation in the agriculture, manufacturing, transport and energy production sectors (Table 11.2). Wide variations among nations in economic structure, weather conditions, demographics and other patterns of human settlement, and cultural preferences, will drive energy and emission patterns (Fulton *et al.* 2000), leading to significant differences in marginal abatement costs across countries. In all cases, iterative action will be required to enable policy makers to learn from experience and incorporate better information over time (OECD 1999*b*).

The costs of achieving the Kyoto Protocol

Much analysis has been undertaken using global macroeconomic or energy-economic models to quantify the economic costs of implementing the Protocol by (Weyant and Hill, 1999; OECD, 1999*a*). The results of these models depend importantly on underlying assumptions about the development of baseline emissions, i.e. what would happen to emissions in the absence of the Kyoto Protocol. They also depend upon assumptions about how the Protocol is implemented. Most quantitative assessments of the economic costs of the Protocol have only taken into account the most important greenhouse gas, CO_2.

The OECD Secretariat has developed a global, multi-region, multi-sector dynamic applied general equilibrium model named GREEN (see Burniaux *et al.*, 1992; Lee *et al.,* 1994) and used it to quantify these costs under a number of different assumptions as to how the Protocol would be implemented. Initial analyses with GREEN focused on mitigation of CO_2 alone, while the most recent analysis broadens the assessment of mitigation to include methane and nitrous oxide.

Single gas mitigation

Much of the literature quantifying the economic costs of implementing the Kyoto Protocol is limited to carbon dioxide emissions. A recent review of economic simulations suggests costs for OECD countries in the range of 0.2 to 2% of GDP in 2010, when meeting the Kyoto targets with cost-efficient domestic measures to reduce CO_2 alone (and without international emission trading) (IPCC 2001*c*). Recent GREEN model estimates fall at the low end of this range (Figure 11.4).

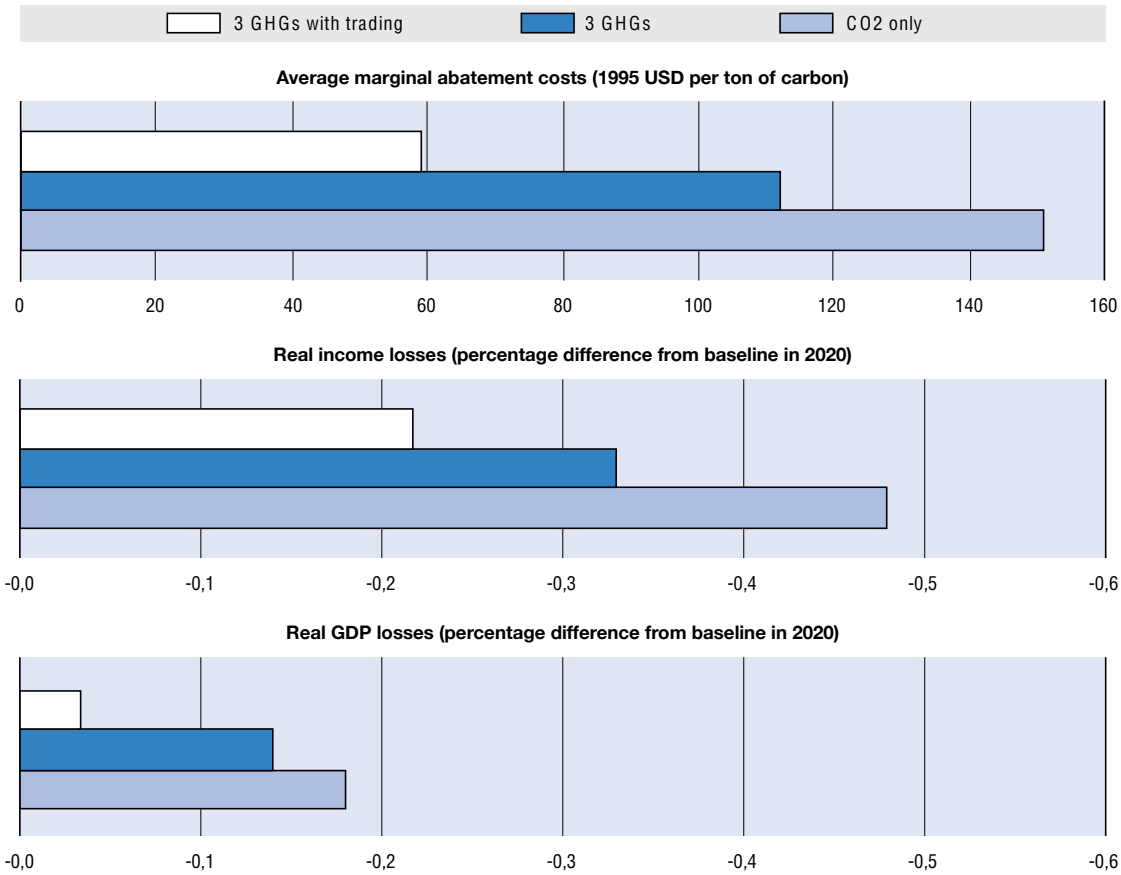
Multi-gas mitigation

Evidence on the effects of wider gas coverage on overall economic costs is still scarce but several studies indicate that ignoring other greenhouse gases gives an upward bias to cost estimates. Gielen and Kram (1998) suggest that emissions of the non-CO_2 gases may decline autonomously over time and estimate this decline to be equivalent to a 25% relaxation of the estimated cut in CO_2 emissions required to meet the European Union emission target by 2010. Results from the GTEM model (Brown *et al.,* 1999) suggest that the inclusion of methane and nitrous oxide reduces the marginal cost of meeting the Kyoto targets by a third as compared with a situation where the targets are reached through cuts in CO_2 emissions alone. Reilly *et al.* (1999) find that taking into account the non-CO_2 gases and the potential for carbon sinks may reduce the cost of implementing the Kyoto Protocol by almost 40%. Manne and Richels (2000) estimate that the inclusion of both non-CO_2 gases and carbon sinks could reduce the marginal cost of meeting the Kyoto targets by 48%. OECD simulations suggest that mitigation of methane and nitrous oxide may reduce estimated economic costs of implementing the Kyoto Protocol by approximately one third compared with estimates based on CO_2 from energy alone (Burniaux, 2000).

The lower costs associated with this wider coverage reflect at least two important influences. First, lower growth in emissions of non-CO_2 gases affect overall abatement needs and thereby economic costs. Second, there may be large differences in marginal abatement costs across different gases, and efficiency gains can be achieved by substituting low-cost emission cuts for high-cost ones. However in the long term, the cost-saving due to multi-gas mitigation are likely to be less significant due to the more rapid growth of CO_2 emissions and their long term dominance in the mix of GHG. Thus, overall, available studies suggest that the economic costs of reaching the Kyoto targets may be exaggerated by quantification that focuses exclusively on CO_2 abatement.

Sources of non-CO_2 emissions are varied, ranging from cattle, dairy and other livestock practices to rice paddies and municipal waste disposal in landfills. Tapping into the relatively low-cost mitigation potential for non-CO_2 greenhouse gases will require governments to work with a variety of different actors, ranging from local municipalities to farmers and multinational energy companies. Experience with policies in these areas is limited but initial analyses indicates promising results, especially from voluntary measures in the United States (Dupont, 1999). Although there may be scope for taxing non-CO_2 gases (e.g. on CH_4 from oil

Figure 11.4. **Costs of implementing the Kyoto targets under alternative assumptions, 2010**



Note: Marginal abatement costs are expressed in 1995 dollars per ton of carbon equivalent (top axis). Real GDP and income losses are expressed in terms of billions of 1995 dollars (bottom axis). The "no flexibility" case corresponds to domestic cost-effective implementation by individual Annex I countries. Under "full Annex 1 trading" abatement costs are equalised between Annex 1 countries. Figures for trading assume unrestricted trade among Annex I countries.

Source: Burniaux J.M. (2000), "A Multi-gas Assessment of the Kyoto Protocol", OECD Economics Department Working Papers No. 270, OECD, Paris.

and gas production, N_2O from fertiliser use, HFCs and SF_6) experience to date is limited (Mullins, 2000). Effective use of carbon sinks in Annex I countries would also reduce mitigation costs.

Carbon uptake by sinks[15]

Terrestrial carbon sinks are a critical dimension of the natural system that regulates climate. Although much of the total flow of carbon to and from sinks is natural, human induced flows are large. Anthropogenic sink activities are estimated to absorb 0.5 to 0.7 billion tonnes of carbon a year in industrialised countries, equivalent to roughly 15% of emissions from burning fossil fuels from these countries (IPCC 2000*b* and UNFCCC 2000*a*). This figure does not include agricultural lands, which the IPCC estimates to contribute to the total terrestrial sink; this could increase the figures another 50% to 75%. Total mitigation potential through sinks in developing countries is estimated to be nearly two times that of industrialised countries (IPCC 2000*b*).

The Kyoto Protocol covers a portion of these human-induced flows. Discussions are underway to clarify definitions and accounting rules. Two key questions are: *(i)* coverage of domestic sinks under the Protocol (in industrialised countries); and *(ii)* possible coverage of relevant activities in developing countries through the Clean Development Mechanism. Some studies indicate that the costs of achieving emissions reductions through sinks could be relatively low cost (Reilly 2000; IPCC 2000*b*).

Though the contribution of sinks to emission reductions is likely to be less important in the longer term, in the 2010 time frame sinks could contribute to achieving Kyoto targets and significantly lower its costs. Use of sinks as a means to mitigate GHG also affects the achievement of other social or environmental policy objectives (e.g. protection of biodiversity and habitats and competition for land); depending upon how such mitigation is undertaken, these could be either positive or negative (IPCC 2001*c*). Decisions on how to account for sinks will need to consider such potential effects to ensure positive overall results.

Use of the Kyoto mechanisms

Macro-economic simulations indicate that the use of the Kyoto mechanisms (i.e. international emission trading and joint implementation) among industrialised countries can significantly lower mitigation costs. An IPCC review of a range of economic model results suggests that aggregate costs for OECD countries could fall to a range of 0.1% to 1.1% of GDP in 2010 when full use is made of emission trading by Annex B countries (CO_2 mitigation only). This range is roughly half of that estimated without the use of trading. OECD simulations result in costs that fall below the low end of this range, with estimates of 0.02% of GDP per year and approximately USD 60 per tonne of carbon (USD 16 per tonne of CO_2, both figures in 1995 USD) for full multi-gas mitigation and trading. These comparatively low costs partly reflect the extension of mitigation to three GHG rather than to CO_2 alone (Burniaux 2000).

Though agreement exists on the economic gains from using the Kyoto mechanisms, part of these gains occur at the expense of higher overall emissions. This is due to "hot air" in Russia and the Ukraine, where allowed emissions are likely to be above actual emissions. Because of this, some countries have called for restrictions on the use of the Kyoto mechanisms, so as to maximise the overall emission reduction associated with the Kyoto targets. However, given the inherent inefficiencies of restricting the use of market mechanisms, it would appear to be more efficient to address this concern through other means (Yamin *et al.*, 2000).

Although legally binding emission targets under the Kyoto Protocol pertain only to industrialised countries, their implementation will affect all countries. Oil exporters would be the more affected, although it is unclear whether the potential loss from implementing Kyoto targets is large relative to normal market fluctuations (Bartsch and Müller 2000). Other developing countries may experience terms of trade gains. Overall, estimates of real income losses in non-Annex I countries are lowest when the Kyoto mechanisms are fully used, and when mitigation is extended to all GHG. OECD simulations (1999*a*) indicate that average real income changes in developing countries could range from a loss of 0.7% per year to a gain of about the same magnitude in 2010, depending upon how Annex I countries implement Kyoto (e.g. without or with use of the Kyoto mechanisms). Lower energy prices outside industrialised countries could lead to some increase in energy consumption in developing countries, partly offsetting the reductions in industrialised country emissions. However, OECD simulations and a recent IPCC review show that such "carbon leakage" is unlikely to be significant in aggregate, but could be substantial for some countries (OECD 1999*a*; IPCC 2001*c*). Most of this leakage will be concentrated in a few industrial countries that face significant competition in energy and energy-intensive production from developing countries.

Adjustment costs and other missing factors

Overall, multi-gas mitigation and full use of the Kyoto mechanisms are expected to limit the overall loss in GDP for OECD and other Annex I countries to less than 1% per year. In the aggregate, these costs seem low, yet they imply significant structural adjustment in all countries. For example, coal prices (inclusive of carbon tax) may need to rise several fold and the average price paid by OECD consumers for energy services and transportation could increase by as much as 50% to 2010. The overall impact on consumers would be less than these figures might suggest, however, because governments retain some discretion over how to distribute costs across the economy through different policy instruments.

In addition, model assessments might under- or over-estimate costs. Under-estimation occurs for at least two reasons. First, general equilibrium models, such as those used by the OECD, assume that domestic

policies are cost-effective and would equalise marginal abatement costs, which is unlikely in reality. Second, these figures do not consider the cost of redeploying labour from industries that need to contract to industries that would expand. A number of energy-intensive sectors would grow less than they would otherwise, and the coal industry would contract significantly, at least in OECD countries as a whole, unless competitive end-of-pipe solutions can be implemented in the coal-fired segment of the power sector. These costs would depend on the degree of flexibility of labour market, geographic location and other factors. Such adjustment costs are linked to rigidity in labour and capital markets and could raise the economic costs in the near term several-fold (OECD 1999*a*). Policies to facilitate market adjustment — such as policies to support flexibility in labour markets by providing displaced workers with re-training and new skill development — could reduce such costs.

Other features of these models may lead to an over-estimation of costs. For example, the OECD assessment deals only with the three main greenhouse gases (CO_2 from energy, methane and nitrous oxide) and does not consider CO_2 from land use change and forestry. CO_2 uptake from land use, land use change and forestry may, as noted above, contribute substantially to the Kyoto reduction commitments at relatively low cost in some major countries. Endogenous technology change is also not accounted for in most model assessments, yet analysis indicates that such change could lower the costs of mitigation in the Kyoto time frame and beyond (Buonanno *et al.,* 1999). Policy reforms, such as cuts in energy subsidies, could also further reduce the costs of reaching the Kyoto targets, relative to the model estimates discussed above. Net ancillary benefits and costs (see below) are also thought to be positive and could offset part of the economic costs of mitigation.

Ancillary benefits and costs

There are close connections between greenhouse gas limitation and other policy objectives. Ancillary benefits include avoiding loss of human life or illness due to air pollution; and eco-system benefits, such as avoiding water quality problems from nitrogen run-off. Ancillary costs of carbon mitigation are also possible; for example, increased use of diesel fuels in transport could lead to additional particulate matter and health costs, despite better fuel efficiency and lower carbon emissions for a given distance travelled. Yet overall ancillary benefits are thought to outweigh costs, and to be quite large especially in urban areas (Davis *et al.,* 2000). Although valuation of ancillary effects can be difficult and controversial, taking them into account can make the cost of achieving GHG objectives more acceptable, due to their immediacy, and assist in the design of policies to achieve multiple benefits simultaneously.

Estimates of the magnitude of these net ancillary benefits and costs of greenhouse gas reduction in OECD countries vary widely. But even the most conservative estimates suggest they are significant and may offset as much as a third of the abatement costs for modest mitigation efforts (Davis *et al.,* 2000). In developing countries, where baseline local air quality is generally poorer and carbon abatement costs may be lower, ancillary benefits could be especially large in terms of saved lives and reduced illness per tonne of carbon abatement. When properly valued, ancillary benefits in developing countries may also prove large relative to abatement costs. Even so, developing countries need to ensure that measures to cut GHG emissions, compare favourably with alternative measures (e.g. control technologies) in terms of reducing local air pollution (Dessus and O'Connor, 1999).

The long -term challenge

The attainment of the Kyoto targets will only be the beginning of what needs to be sustained over many decades if atmospheric concentrations of greenhouse gases are to be stabilised. Industrialised countries cannot stabilise concentration levels on their own; even if they reduced their emissions to zero, expected growth in the rest of the world would be too high. Under the "business as usual" scenario of GREEN, the share of emissions originating from non-OECD countries may rise from around 38% today to 50-60% by 2020 (OECD 1999*a*; IEA 2000). India, China and the rapidly industrialising countries of East Asia and Latin America are expected to account for the major share of this increase. The participation of developing countries is therefore essential.

Assisting developing countries

Developing countries are already engaged in the international process and some have taken actions to respond to other development priorities that indirectly affect climate change (Biagini, 2000). OECD countries are assisting developing and transition countries to respond to climate change in various ways (Box 11.5).[16] However, by and large, climate change does not figure highly on the policy agenda of most non-OECD countries. There are a number of explanations for this, including the urgency of other priorities such as eradicating poverty, building institutional frameworks for private investment, providing water, sanitary and other services, and infrastructure in cities and access to electricity in rural areas.

Box 11.5. **Assisting developing countries in responding to climate change**

The Convention and the Protocol require Annex II countries to provide financial resources, including the transfer of technology, for the purpose of assisting developing countries to implement their obligations under the Convention (e.g. reporting) and, more generally, to build capacity to respond to climate change. The Global Environment Facility (GEF) is the main financial mechanism. However assistance is also provided through bilateral co-operation. Capacity building, technology co-operation or transfer, and adaptation are the main targets for action:

- *Financial assistance.* The GEF is an independent multilateral financial mechanism established in 1991 to assist developing countries to protect the global environment in the areas of biodiversity, climate change, international waters, and ozone layer depletion. The GEF, which is jointly managed by the United Nations Development Program, the United Nations Environment Program, and the World Bank, currently funds approximately 300 projects in developing countries, having committed USD 1.1 billion in grants, and raised several billion in co-financing. In the area of climate, the GEF assists developing countries to comply with their obligations under the UNFCCC to elaborate GHG inventories and to report on these to the Conference of the Parties to the Convention. In addition, the GEF assists developing countries in formulating national action plans to mitigate and adapt to climate change, and provides financing to cover the incremental costs of investment projects that deliver additional climate benefits.

- *Capacity building.* Some developing and transition countries have sought to integrate climate change objectives into national development plans and to develop the necessary policy frameworks. Many capacity needs identified in the Convention have relevance beyond climate change. For example, the development of capacity in emission forecasting, monitoring of ecological and socio-economic conditions, awareness-raising and disaster prevention are also relevant to desertification and biological diversity. Capacity development for policy-formulation and planning in agriculture, energy, and transport also have relevance beyond climate change. Capacity development programmes should foster policy integration across sectors and seek to exploit these synergies.

- *Technology co-operation.* Technology co-operation in the context of climate change includes technology needs assessment; identification of sources and suppliers; determination of optimal modalities for the acquisition and absorption of relevant technologies; provision of training for firm managers, engineers and technicians; demonstration and pilot projects; and dissemination of best practices at the national and international level. Technical co-operation to meet climate objectives is similar to technology co-operation in other areas, and can draw on considerable experience accumulated over the years (see Chapter 9).

- *Adaptation.* The Climate Change Convention commits developed country Parties to "assist the developing countries that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects" (Article 4.4). The Protocol calls for a share of the proceeds from CDM investments to be used to help vulnerable developing countries to meet the costs of adapting to climate change. More detailed regional impact assessments in developing regions are a prerequisite for adaptation planning.

Negotiating mitigation commitments

Negotiations on the shape of future mitigation commitments are likely to be driven by two main issues: What is the level and timing for required global emission reductions? And, how to allocate the responsibility for required emission reductions? Answers to both questions will shape the costs of responding to climate change, in the aggregate and for individual countries. Alternative development pathways, and the baseline against which emission reductions will be made, will also determine costs. IPCC recently elaborated six different reference scenarios that show the possibility for a wide variety of possible energy futures. Over the 21st century, significant investment in new energy sources will be made which could significantly alter the mix of energy compared to today. Most such investment today is directed to fossil resources, however. The nature of such investment in the future will determine the level and cost of required emission reductions (IPCC 2001*c*).

Most mitigation scenarios suggest that deep global emission reductions and lead times of half a century or more will be required to achieve any reasonable stabilisation target. Freezing emissions at current levels, for example, would only postpone the doubling of CO_2 concentrations until 2100, and would not be enough to prevent a continuing rise thereafter.[17] Even relatively high concentration levels (750-1000 ppmv) would require emissions to be less than half current levels, per unit of economic activity, in the coming century and thereafter (IPCC 1996*a*). Reaching lower stabilisation levels (e.g. 450-550ppmv) by 2100 would require earlier and more significant reductions, especially for the longest lived GHG (e.g. CO_2, HFC, SF_6). The timing of required emission reductions could also be affected by a need to limit the rate of climate change (e.g. thresholds for decadal change in global average temperatures) (Alcamo *et al.* 1998; Berk *et al.*, 2001).

Participation in future agreements will also depend upon how required emission reductions are shared or allocated among countries. Notions of equity differ widely across countries but such notions are likely to drive decisions by developing countries about any future agreement (Shukla 1998, Rayner 1994, Yamin 1999). Future agreements will also need to recognise the diverse situations of developing countries with respect to their level of economic development, their vulnerability to climate change and ability to adapt or mitigate it (Box 11.6).[18]

Setting ecological objectives to guide mitigation

Early agreement on specific climate objectives of future mitigation commitments could advance agreement on burden sharing and help different actors shape expectations about future requirements. For

Box 11.6. **Developing countries and climate change: highly differentiated contributions and vulnerabilities**

Following the categorisation of countries made by the Convention and Kyoto protocol, discussions on climate change often focus on Annex I (most OECD countries and countries with economies in transition) versus non-Annex I countries (mostly developing countries). However, non-Annex I countries themselves are a very diverse group as regards contribution to climate change. One could distinguish between countries with:

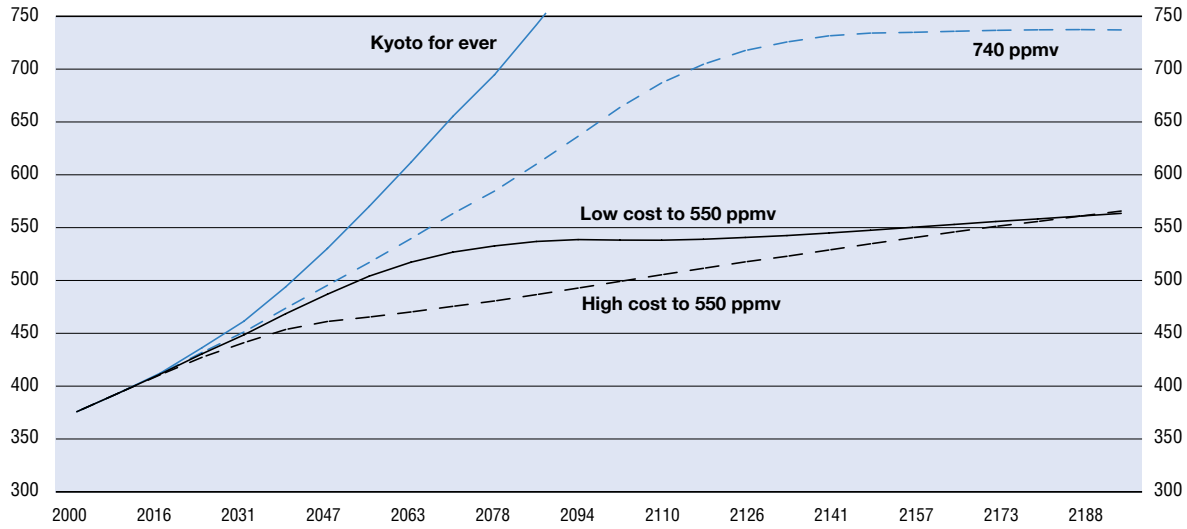
- Low-income, high total GHG emissions (e.g. China, India and Indonesia).
- Middle-income, high total GHG emissions (e.g. Brazil, Argentina, Thailand).
- Oil-rich, which could suffer from global shifts away from fossil fuels.
- Low-income, low GHG emissions (both per capita and in absolute terms). These include "small island developing states" and most of the countries of sub-Saharan Africa. Many of these countries are highly vulnerable to the impacts of climate change, and have a vital stake in the success of efforts to contain global emissions.

example, a concentration level of 550 ppmv represents an approximate doubling of the pre-industrial concentration and has been proposed by some as an implicit target for the end of the 21st century. Another factor that will influence climate objectives is society's preference for risk aversion. High risk aversion may argue for lower concentration targets and for earlier emission reduction.

Early emission reductions may be justified by at least two arguments — one ecological, the other pertaining to technical innovation. The first argument suggest the existence of environmental thresholds beyond which irreversible change, or change with major economic damages, could occur (Alcamo and Kreileman 1996; Berk *et al.,* 2001); this argument suggests setting benchmark in terms of rates of global temperature change per decades. Under rapid climate change, scientific evidence indicates risk of major economic damages, as the pace of change would limit the ability of humans or other species to adapt in a timely manner. Keeping the rate of climate change below a maximum threshold would be likely to require much earlier emission reductions than otherwise.

The second argument for early mitigation is related to incentives for technology innovation.[19] Early emission mitigation could stimulate technical progress and innovation, reducing abatement costs later (Grubb 1997). On the other hand, others have suggested that it could be beneficial to delay emission reductions, until cheaper abatement technology becomes available (Wigley, *et al.,* 1996). OECD simulations indicate that, for given emission reduction targets, an early and gradual phasing in of action, incurs lower costs than waiting and then introducing measures more abruptly (OECD 1999*a*). This is because a gradual strategy minimises the extent to which rapidly changing relative prices would force premature scrapping of capital equipment. Early clarification of the terms and conditions for emission mitigation obligations will be important to accelerate technology progress.[20]

Figure 11.5. **Long term concentration pathways for carbon dioxide**



Note: ppmv = parts per million by volume. Concentration paths are derived from assumed emissions paths with model of Wigley T.M.L. (1993), "Balancing the global carbon budget" *Tellus,* Vol. 45. Coefficients are based on Ha-Duong, M., M.J. Grubb and J.C. Hourcade (1997), "Influence of socio-economic inertia and uncertainty on optimal CO2 emission abatement", Nature, Vol. 390.
Source: OECD (1999), *Action Against Climate Change,* Paris.

Assessing alternative pathways

The OECD has investigated four possible concentration pathways for carbon dioxide (Figure 11.5) (OECD 1999*a*). The purpose of the scenarios is to explore the relationships between different types of targets, emission levels and mitigation costs.

The first pathway maintains emissions by Annex I countries constant at the levels embodied in the Kyoto Protocol; this strategy would, at best, delay by one decade (compared to business as usual) the time when the 550 ppmv level is reached, and concentration levels would continue to rise steadily. This "Kyoto forever" pathway does serve as a reasonable reference scenario. Achieving a concentration target of 750 ppmv by the middle of the 22nd century would imply significant reductions from today's levels of emissions.[21] Two additional pathways assume a higher degree of risk aversion and concentration targets at the level of 550 ppmv; a low cost scenario assumes emission reductions are gradually phased in towards 550 ppmv in 2080, and stabilised thereafter; a high cost 550 ppmv scenario aims to keep concentration levels below 550 ppmv over the next century. The latter scenario assumes much higher and earlier emission reductions in the early part of the century, and much higher economic costs.[22]

Allocation of emission allowances

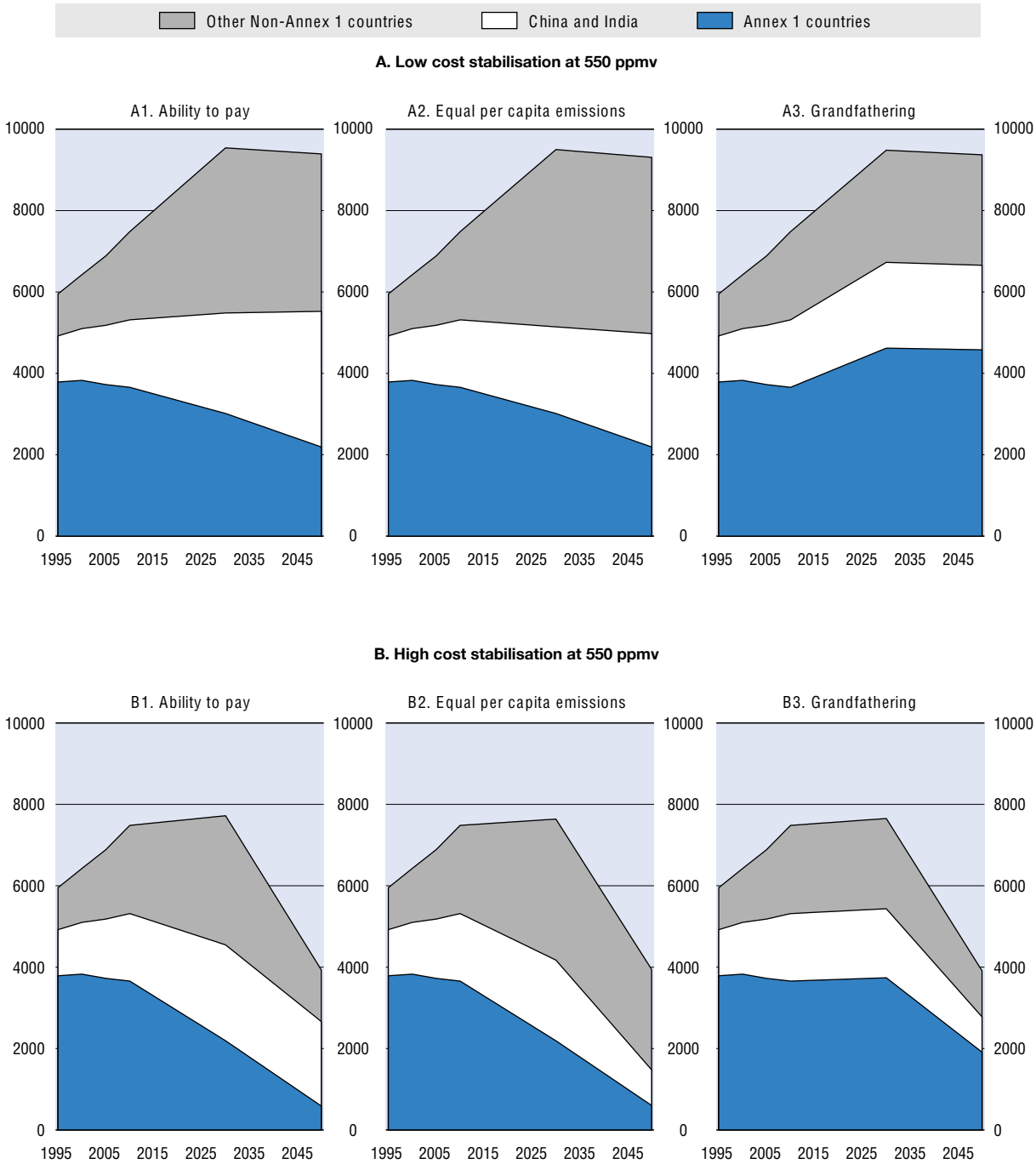
Allocation of mitigation responsibility, or emission allowances, under any future agreement will be central to determining mitigation costs. A variety of approaches can be illustrated with the use of the mitigation scenarios outlined above. Some type of egalitarian principle, consistent with the notion of differentiated responsibilities and commitments, could help to guide decision making on the allocation of future commitments. OECD (1999*a*) explored several approaches to assess economic and emission reduction implications of each. A first approach is based on the principle of "ability to pay", where non-Annex I countries accept commitments only when their real income per capita reaches a given level, and commitments are proportionate to relative levels of per capita income. A second approach (referred to as "equal per capita" emissions)[23] sets a benchmark for per capita emission equal to the average across Annex I countries; once a country reaches this level, it joins the coalition of mitigating countries. Under this scenario, all countries converge towards the same level of per capita emissions. Further, the pace at which Annex I countries reduce their emissions, will determine the time at which non-Annex I countries will accept binding limitation. An alternative "grandfathering" approach entails freezing the share of emissions in each region at its 2010 value. Under both approaches, two types of financial flows between countries would occur: first, flows from (full) permit trading; and, second, (unilateral) transfers towards those developing countries that would lose economically from the agreement, so as to provide incentives to participate to countries that could otherwise "free ride."

Emission pathways and the allocation of emissions allowances under these various approaches for two of the stabilisation scenarios are shown in Figure 11.6. The 550 ppmv high-cost scenario shows that keeping concentrations below this limit would require world emissions to decline well below current levels. However all scenarios allow significant growth in emissions from developing countries, with the Annex I countries contributing relatively more to the emission mitigation effort.

Box 11.7. **Alternative forms of mitigation commitments**

Some authors suggest that developing country participation under future commitment periods might start in the form of indexed targets – such as CO_2 per unit of GDP (Baumert, *et al.*, 1999). Fixing indexed targets would both avoid the possibility of "hot air" and would not penalise countries whose economic and emission growth are above expectations. Indexed targets, combined with the opportunity to trade any emission reductions below such "targets" is another possibility that would provide economic incentives to developing countries to reduce growth in emissions. Mitigation commitments could also take softer forms, for example non-binding targets, voluntary agreement upon future baselines against which emission reductions could be measured, or agreement to implement policies and measures to mitigate GHG (Philibert and Pershing, 2001).

Figure 11.6. **Emission allowances in alternative scenarios, 2010-2050**



Note: Millions tons of carbon.
Source: OECD (1999), *Action Against Climate Change*, Paris.

Estimated costs of long term stabilisation targets[24]

The costs to individual countries of meeting an absolute concentration or emission target, as well as the gains from trade and the size of possible required financial transfers (or side payments) will depend upon the baseline against which the mitigation scenario is compared.[25] Emission growth rates under the baseline scenario vary significantly by country or world region, with growth in non-Annex I countries twice as high (or more) than in Annex I countries. On average, world emissions of CO_2 are projected to grow 2.6% per year between 2010-2030, and to drop to 2.3% in the later period (2030-2050).

Precisely because of its influence on costs and its implications for equity (e.g. equal shares to the global atmosphere, opportunity costs of such shares), the allocation of emission allowances is a contentious issue. Economic costs clearly increase with the degree of ambition of the emissions constraint. They also vary largely with and without emission trading. In the absence of emission trading, aggregate world costs (measured as aggregate real income losses) are lower when the "grandfathering allocation" rule is combined with side payments to compensate those developing countries that would incur economic losses. Conversely, with full trading, aggregate costs become much less dependent on the initial distribution of allowances — as emission trading equalises marginal abatement costs among participants. The rules based on "ability to pay" and "equal per capita" emissions lead to more international redistribution due to permit trading than grandfathering, which requires higher side payments.

Table 11.3 shows the estimated costs of achieving the two 550 ppmv scenarios. For Annex I countries, estimated losses in real income are in the range of 0.7% to 1.5% in the case of no trading. Not surprisingly, real income losses are highest in the case of risk averse or early stabilisation — "high cost" 550 ppmv. Emission trading also has the least impact in this high cost scenario, as marginal abatement costs for all countries converge at relatively high levels, thus limiting the cost-reducing impact of trading.[26] For non-Annex I countries, the real income losses range from nearly 3% under the "ability to pay scenario" without trading, to gains in the scenarios with trading and financial transfers. Non-Annex I countries benefit most from emission trading. For both Annex I and non-Annex I countries, the allocation of emission allowances influence costs less than the level and the timing of the concentration target. In all scenarios, resource transfers are likely to be needed to compensate some developing countries for losses.

Table 11.3. **Costs of alternative concentration targets for Annex I and non-Annex I countries**
Average per cent deviation relative to baseline , 2010-2050

	Annex I	Non-Annex I	Annex I	Non-Annex I
	High cost 550 ppmv		Low cost 550 ppmv	
Grandfathering				
No trade	-1.04	-2.13	-0.70	-0.78
World full trade	-0.76	-0.92	-0.31	-0.35
Full trade plus transfers	-1.42	0.48	-0.60	0.27
Equal per capita emissions				
No trade	-1.46	-2.39	-1.22	-1.20
World full trade	-1.34	0.67	-0.51	0.29
Full trade plus transfers	-1.63	1.28	-0.65	0.59
Ability to pay				
No trade	-1.46	-2.78	-1.25	-1.65
World full trade	-1.36	0.84	-0.51	0.33
Full trade plus transfers	-1.91	2.01	-0.69	0.70

Note: In terms of equivalent variation in household real income, with a 3% discount rate.
Source: OECD (1999), *Action Against Climate Change*, Paris.

The policy challenge

Mitigation

Recent IPCC scenarios indicate that development choices will significantly influence the evolution of GHG emissions in the coming century, even in the absence of specific climate policies (IPCC 2000*a*). Baselines for emissions could vary widely depending, for example, upon the sustainability of the energy system. Multiple economic benefits could follow from development pathways characterised by lower greenhouse gas emissions. Such alternative development pathways may be influenced by policies that internalise non-climate externalities and, as a secondary benefit, lower GHG emissions (IPCC 2000*a*).

Specific GHG mitigation objectives are nevertheless necessary to ensure a safe climate. Long-term decisions should take into account the risk for significant change and uncertainty over long time frames, an issue already recognised in the emerging international regime under the Convention. Agreeing on initial ecological objectives for managing climate change over the long term is important, as they would provide boundaries for the discussion about approaches to sharing mitigation responsibilities.[27] OECD countries, as the largest contributors to the past increase in GHG concentration,[28] have a special responsibility to lead the implementation of policies to reduce emissions and enhance carbon removal by sinks.

All assessments indicate the need for radically altering the carbon intensity of economic activity. Energy efficiency improvements, accelerated use of natural gas, bio-energy and forestry options will contribute to lower carbon-intensity of the economy and will help in the transition to the long term. In the second half of the century, zero-emission technologies will be required to drive required reductions in emissions (e.g. renewables, nuclear energy, hydrogen fuel cells, and carbon removal and storage). Use of market based instruments, such as carbon taxation or emission trading, can create the price incentives needed. Many scenarios also stress the importance of behavioural change to move lifestyles toward more sustainable patterns, for example in shaping the demand for services from the transport and buildings sectors (Morita and Robinson 2001).

Adaptation

Even with radical action to limit emissions of greenhouse gases, changes in the climate are already occurring and are likely to continue. Policies to adapt to climate change will play an increasing role — alongside mitigation strategies — in national and international responses.

Understanding of the physical impacts resulting from long-term climate change is limited, although in-depth regional studies have recently yielded important insights (UEA 2000; US GCRP 2000; UK DETR 2000). As climate change poses a risk with uncertain and perhaps very high consequences, precaution should guide adaptation policies. Estimates of increased losses due to extreme weather events over the last decade indicate that current expenditure on adaptation falls far short of what is required to prevent significant economic losses that could arise from climate change (IPCC 2001*b*).

Natural ecosystems and socio-economic systems are sensitive to both the magnitude and the rate of climate change. The ability of societies and economies to adapt to these changes depends on access to financial resources, technology and scientific expertise, as well as on the strength of social, political and economic institutions. For these reasons, developing countries are generally more vulnerable to climate change impacts , although vulnerability varies.

Some developing countries are particularly vulnerable to climate change impacts because of exposure to recurrent droughts and dependence on rain-fed agriculture and greater incidence of vector-borne diseases, all of which can aggravate poverty. In mountainous ecosystems, arid or semi-arid lands, water-limited and flood-prone areas, climatic variability combined with unsustainable land-use practices could aggravate already severe socio-economic and health problems. Constraints in adaptation capabilities make Africa the most vulnerable continent along with small island states which would be particularly threatened

by a rise in sea levels, a loss of coastal land and disruptions to marine resources. Countries with inland, underground water resources, and where large proportions of the population live in low lying coastal areas — such as Bangladesh, China and Vietnam — are also particularly at risk. It is estimated that tens of millions of people in Bangladesh would be displaced by a 1-metre increase in sea levels. A growing number of cities are located in coastal areas, implying that large amounts of infrastructure may be affected.

In the OECD and possibly some other regions, the rate of climate change may be moderate and difficult to detect from year to year or even from decade to decade. In such a situation, adaptation to climate change may be part of the changing background to most people's lives. In many circumstances, ensuring that adequate information is available, and allowing market forces to reallocate resources, may be sufficient. However, long-term planning will be necessary for human settlement and other land use changes. Water supply infrastructure may also need to anticipate climate change effects, because of changes in overall quantities of precipitation, increased seasonal variation, and greater frequency of both storms and dry periods (IPCC 1999). This will have implications for urban planning, to avoid higher vulnerability to water shortages or flooding. A variety of other impacts in economic sectors, such as agriculture and fisheries or tourism, may also be relevant to policy choices and adaptation.

Given the prevailing uncertainties, the most efficient adaptation strategy, in all regions, is to ensure flexibility and resilience of systems to cope with such shocks. This may also require longer-term precautionary measures to increase the robustness of structures (e.g., development of coastal zones, infrastructure investments) and to allow for earlier replacement (Fankhauser *et al.,* 1999).

More research could assist in defining the appropriate level and type of policy response. Climate change in the foreseeable future will not take the form of some new stable «equilibrium» climate, but rather an ongoing sequence of "transient" process. Future research needs to focus on developing countries and tropical regions, and on relevant key variables, including the magnitude and frequency of extreme events. The focus should shift from single predictions, or extreme ranges of uncertainty, to risk assessment. Thresholds critical to impacted sectors and ecosystems should be identified, and expressed as functions of climatic variables. A major task of adaptation science is also to identify those "dangerous levels of greenhouse gases" beyond which adaptation becomes impractical or prohibitively expensive.

Conclusions

A stable climate requires wide international participation to sharply reduce global GHG emissions. Even with aggressive mitigation action, some climate change is likely to occur, increasingly requiring the allocation of resources to vulnerability assessment and adaptation measures. Improved understanding of the nature, range, and regional distribution of the possible impacts from climate change has highlighted links between climate change and development. Climate change is expected to hit the poorest countries hardest, requiring governments to adopt coherent approaches today that encompass concern about long-term social well-being, health and environmental quality.

Greenhouse gas reduction policies should also be motivated by precaution. Although the process of climate change is not fully understood, recent scientific assessments strengthen evidence that "most of warming observed in the last fifty years is attributable to human activities" (Watson 2000; IPCC 2001*a*). Environmental discontinuities may generate severe or irreversible outcomes in some regions. Expenditure to reduce the risk of severe outcomes and improve the ability of local populations to deal with such threats are important, even if it did little to alter the average "expected" outcome. In the coming decades, more efforts will be needed to determine the magnitude of costs of climate change, and the amount of mitigation and adaptation efforts justified by economic and equity considerations.

The first milestone in this process will be to complete the negotiations on the Kyoto Protocol. Although differences exist over how the Protocol should be implemented, this should not divert policy-makers from the need to start domestic action now. Indeed, if too many countries plan to meet their targets through

buying emission allowances in the future market for permits, they risk being faced with unexpectedly high permit prices and, in a worst case scenario, an institutional lag that artificially raises the price of permits by restricting supply.

New and stronger domestic policies will be required in industrialised countries to bring Kyoto targets into reach. Subsidy and tax reform, eco-taxes and emission trading schemes (both international and domestic) are the essential instruments to be employed. International emission trading, coupled with multi-gas mitigation, can significantly lower overall abatement costs in the Kyoto time frame. Applying these policies across sectors will improve their economic efficiency by equalising the marginal costs of abating GHG emissions. Governments should also strengthen and improve the cost-efficiency of sector-specific performance regulations and support investment in relevant research, development and demonstration. Consideration of the multiple benefits and interaction of greenhouse gas reduction with other policy objectives is likely to influence the types and level of policy action, and could argue for stronger emission reduction in the near term. Finally, progressive, iterative action will be required to encourage new investment, to enable policy makers to learn from experience, and to incorporate better scientific and market information over time.

Stabilising atmospheric concentrations of GHG by 2100 at 750 ppmv or lower would require that CO_2 from the energy system drop to a fraction of what it is today, with OECD emissions falling substantially, and emissions growth slowing in relation to GDP in developing countries. This will require a radical technological transformation, likely to depend in the near term upon high-efficiency natural gas and biomass energy, on the supply side, to bridge the transition to zero-emission alternatives in the long term. Social and institutional innovation can also lead to emissions reduction, especially in transport systems, buildings, improved recycling and cleaner, more efficient production processes (IPCC 2001*c*).

Importantly, the magnitude of required emission reductions in the long run will depend upon how the world would develop in the absence of climate policy (IPCC 2000*a*). Development and policy choices even in the absence of climate considerations, such as identification and pricing of (non-climate) environmental externalities of fossil fuel use, will influence baseline GHG emission levels. In turn, setting ecological targets — for example, stabilisation levels for atmospheric concentrations of GHG or tolerable rates of change per decade — would determine the size and timing of required emission reductions (Berk *et al.*, 2001).

As future emission allowances amount to a form of wealth, their negotiation will likely require explicit consideration of equity, rights and responsibilities. Such negotiation will also need to consider the possibility of providing direct financial transfers from OECD to some developing countries. All assessments indicate the need to allow non-Annex I emissions to increase significantly in the coming century, which implies deeper emission cuts for OECD countries. Market-based solutions are essential to contain the costs of emissions abatement in the long-term while easing the transition to a low emission future. They would lower aggregate and marginal costs of mitigation regardless of the level of reduction required, leaving most developing countries better off than without their use. Depending upon how the mechanisms are structured, and most importantly on the emission allocations, they can provide a vehicle for resource transfers to developing countries.

Even without further international action, OECD countries should continue to advance domestic mitigation policies and promote international co-operation to address climate change. There are a variety of reasons for this. Firstly, most estimates for the costs of climate change consider socio-economic impacts that will probably occur anyway, even if successful emission mitigation policies are introduced. In the absence of such mitigation policies, climate change impacts and costs could be larger and probably continue for several centuries, and the damage may well increase exponentially and lead to irreversible change. Secondly, OECD countries should be concerned about severe consequences of climate change in developing countries, as these may exacerbate tensions due to migration pressures, water stress and food security. Thirdly, the multiple benefits of actions to reduce GHG emissions may be substantial and contribute to achievement of broader environmental and development goals in the OECD. Finally, OECD mitigation action will lead the way to technical and social innovation that could lower emissions in the future and enhance economic growth in developing countries and globally in the longer term.

NOTES

1. Much of the literature on climate change policy applies conventional economic analyses in an attempt to identify economically efficient or "optimal" policy pathways. Inter-disciplinary analyses challenge these approaches for failing to take fully into account social and institutional considerations, which shape policy in real life. Social science perspectives argue for consideration of institutional change, human choice and values to shape policy especially when uncertainty about costs and benefits of action is high. For a discussion see: Rayner and Malone, eds. (1998), Odingo *et al.,* 1994.

2. The climate system is complex involving interactions among the terrestrial eco-systems, oceans and the atmosphere. Though the accuracy of global climate models is thought to have improved significantly since the mid-1990s, scientific understanding of the atmospheric chemistry of global warming, and the fluxes and lifetimes of individual gases, is still evolving and thus still subject to debate and change. It is also important not to exaggerate the uncertainty about the results of climate models, which is no greater than the uncertainty associated with results of economic models commonly used as an input to decision making.

3. Fossil fuel combustion again influences lower atmosphere (tropospheric) ozone levels through emissions of CO, NO_X and VOC and aerosols through emissions of sulphur and soot. Tropospheric ozone is also a GHG.

4. This range of temperature increase compares to that reported earlier by the IPCC of 1.0 - 3.5 degrees C°. The increase is due primarily to assumptions about lower sulphur dioxide emissions stemming from structural changes in the energy system and concern about local and regional pollution.

5. Direct-cost estimates are usually employed to measure the economic damages of sea level rise, but this approach has its limitations. This is because values of threatened land and biodiversity are uncertain, the loss of these does not affect consumer prices, and effects on international trade are not taken into account. If accurate values for dryland and wetland were to include market and non-market components, direct cost estimates would differ significantly.

6. Mendelsohn's estimates are an exception as they are based on a future population-economy scenario.

7. The UN Framework Convention on Climate Change (UNFCCC) calls for: "...stabilisation of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Such stabilisation should be achieved with a time frame sufficient to allow ecosystems to adapt naturally, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" (UNFCCC 1994, Article 2). In this way the Convention avoids defining dangerous climate change, using atmospheric concentrations of GHG as a proxy for managing climate change.

8. The Protocol has not yet been ratified. It will enter into force after ratification by 55 Parties to the Convention, incorporating Parties included in Annex I which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 of the Parties included in Annex I (UNFCCC 1994, Article 25).

9. This group of countries is also often referred to as Annex I countries, in reference to countries listed in Annex I of the Convention. It includes all countries that were Members of the OECD in 1992 plus Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russian Federation, Slovakia, Slovenia and Ukraine. Annex B is found in the Protocol and in comparison to Annex I, it excludes Turkey, which has never ratified the Convention.

10. Several small countries have already ratified the Kyoto Protocol.

11. CO_2 capture and storage in used mines, depleted oil fields, and saline acquifers is the subject of an active research and development programme; the viability of coal or other fossil fuels as part of the long term solution to climate change depends upon technical and economic feasibility of such options. (See IEA 2000*a*, p.281)

12. China, India, Indonesia, Iran, Kazakhstan, Russia, South Africa and Venezuela.

13. Denmark, Finland, France, Germany, Italy, Austria, Sweden, Switzerland, the Netherlands, Norway, and the United Kingdom all have or are implementing some form of energy/carbon tax, though the link with the carbon content of energy is usually weak.

14. See IEA (2000*b*) for an inventory of recent energy-related measures.

15. The term refers to carbon uptake or removal from the atmosphere due to photosynthetic activity in terrestrial vegetation.

16. This refers to countries listed in "Annex II" of the Convention which corresponds to OECD countries at the time of signature in 1992 – the present Membership excepting recent Members of Korea and Mexico, Poland, Hungary, the Czech Republic and Slovakia. Turkey, having never ratified the Convention, is listed in Annex II but is not a Party and thus is not bound by its provisions.

17. Carbon dioxide concentrations are measured as parts per million by volume. It is estimated that the level of atmospheric concentration increased from around 280 ppmv in pre-industrial times to some 360 ppmv in 2000. The UNFCCC does not specify a target value.

18. See also Shukla 1998, Yamin 1999 and OECD Forum on Climate Change (OECD 1999*c*), where F. Tudela of Mexico presented similar ideas.

19. Similar arguments apply for early abatement by industrialised countries under the Kyoto Protocol.

20. Conclusions based on OECD simulations on implementation of the Kyoto Protocol and extracted to future commitment periods even though GREEN does not embody any forward-looking behaviour. If agents anticipated future relative price changes — e.g. the introduction of a carbon tax — the advantages of targeting early emission reduction would probably be reduced. Early clarification of the terms of a binding agreement can also help formation of such expectations.

21. This pathway is not discussed further below since it is considered to lead to unacceptably high risks of rapid climate change.

22. The higher costs relate mainly to assumptions about backstop technologies.

23. Equal per capita emissions are often forwarded as an appropriate approach, reflecting the concept of ecological equity. This corresponds to the idea that property rights to the atmosphere should be held equally. The implication of this approach is that the pace of emission reductions in Annex I countries will determine how quickly developing countries join (see for example, Meyers 1994).

24. GREEN results summarised in this section are based on an assessment of CO_2 mitigation only, ignoring the possible impact of mitigation across the basket of GHG.

25. Emissions growth in the GREEN baseline is driven by GDP and population assumptions, as well as by assumptions about the availability and price of backstop technologies and the rate of autonomous energy efficiency improvement. For a full description of the baseline see OECD 1999*a*.

26. This is due to assumptions about the cost and availability of "backstop" technologies which also tends to make marginal abatement costs converge, thus lower benefits from trading and raise the costs of mitigation.

27. Early proposals for such approaches emerged during the negotiation which led to the Kyoto Protocol. See for example the description of the AOSIS position in UNFCCC 2000*b*.

28. As of the late 1990s, the share of industrialised countries' contribution to anthropogenic build up of CO_2 atmospheric concentrations appears to be between 65-75% (den Elzen, *et al.*, 1999).

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Section V

SECTORAL AND TERRITORIAL APPROACHES

Chapter 12.

ENERGY

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ENERGY

Introduction

Energy has deep and broad relationships with each of the three pillars of sustainable development — the economy, the environment and social welfare. While certain forms of energy production and consumption can diminish environmental sustainability, energy is crucial for economic development. Energy services also help to fulfil basic needs such as food and shelter and contribute to social development by improving education and public health.

But the three pillars have not historically carried the same weight and interest in OECD governments as in the broader global community. Shifts have occurred and continue to occur, as both energy use and our knowledge of its impact continue to grow. For much of the history of energy, available technology for using scarce and costly energy supplies was simple and inefficient — met mostly through biomass, and human or animal muscle power. When the production of larger scale, commercial energy became an option (initially through water mills and wind, and later with coal), it largely powered business growth, and was only available in limited quantities for individual use. Environmental concerns were for the most part not considered.

Gradually, social considerations have been integrated into the energy development picture. From a national perspective, OECD countries' social concerns related to the energy sector have centred on access at reasonable cost and diversity in the sources of supply. Over the past several decades, issues related to secure, low-cost availability of energy (predominantly oil) have dominated international energy-related discussions in OECD countries. In responding to the oil shocks of the 1970s and 1980s, OECD countries have sought to diversify supply, investing enormous resources in new energy technologies and efficiency improvements, and creating emergency stockpiles to ensure continuity of supply should international supplies again be disrupted. In recent years, considerations linked to both the local environment (e.g. air and water pollution) and the global environment (e.g. climate change) have played an increasingly important role. Energy policy makers have acknowledged that the choice is no longer whether to participate or not in the discussions about sustainable development, but how.

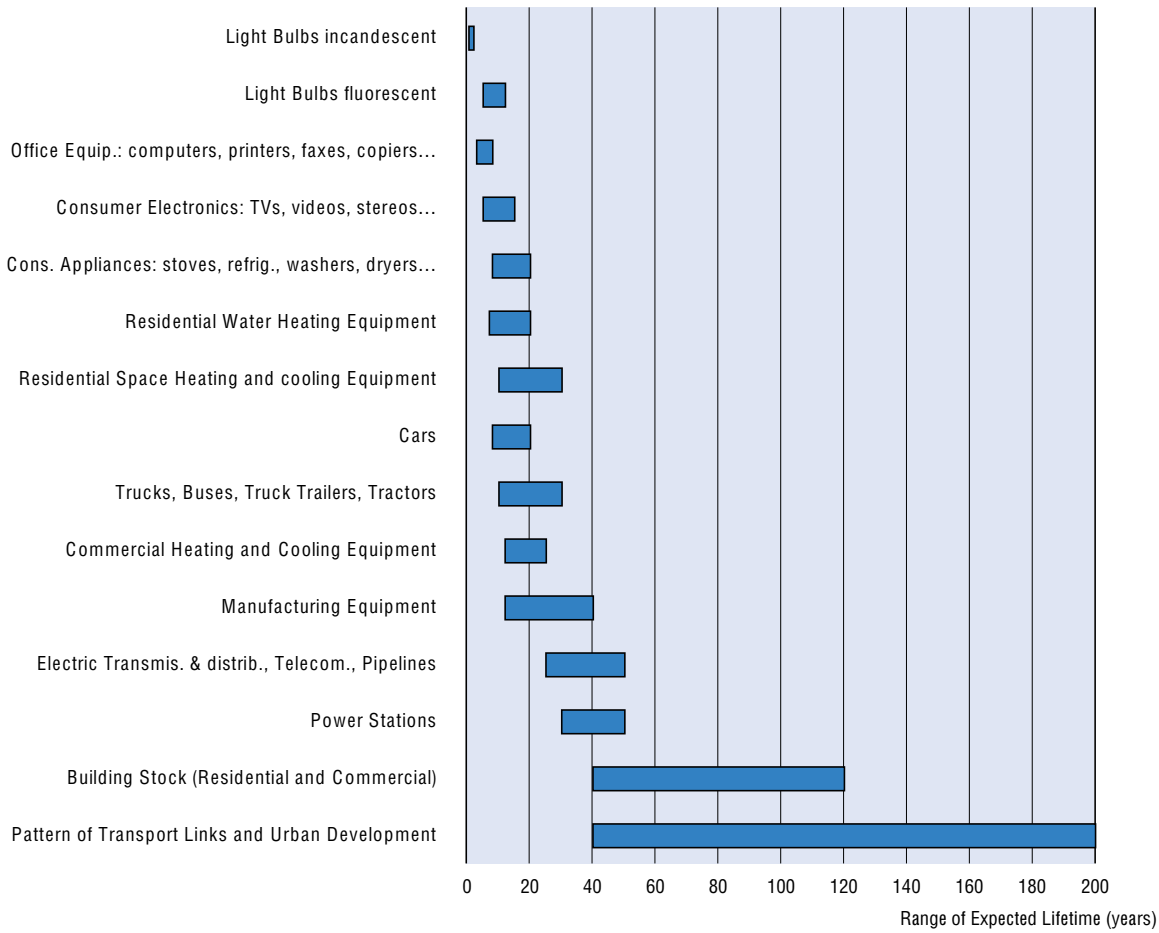
Developing countries, which account for a large and rapidly growing share of global energy demand, do not have the same social priorities as OECD countries when it comes to energy. For most of the world's people, acquiring basic energy services such as refrigeration, heating and lighting, remains an urgent need. Furthermore, developing countries seldom have adequate financial resources to purchase the most up-to-date, environmentally sound and efficient energy technologies. The net result is both a steadily increasing gap between the rich and poor of the world (both within and between countries), and a deterioration in the quality of the environment.

In the developing world, energy use is closely linked to a range of social issues including health, opportunities for women, population growth, and urbanisation. Nevertheless, the overriding consideration for developing countries is poverty — where some 1.3 billion people live on less than one dollar per day. Accessible and affordable energy services could dramatically improve standards of living and offer more opportunities to people in these areas.

Providing choice to consumers and citizens in the forms of energy and energy systems that they use is an essential element of sustainable decision making in the energy sector. Governments need to find ways of assuring universal access to energy services while at the same time addressing co-ordination failures (particularly environmental ones) and avoiding the inefficiency of direct involvement in the micro-management of operations. For both present and future generations, sustainable development of the energy system is principally about maintaining the flexibility to respond to both the unforeseeable shocks and the anticipated consequences of existing actions (e.g. climate change) that would otherwise lead to irreversible damage.

To some extent, risk management and the quest for flexibility in the energy sector are aided by the fact that energy use is not an end in itself, but rather a means to an end. Safe and abundant energy supplies translate into welfare only through the availability of transport, motive power, lighting, heating and cooling — that is, through the availability of *energy services*.[1] Thus the same ends (i.e. heat, power, lighting, mobility) can be provided by different means — different fuels, transformation and end-use technologies. As each fuel and each technology has a different economic, environmental and social impact, choosing and mixing the different components of energy services provides an important degree of freedom for policy making.

Figure 12.1. **Average life-spans for selected energy-related capital stock**



Note: Figures are intended to illustrate typical life-spans, for which there will always be exceptions. For example, some hydroelectric power plants are over 90 years old.

Sources: Compiled from a range of sources by the IEA.

However, the energy sector is characterised by large-scale projects and long time-frames for the planning, operation and decommissioning of energy installations and infrastructures (Figure 12.1 provides some illustrative examples). The slow turnover of energy-specific capital stock creates rigidities once a decision has been made.[2] The resulting inertia and rigidity exposes energy systems, and in some instances society at large, to disruption by limiting flexibility in the face of unexpected shocks. The necessity of conscious risk management and maintenance of flexibility (e.g. through fuel switching) is a direct consequence of the inherent inertia of energy systems.

This chapter looks at the current energy system, and describes both medium and longer-term scenarios. It examines the importance of energy as a strategic commodity, in particular assuring secure energy supplies, along with the environmental impact of energy development, and the role of markets. The chapter also considers some of the indicators used to assess sustainability in the energy system, and the role of governments — including the instruments available to them — in ensuring sustainability. Given this context, a few possible "win-win" sustainable development opportunities are examined, along with a brief discussion of possible barriers and challenges to their implementation. Finally, some conclusions are drawn and recommendations made on actions that could be taken to help direct current energy trends toward a more sustainable future.

The energy system

For fossil fuels as a whole, the prospect of resource exhaustion over the short to medium term is not likely to be a limiting factor. Thus resource shortages will not drive change towards a different near-term energy path. However, over the longer term (more than 50 years), constraints on supplies can be expected to contribute to the drive for alternative and environmentally friendlier energy technologies, although action will be necessary much sooner if these technologies are to be developed to meet expected demand. Finally, conservation and enhancement of the resource base alone will not address the specific needs of developing countries that face different challenges and barriers to ensuring reliable and secure energy services.

The short to medium term

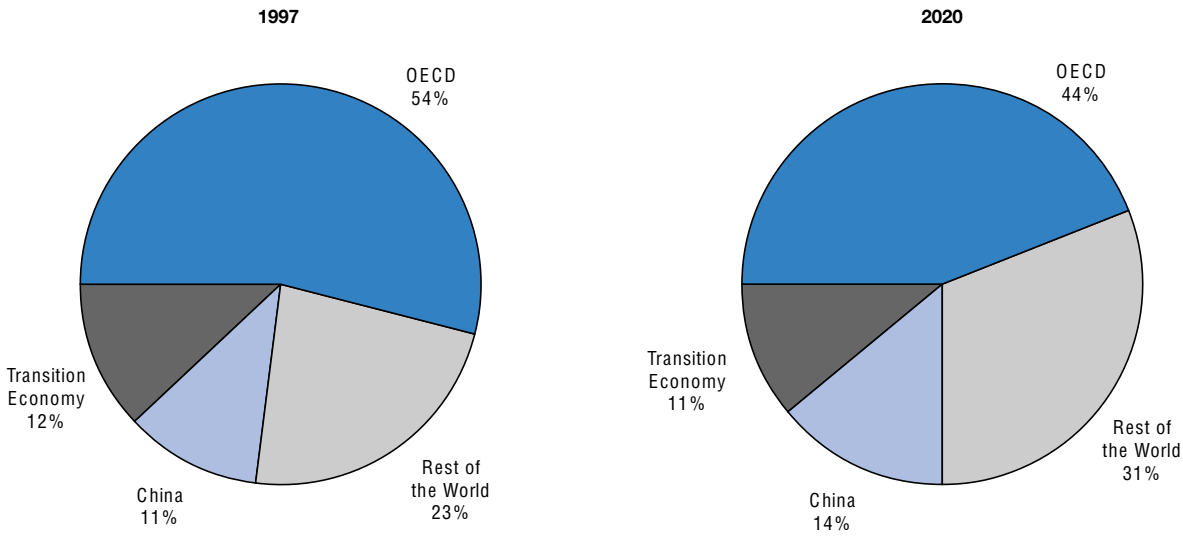
The quest to assure sustainable development in the energy sector must be seen in the context of present day reality: we live in a fossil-fuel world, which is likely to lead to a similar fossil-fuel future with an increasing concentration of oil suppliers. In the Reference Scenario of the IEA's *World Energy Outlook 2000* (IEA, 2000*c*), world total primary energy demand for commercial fuels is projected to increase by more than 57% between 1997 and 2020. This represents an average annual increase of 2%, to slightly more than 13 500 million tonnes of oil equivalent (Mtoe), just under the annual average growth rate of 2.2% between 1971 and 1997.

The bulk of the projected increase in world energy demand over the next 20 years is expected to come from regions outside the OECD area (Figure 12.2).[3] Consequently, the current 54% share of OECD countries will decline to 44% by 2020, while that of developing countries will rise to 46% (from the current 34%). The share of transition economies in world energy demand will decline slightly over the same 20-year period.

Oil will remain the dominant fuel, with a share of almost 40% by 2020, growing at the same rate as total primary energy demand (Figure 12.3). This corresponds to a volume of close to 96 million barrels per day in 2010 and 115 million barrels per day in 2020 (from 74 mb/d in 1997). In the OECD countries, oil demand growth is driven entirely by the transport sector. In other sectors, oil continues to lose market share to other fuels, particularly gas. In non-OECD regions, oil demand growth is also led by transportation, but household, industry and power generation sectors also contribute to the increase.

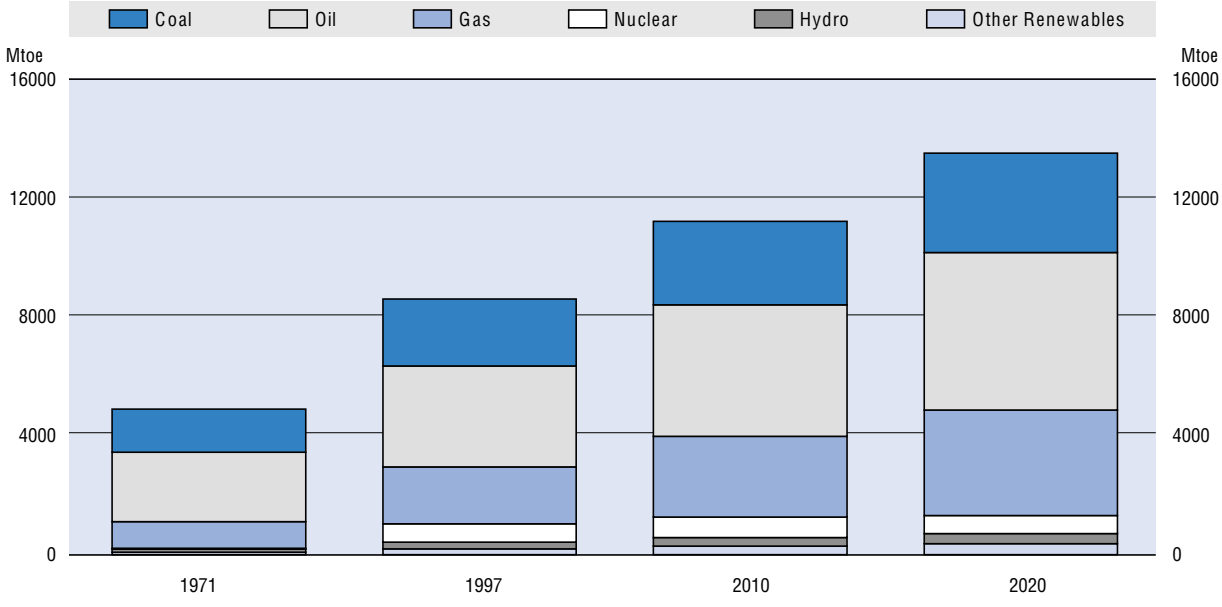
Natural gas is the second-fastest growing energy source after non-hydroelectric renewable energies in the global energy mix, with 2.7% growth per annum over the projection period. As a result, its share in

Figure 12.2. **Composition of world energy demand by region**



Note: World energy demand is projected to increase by 57% from 1997 to 2020
Source: IEA(2000), *World Energy Outlook 2000,* OECD/IEA, Paris.

Figure 12.3. **World primary energy supply by fuel**



Source: IEA (2000), *World Energy Outlook 2000,* OECD/IEA, Paris.

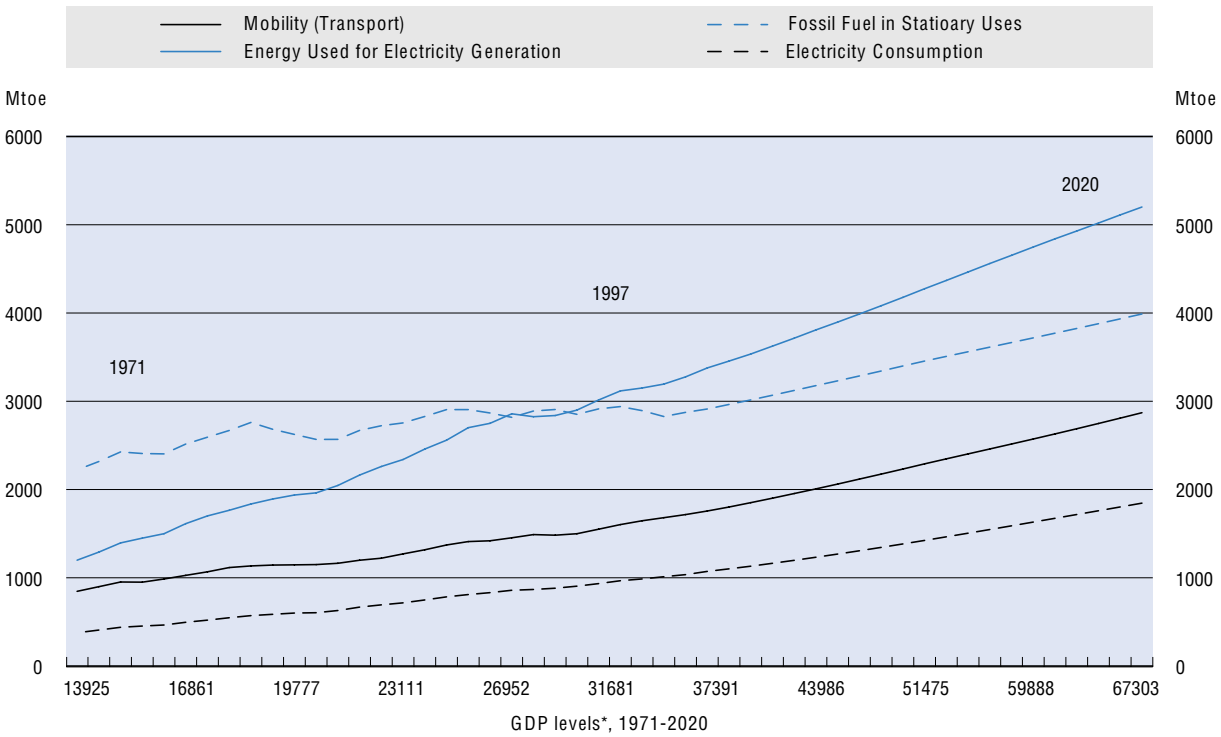
world primary energy demand will increase from 22% today to 26% by 2020. Most of this increase will come at the expense of coal. As shown in the graph above, gas is expected to surpass coal in terms of total primary energy supply (TPES)[4] just after 2010. The bulk of the incremental gas demand will come from new power plants, where technological advances in combined-cycle gas turbines have shifted the economics of power generation in favour of gas.

Over the period to 2020, world demand for coal is projected to increase by only 1.7% per annum and thus to reduce its share of TPES. In OECD countries, virtually all the increase in demand for coal stems from power generation, while the switch from coal to gas in industrial applications and household heating continues. The picture differs in non-OECD countries. While coal's share in the primary fuel mix in the transition economies as a whole is expected to remain flat, it will decline slightly in Russia. China and India, countries with rich coal bases and high electricity demand growth prospects are expected to contribute more than two-thirds to the increment in world coal demand over the projection period.

Nuclear power accounted for 7% of global TPES in 1997, providing 17% of the world's electricity needs. Its contribution is assumed to decline slightly by the end of the outlook period (after 2010), to 5% in 2020, as a significant number of the current 350 reactors in the OECD are expected to be retired during this period. A reduction in the OECD's nuclear power output is not offset by the new facilities being built in developing countries. However, there is a trend towards lifetime extensions of existing plants that could potentially slow this projected decline in nuclear capacity.

Hydropower met 3% of the world's primary energy needs in 1997 and is currently the world's second largest source of electricity (about 20% of total generation) after coal. The world is expected to be using some 50% more hydroelectricity by 2020, mainly in developing countries. Growth, particularly in the OECD regions, is limited by the availability of suitable sites and environmental considerations. Its share in the global primary energy mix will decline slightly. Non-hydroelectric renewable-based energy is expected to be the fastest growing primary energy source, with an annual growth rate averaging 2.8% over the outlook period. Despite this strong growth, the share of non-hydro renewable energy in the global energy mix will only reach 3% by 2020 because of the current low starting point (2% of world's energy mix). Most of this increase will be accounted for by power generation in OECD countries.

Figure 12.4. **World energy-related services**



Note: Billion of 1990 USD at purchasing power party exchange rates (PPP).
Source: IEA (2000), *World Energy Outlook 2000*, OECD/IEA, Paris.

A sector that deserves special mention is transport. By 2020, transport is likely to account for more than half of world oil demand and roughly one-quarter of global energy-related CO_2 emissions, resulting in considerable local air pollution problems. It will grow faster than any other end-use sector. Rapid changes have been difficult to achieve in this sector for a number of reasons, including the inelastic response of the transport sector to energy price movements and the slow turnover of infrastructure. Nevertheless, there is widespread recognition of the need for a stronger policy focus on transport issues (see Chapter 13).

The long term

The World Bank has sought to develop a longer term "consensus" scenario that shows the possible fuel mix reflecting a pooling of views from the World Energy Council, Shell, the Intergovernmental Panel on Climate Change (IPCC) and other scenarios (World Bank, 2000*a*). In this vision of the future for 2060, renewable energy[5] grows to about 30% of the fuel mix, with nuclear energy and hydroelectricity at over 15%. Liquids and gas decline to under 30% and coal continues a slow decline to 15%. Interestingly, it also presumes a continuing decline in the use of traditional biomass (mainly in developing countries) to about 5%, which may indicate a move to more modern bio-energy sources with less potential impact on desertification, as well as increasing commercial energy procurement.

A 1995 study by the Stockholm Environmental Institute (SEI) predicts that fossil fuels will continue to dominate world energy supply to 2050, but also a significant expansion in the contributions from renewable and nuclear energy (SEI, 1995). Demand will be led by the developing countries, with energy consumption increasing more than six-fold in China between 1990 and 2050. The SEI predicts that there will be increasing pressure on fossil-fuel resources, including uncertainties regarding energy price and availability, and geopolitical tensions caused by the concentration of oil and gas resources in a few regions of the world. It foresees also significant barriers to the expansion of nuclear energy (due to concerns about cost, safety, radioactive waste disposal and security issues). Other concerns will arise, such as habitat and ecosystem constraints that limit the full potential of hydroelectricity. While this scenario tracks the path signalled in the *WEO 2000* very closely, it indicates some of the longer-term problems that may arise.

However, longer-term future scenarios differ. For example, although Royal Dutch/Shell predicts a similar fossil-fuelled growth in developing countries, its scenario projects a reduction of the carbon content of fuels, with a long-term shift from coal to oil to gas to renewable energy.[6] Shell predicts that renewable energy could satisfy 50% of worldwide energy demand by 2050. Such an outcome could require many different levels of sustained intervention in markets, which are not currently geared to this objective.

Where all of these scenarios converge, however, is in the prediction that economic growth will continue to fuel strong energy demand on the part of developing countries. This emphasises even more forcefully the importance of ensuring that growth and energy consumption are decoupled.

The social dimension: energy supply and access

While much of the debate on sustainable development has focused on the interplay between economics and the environment, there is clearly a social dimension that must be included. In the case of energy, the social dimension is multifaceted: it includes not only energy security, but also the issue of access to energy services, energy sector employment, disruption to societies resulting from price shifts in the energy sector, and issues such as the social implications of energy-related land use. None of these factors can be considered in isolation — each has economic and environmental implications.

Of these social concerns, much of the focus in OECD countries has been on energy supply, especially the need to assure secure and affordable access. In all future scenarios, energy remains a strategic commodity, as energy and the services it provides remain necessary to fuel social and economic growth.

Energy security is a broad concept. It embraces all energy sources (not just oil). It requires efficient markets, secure frameworks for investment, undistorted pricing, integration of environmental concerns, and stable and transparent relations between consumers and suppliers.

Diversification provides one element of supply security. Fighting the temptation to "put all your eggs in one basket" — that is, to go all out for what appears to be the economic or political least-cost solution in the short run — is an essential part of risk minimisation. For longer-term energy diversity, that means fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil energy services, particularly nuclear and hydroelectric power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

Security issues related to *oil* have not dissipated, and may increase over the medium term. The oil market is not free and is dominated on the supply side by a relatively small number of producers (and countries) that try to manipulate the crude flows according to a changing mix of political and commercial motives — and this trend is expected to continue. OPEC Middle East producers account for 26% of world oil supply today and (according to the *WEO 2000)* this share could grow to almost 50% in 2020, as production in other areas peaks and begins to decline. The recent oil market volatility, which has translated into significantly increased prices at the consumer level, has yet again focused worldwide attention on the cartel power controlling a large share of the world's production. Restraints on world oil supply and sharp increases in oil prices could feed inflation and slow economic growth, particularly in developing countries. On the other hand, higher prices could encourage broader deployment of more advanced technologies (e.g. more-efficient or alternative-fuelled vehicles) and renewable energy, which could reduce overall fossil energy consumption and improve the environment.

The situation in natural *gas* markets is structurally similar to the oil market, inasmuch as gas markets in Europe and Asia rely on a small number of producing countries, some of which have experienced abrupt political change in the past. Two regions, the Former Soviet Union and the Middle East, account for 70% of global reserves. Gas security is not an issue of absolute physical scarcity, but rather a question of regional distribution (e.g. Europe is expected to import 60% of its gas demand by 2020) and the stability of supplier-customer relations. Evidence thus far suggests that the increased efficiency gains and more market-driven investment decisions (in part through the structural reforms of the gas market) have contributed to a broader range of services and lower prices to most consumers (IEA, 1998*b*). They have also strengthened long-term security through development of transmission and storage. However, governments are important in enhancing both short and long-term security, for example in facilitating international trade and investment in pipeline interconnections, determining appropriate security levels for small consumers, and setting safety requirements. Many see a switch away from oil and coal to gas (which has the least CO_2 emissions per unit of power generated of all the fossil fuels, and lower costs for power generation) as part of a near-term strategy to combat climate change. Getting that supply to the markets that need it, however, will remain a considerable challenge.

The global *coal* market is instead characterised by a number of supplier countries with a certain degree of political stability that compete on price and quality. The top ten coal-producing countries account for over 90% of the world's coal endowment. Because coal is relatively expensive to move and store, and because many countries have indigenous resources that meet part or all of their coal needs, only about 14.5% the world's coal production is sold in an international market (IEA, 1999*a*).[7] The two main factors affecting coal use in developed countries are its competitiveness against natural gas in power generation and environmental regulations. Efforts to reduce emissions of sulphur, particulates and nitrous oxides are already having a significant effect on coal use and operating costs. It remains to be seen whether technology will evolve to eliminate emissions of these pollutants, and how implementation of climate change policies will effect the future of coal. The long-term future of coal may depend on, among other things, the market value set on carbon (coal has the highest CO_2 emissions per unit of power generated) and the development of cost-effective technologies for carbon sequestration. Reform of electricity markets and advances in combined-cycle gas turbine technology have given gas an economic advantage over coal. This advantage could be eroded over the longer term by secular increases in natural gas prices. For some major developing

countries with abundant indigenous coal resources (namely India and China), the economics as well as security-of-supply concerns will result in continued growth in coal-generated electricity and commensurate increases in CO_2 emissions — unless better and more efficient technologies are used.

Nuclear energy interacts, positively and negatively, with the three different dimensions of sustainable development in perhaps a more pronounced fashion than other forms of energy. Nuclear power presents no major resource depletion issues, produces only negligible amounts of greenhouse gas emissions, and has significantly contributed to past reduction of CO_2 emissions in some OECD countries. In virtually all electricity markets, existing nuclear power plants are commercially viable, but new investment is not currently attractive for most OECD countries. Nuclear energy is often also socially contested due to perceived long-term risks stemming from radioactive waste management and disposal, and potential accidents at operating plants, or during the transport of radioactive wastes. These conflicts make it difficult to predict the magnitude of the future contribution of nuclear power.

As its contribution to the OECD project on sustainable development, the Nuclear Energy Agency has prepared a document to help governments assess the extent to which nuclear energy is compatible with the goals of sustainable development, and to identify areas in which nuclear energy could contribute to sustainable development. The specific characteristics of nuclear energy are reviewed from economic, environmental and social viewpoints, providing data and analyses on the nuclear option. The primary audience for the document is policy makers within the OECD and Member country governments. The document may also be of interest to the nuclear, energy and environmental policy communities, as well as to a broader public of interested and affected parties. The intent of the document is not to arrive at judgements as to whether or not nuclear energy can be considered a sustainable technology in particular situations or countries, as this will depend on a wide range of factors, many of them specific to local situations. Furthermore, the document does not prejudge the policies of individual Member countries towards nuclear energy (NEA, 2000).

Engaging in a broad and transparent discussion of the complex trade-offs between different dimensions of risk (climate change, local pollution, economics and potential of accidents) allows a review of the appropriate role of various energy sources in providing secure energy services.

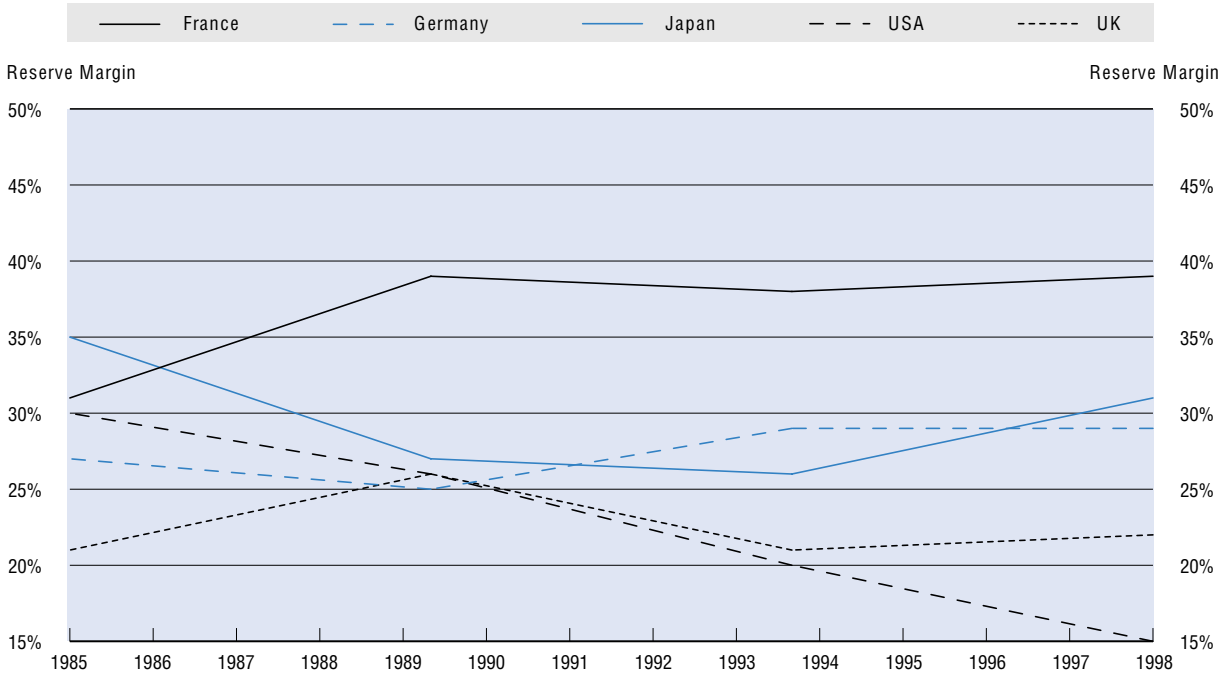
A case study of the power sector

Security of supply in the power sector refers to three elements: system reliability, or the short-term capacity of the power industry to cover demand; adequate capacity investment, or the long-term capacity of the system to cover peak demand; and fuel diversification, or spreading the risk across fuel sources (IEA, 1999*c*). Reliability standards were in the past set by governments, and often at a stringent level on the assumption that almost all customers required the same standard. It remains to be seen whether some consumers, now faced with a myriad of pricing options based on reliability, will discount the importance of security for a lower price, not appreciating the potential ramifications of the trade-off.

The impact of market liberalisation on investments in generating capacity and diversity of fuel inputs is not yet fully clear. However, recent capacity shortages in some jurisdictions may signal that there will be transitional consequences of moving from regulated monopolies to functioning markets. Under regulated regimes, margins tended to be generous — reserve generating capacities for OECD countries remained for the most part well over 20% (Figure 12.5).[8] Arguably, this over-capacity was not efficient — it may have resulted in higher electricity rates — and is not sustainable under a liberalised market. Still, if the trend arising in the United States is any indication, other OECD countries may see their generating margins dropping towards 15%. This may give rise to temporary shortages due to unforeseen demand stresses, particularly at the regional level.[9] On the other hand, power shortages send clear market signals that can encourage new capacity development.

Access to secure and reliable sources of electricity is a fundamental concern for the two billion of the world's six billion people who are without it. This number has remained relatively constant over the last thirty

Figure 12.5. **Reserve margins in electricity generating capacity for selected OECD countries**



Source: IEA(1999), *Electricity Reform: Power Generation Costs and Investment*, OECD/IEA, Paris.

years as population has expanded at pace with electrification. The actual number of people without electricity in their homes, however, might be considerably higher if "access to electricity" is defined as grid extension to a village. In many developing countries, sizeable proportions even of urban households are unable to connect themselves due to the high costs of connection, which can run from a single-phase connection for USD 50 to several hundreds of dollars. Even when access to electricity in a city can be qualified as "easy", only half of all inhabitants might ultimately use electricity (World Bank, 2000*b*). In addition, unlike OECD countries that currently have significant power reserve capacity, most developing countries face capacity shortages. For example, the power sector in India was faced with a shortage during peak demand periods of around 16% during 1990-91, but the position had worsened to 18% (or about 11 500 billion kWh) by 1997, as capacity additions did not keep up with demand (let alone overcome the initial shortfall) (CSISL, 2000).

Fixed costs are relatively high for grid extensions to remote communities, where population density and demand is low, and concentrated at peak times. Hence a great deal of attention is being focused on the potential for off-grid energy services, but alternatives — such as photovoltaic systems — are currently costly. Still, where dry-cell and car batteries are frequently used in areas without grid access at costs of several dollars per kilowatt-hour, photovoltaics and other renewable energy sources may provide a more economical and environmentally benign option. Although the technologies are varied, other barriers — such as intermittent service (e.g. wind), insufficient supply for peaks or oversupply off-peak (e.g. small hydroelectric plants), or expensive batteries (e.g. wind or solar minigrids) — tend to cap consumption.

Furthermore, the electricity sector in developing countries has considerable room for improvement. For example, older power plants in developing countries consume 18-44% (World Bank, 2000*b*) more fuel for each unit of electricity produced than do plants in OECD countries. Transmission and distribution losses range from 20% to 40%, contrasting with OECD ranges in the single digits. Some barriers to investment in improving the status quo are discussed below.

Energy and environmental sustainability

Energy production, transport, use, and consumption affect the environment from the extraction of primary geological resources to end-use services. The severity of impact varies greatly, as does the degree to which the environmental risks have been captured, either by regulatory action or by pricing structures. Although many of the issues outlined below are being addressed — or the risk of their occurrence have been reduced — others remain of concern or represent significant potential risks in terms of the magnitude of damage. Managing the interaction between energy and the environment thus remains one of the major sustainability challenges for energy policy-makers today. Policy-makers in other areas (environment, competition, etc.) also need to better understand how energy markets work, as well as the balances between supply security and environmental considerations.

Extraction, production and processing

Extraction (open-pit mines for coal, and drilling for oil and gas in ecologically sensitive areas) poses problems for local fauna and flora. Land-use pressure in the energy sector — when energy activities are sited in conflict with agriculture and housing opportunities, or where natural ecosystems could be lost — has focused on mining sites and hydroelectric reservoirs. However, new efforts to find suitable sites for large-scale wind or solar photovoltaic fields have faced some of the same pressures. Global demands for oil and gas have led to exploration and production further and further afield, often in areas of high environmental sensitivity. Acid drainage problems can occur from existing or abandoned mines. Uranium mining and milling releases radon and radon compounds, which are potential occupational hazards, although the overall scale of their impact is limited because of the high energy density contained within uranium. Process effluent and tailings may cause groundwater contamination. The production and processing phases of fossil fuels contribute to methane (CH_4) emissions (released through the venting of natural gas and in the production of coal, especially deep-mined coal), a greenhouse gas with a high warming potential.

Transport

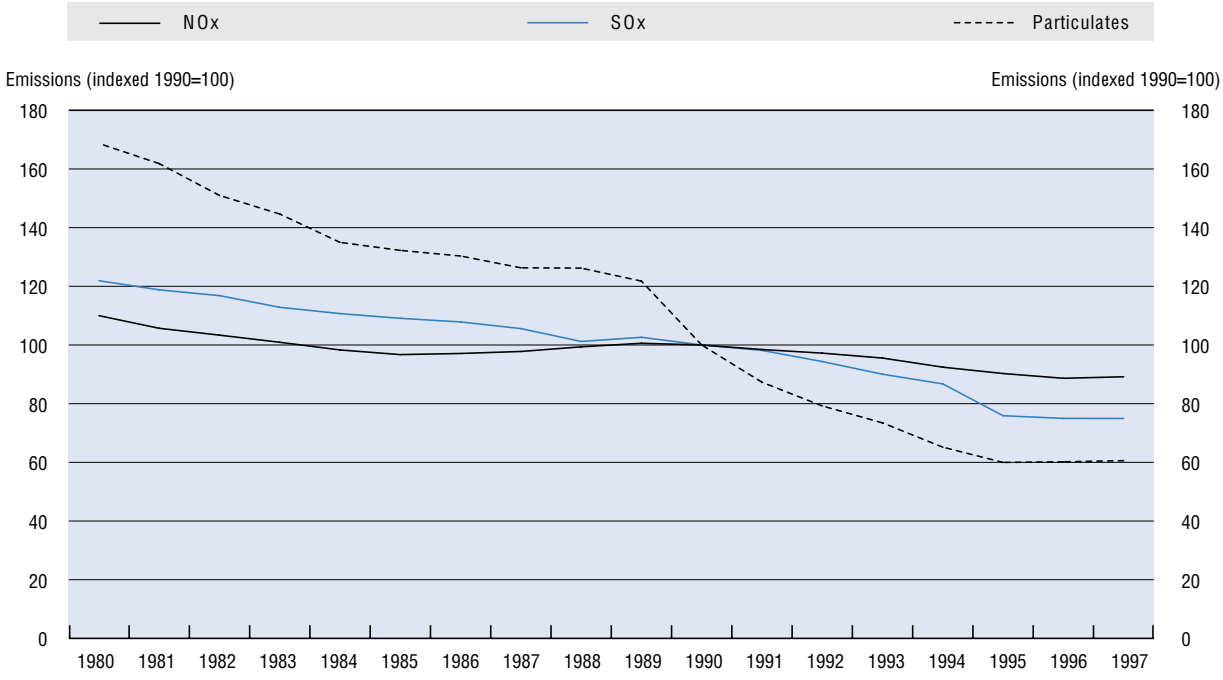
Fuel transport presents environmental, health and security concerns (e.g. from leaking oil tankers, and oil and gas pipelines, as well as transport of radioactive materials). Because of the very visible environmental consequences and the number of recent accidents involving marine-based pollution, much concern has centred on oil discharge and spills. Spills can occur in coastal waters important to fishing, tourism or industry, and cause damage to marine ecosystems. Creating the pipeline infrastructure presents another environmental (e.g. methane leakage and land use implications) and political (e.g. siting and construction of transboundary pipelines) challenge. Although there have so far been no major accidents involving the transport of nuclear waste, it is a perceived public concern (see also Chapter 13).

Table 12.1. Airborne concentrations of major pollutants, 1995

Country	City	City Population 1,000s	Total Suspended Particulates (mg per m^2)	Sulphur Dioxide (mg per m^3)	Nitrogen Dioxide (micrograms per m^3)
China	Beijing	11,299	377	90	122
Russian Federation	Moscow	9,269	100	109	-
India	Delhi	9,948	415	24	41
Indonesia	Jakarta	8,621	271	-	-
Iran	Tehran	6,836	248	209	-
South Africa	Capetown	2,671	-	21	72
Venezuela	Caracas	3,007	53	33	57
WHO Guideline		-	90	50	50

Source: Compilation on the basis of World Bank (1998), *World Development Indicators*, 1998, Washington. DC.

Figure 12.6. **Progress in reducing selected emissions from power generation in OECD countries**



Note: Data refers to emissions of particulates, sulphates and nitrous oxide.
Sources: Compilation on the basis of OECD (1999), *OECD Environmental Data – Compendium 1999*, Paris.

Box 12.1. **The case of particulates, NO_X and SO_X**

OECD countries have made considerable progress in recent years in reducing the emissions of local and regional pollutants (criteria pollutants) such as particulates, sulphur-dioxide, volatile organic compounds or nitrogen oxide (Figure 12.6). Progress was made mainly in the wake of regulatory efforts such as the Large Power Plant Directive in the European Union and the Clean Air Act in the United States, rather than as a consequence of fiscal internalisation.

However, given their sometimes severe health impacts, reducing energy-related emissions remains a formidable challenge in many developing countries. Table 12.1 shows ambient air quality levels in several large cities, in which emissions are in most cases well above the World Health Organisation (WHO) air-quality guideline levels for maximum annual means.

Energy-efficiency improvements, fuel switching (e.g. from biomass, dung and coal to natural gas and electricity) and basic emissions controls could achieve significant reductions at limited costs. The local benefits of such actions — both in terms of human health, and economic welfare — can help catalyse action for improvements. However, overall costs of remedial or preventive actions are considerable — preventing many of the least-developed countries from taking actions already adopted by OECD countries. Finding ways to capture the economic benefits of remediation strategies will help generate the financial flows necessary to drive change.

Combustion and energy use

Combustion of fossil fuels leads to emissions of particulate matter, sulphur oxides (SO_X), nitrous oxides (NO_X), volatile organic compounds (VOCs) and greenhouse gases. Without proper controls, the combustion

of high-sulphur, low-quality coal and other fossil fuels produces emissions of particulates dangerous to human health, and of sulphur dioxide (SO_2), a precursor to acid rain (Box 12.1). The ecological consequences of acid rain include acidification of lakes, streams and groundwaters (resulting in damage to fish and other aquatic life), damage to forests and to agricultural crops, as well as deterioration of man-made materials (such as buildings, metal structures and fabrics). Nitrous oxides can also have serious effects on human health and the environment (OECD, 2000).[10] Both electric power and road transport are important sources of NO_X emissions. Soil deposition of nitrogen from combustion-related NO_X can lead to nitrogen run-off, which, along with nitrogenous fertilisers, can stimulate the growth of algae and other aquatic plants leading to algal bloom or entrophication of lakes, rivers and streams. Lead pollution from combustion in motor vehicles is still a problem in a few OECD countries and an ongoing problem in many developing countries, causing mental health disorders particularly in children.

Energy-related activities involving large facilities or complex industrial processes, such as fuel refining or electric power generation, are also subject to siting and land-use concerns. In addition to energy activities which traditionally have faced siting difficulties (such as power stations or refineries), there are growing siting problems for the disposal of solid wastes ranging from those generated in pollution-control operations (e.g. thermal discharges of cooling systems in power plants) to high-level radioactive waste. In many cases, opposition to siting specific projects (the so-called "not in my backyard" or "NIMBY" syndrome) stems from a combination of concerns about land use, effects on land values, pollution and accidents — factors not easily separated and evaluated. In this context, the potential risk of failure and the environmental effects of an accidental leak remain the major area of concern with respect to nuclear reactor operation, although much has been done to demonstrate that safety in operation.

Even the use of renewable energy sources is not without problems of its own, generated by the toxic substances released in the manufacture of solar cells, the "visual pollution" of wind-farms, and biodiversity-poor mono-cultures used for bio-fuels. These problems, however, are typically site-specific and local in

Box 12.2. **The case of greenhouse gases**

Energy accounts for 85% of total greenhouse gas (GHG) emissions in industrialised countries. Historical data and projections indicate a growing contribution to world GHG emissions from developing countries, which represent 39% of global CO_2 emissions from energy today, and about 50% by 2020. Per capita emissions of developing countries remain, however, considerably lower than those of developed countries (IEA, 1999*f*). Since energy use per unit of output is higher in developing countries, the potential for improved efficiency may, to some degree, offset the growth in emissions per capita that is likely to result from economic growth.

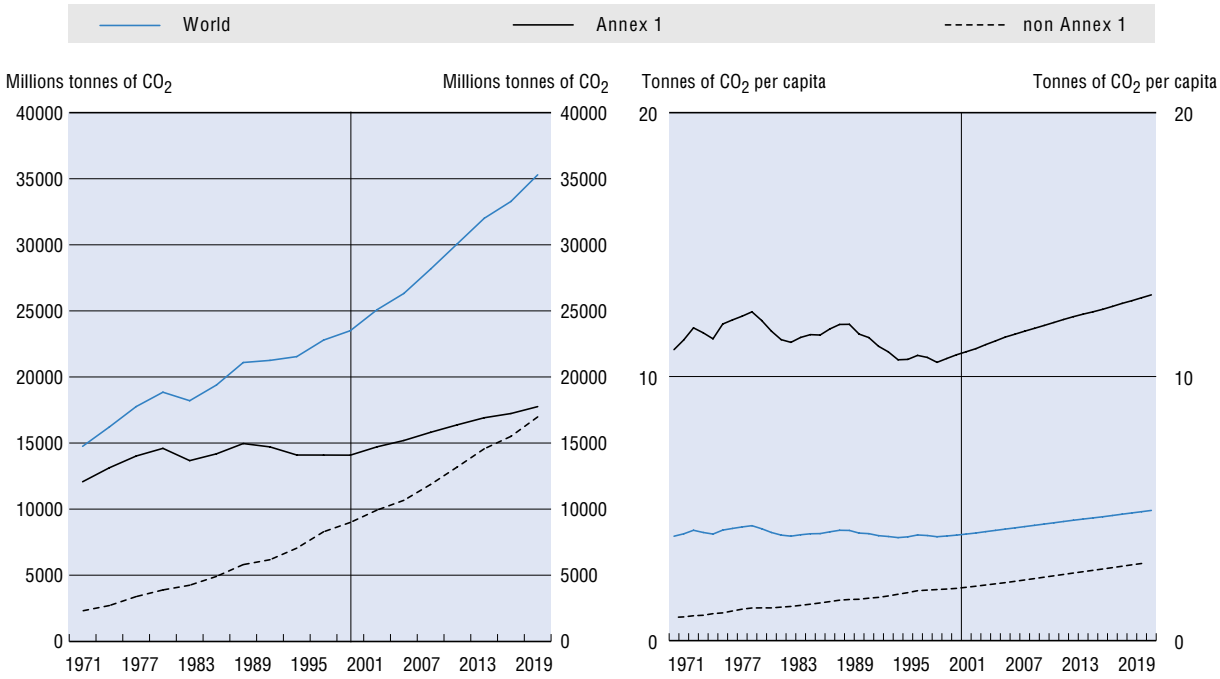
Actions to curb this global environmental problem will shape the future of energy. IEA energy forecasts suggest that meeting Kyoto goals requires stronger new policies. Actions are focused on the energy sector because of its relatively significant contribution to the problem. Of course, since affordable and accessible energy services (e.g. heating, cooling and mobility) are important components of many OECD/IEA countries' relatively high standards of living, policy makers are faced with the challenge of efficiently reducing emissions while not compromising energy services and sustained economic growth.

Technical choices to tackle this unprecedented environmental challenge include: switching to less carbon-intensive fuels; developing non-fossil energy resources (such as nuclear power and renewable energy); improving end-use efficiency; fostering structural change towards less energy-intensive production and consumption patterns; and removing and storing carbon from the atmosphere. Policies that can bring about such changes include economic instruments (such as taxes, subsidies for research and emission trading), regulations, voluntary initiatives by industry, and specifically targeted government technology policies. International instruments under the Kyoto Protocol, such as emissions trading, the Clean Development Mechanism to help developing countries reduce emissions, and the inclusion of non-CO_2 greenhouse gases, can help reduce the costs of meeting the Kyoto targets and encourage developing countries to reduce emissions over the longer term.

nature. There are a number of ways to minimise these negative environmental effects — and in many cases, associated externalities are easily reversed with policy changes. Nevertheless, if there is a significant increase in the use of renewable energies, their impact could be much greater (IEA, 1998a).[11]

While local problems are often significant, it is the new class of global environmental damage that may be most critical to long-term sustainability in the energy sector. Most prominent among these is the issue of global climate change, related to the emissions of greenhouse gases (Box 12.2) such as CO_2 and methane from fuel combustion. Nitrous oxide (N_2O), another greenhouse gas, is emitted in the energy sector primarily through the burning of wood as fuel and from motor vehicles (an unintended by-product of catalytic converters).

Figure 12.7. **World energy-related carbon dioxide emissions**



Sources: IEA (2000), *World Energy Outlook 2000 Edition,* OECD/IEA, Paris.

Sustainable economic growth: the role of markets

In addition to governance over public goods, governments also have an obligation to create the appropriate framework conditions for well-functioning and competitive markets. The protection of property rights, the enforcement of contracts, and the regulation of competition are perhaps the best known functions of government in this respect.

Energy markets have also experienced substantial government involvement to achieve various policy objectives, for example to overcome large project and financial risks, to assure efficient pricing in activities that tend towards natural monopolies, to encourage resource development, and to increase access to energy services. With a recent trend toward deregulation of the production and supply functions in natural gas and electricity markets, the rational scope for government involvement in energy markets has narrowed.

Regulatory reform and the liberalisation of energy markets offers significant potential benefits in terms of improved economic efficiency, lower prices for consumers, improved risk allocation, and stimulus to

economic growth and competitiveness. One of the main benefits of market liberalisation occurs when reduced supply costs resulting from competitive pressures are translated into lower prices for consumers. A considerable body of evidence shows that this has occurred with the liberalisation of electricity and gas markets (IEA, 1999*c*; IEA, 1998*b*).

Sustainability of the current energy system: energy indicators

Organising agreement on the choice of appropriate indicators for progress towards sustainable development is one task that policy makers must face. While no one indicator can assess whether or not there is movement down a sustainable energy path, different indicators can identify and then help track progress towards precise goals.

The World Bank has examined some of the wider social welfare indicators pertaining to energy and sustainable development in developing countries (World Bank, 2000*b*). Three sets of indicators were developed covering access to energy services, their affordability, and effects on health and education. These included: coverage index (household access by fuel); average fuel cost per effective unit of energy; economic burden (e.g. capital cost of household energy use); and reliability index (reliability of access by fuel). This assessment consequently focused on energy consumption rather than just on electricity access.

Broadly speaking, indicators of energy use and efficiency can also help describe the links between energy use and human activity in a detailed and quantitative way. Energy indicators measure the performance of energy use or emissions in much the same way stock indices measure economic performance. Understanding how the components of energy demand interacted in the past is key to improving perceptions of the range of future possibilities.

Disaggregated indicators allow for a practical understanding of differences between energy use within a country and among countries. Aggregate comparisons of per capita energy use (or the ratio of energy use to GDP) do tell how national energy-use patterns differ but do not tell in what way or how efficiently the energy is used. Many factors contribute to variations between different countries, sectors, and periods. These include geography, climate, income, energy-price levels, technological progress, energy efficiency programmes, structural changes (in mixes of materials, goods and services produced), and changes in levels of comfort and mobility. A bottom-up approach to indicators that links energy uses to activities or output and energy intensities, or energy use per unit of output, can help measure changes in energy efficiency (IEA, 1997*a*; IEA, 1997*c*).

A relatively short list of key uses — car driving, freight haulage, home heating, production in energy-intensive industries — reveal the major sources of changes in consumption. Some examples of disaggregated indicators are vehicle efficiency, energy use per building area heated or cooled, and energy use by manufacturing for value-added by product.

Each of these indicators is relevant to the issue of energy and sustainable development. For example, trends in energy intensity in developed countries show significant decreases, suggesting that economic production per unit of energy consumed is increasing. This is a positive trend for the economic pillar of sustainability, provided there is no leakage (i.e. industries do not relocate) to developing countries with less efficient or more carbon-intensive energy production. However, the domestic travel indicator is more ambiguous, showing a rise in every IEA country. This trend suggests increased mobility (with concomitant economic and social benefits) and also increased environmental damages. Making sustainable policy choices requires carefully weighing benefits and negative consequences, and such indicators can help in that process.

The role of governments

The large dimensions and long time scales connected with energy installations, as well as the intrinsic connection of energy to public goods such as the environment and social development, have historically

resulted in significant government involvement in energy-related decision making. Further, increasing returns to scale due to large fixed costs have in the past provided a rationale for government ownership and price setting in the energy sector. To the extent that a commitment to sustainable development implies a desire to improve on the outcome of private markets, policy makers must provide leadership.

This does not imply rigid, command-and-control style intervention and, even less, continued government ownership. The division of labour between markets and governments takes place along a moving frontier that shifts according to changing structural parameters. OECD governments have recognised that in some cases — particularly for the provision of electricity and natural gas — deregulation allows markets to operate more efficiently and cost-effectively. However, governments also recognise that there are reasons for their continued involvement. Long-term uncertainties, the fact that markets do not always account for environmental and social objectives, the continued monopoly nature of natural gas and electricity transmission grids, and the global nature of some of the problems such as climate change, are just some examples of the rationale for a continuing government role.

Box 12.3. Life cycle analysis and the assessment of sustainability

Several studies have tried to assess the costs stemming from energy-related airborne emissions in terms of human health and environmental degradation. All have been hampered by uncertainty about the precise monetary value of the damage, as well as of the underlying biophysical dose-response relationships. Table 12.2 shows that different methodologies, technologies, location and population densities can produce wide differences in estimates. These differences highlight the difficulty and limits of this tool. In particular, they indicate that it works best for local and regional pollution, on short time-frames (where measurement promises at least some perspective of success). Estimating global environmental damages such as climate change or ozone layer destruction (where the time frames for impacts are much longer) remains speculative.

Local and regional impacts of energy production and consumption can be assessed through life-cycle analysis, cost-benefit analysis, and the internalisation of external costs, allowing for a least "full" cost (including all environmental and social costs) energy system.

The likely life-cycle emissions from the main renewable energy technologies have been evaluated through a recent IEA publication and compared to life cycle emissions from conventional electricity generation (in the United Kingdom). Tables 12.3 and 12.4 show these results. The results are only intended as indicative, to show the variations and relative differences between the various fuel inputs. As can be expected, life-cycle emissions are small compared with those from a fossil fuel plant.

Several other studies include similar figures for greenhouse-gas emissions per kWh, which range from 8 to 60g/kWh. The studies summarised in Tables 12.3 and 12.4 did not examine nuclear energy, but its generation does not release SO_2 or NO_X. These figures place nuclear power, on a life-cycle basis for the gases shown above, in the ranges shown for non-hydroelectric renewable energy. Tables 12.3 and 12.4 deal only with emissions and not with internalising other environmental, health and safety costs, and thus form only a partial representation of life-cycle analysis used for illustration.

A more in-depth example is the European Commission 1995 set of studies which developed an operational accounting framework for the external costs of fuel cycles ('ExternE'). Separate volumes address analyses of nuclear, fossil and renewable fuel cycles for the assessment of externalities associated with electricity generation. The type of impacts considered include: effects of air pollution on the natural and human environment; noise and visual intrusion on amenity; and the effects of climate change. The project addresses complete "cradle-to-grave" analysis for site and technology-specific fuel cycles.

Source: European Commission (1995), *ExternE: External costs of Energy*, Luxembourg

For example, commercial considerations based on market discount rates do not place much value on long-term effects (including possible irreversible environmental damage). There is little private value to these investments, which do not pay off for many years. In the absence of internalised prices for externalities, long-term objectives such as climate change will not form part of commercial investment decisions. For example, new coal-fired power plants (with fifty or more years of expected operating life) will continue to be built in spite of their projected long-term contribution to CO_2 emissions.

Table 12.2. **Estimates of damage costs from energy-related airbome emissions**
(USD per tonne)

Study		SO_2	NO_X	Particulates
Externe	High estimate	6 050	12 610	16 060
	Low estimate	4 140	0	16 060
ORNL/RFF Study	High estimate	1 002	2 003	4 004
Southeast reference site	Mid estimate	60	120	1 900
	Low estimate	10	90	850
New York State	Urban	1 200	1 100	43 800
Externalities Study	Suburban	800	900	7 700
Central estimates	Rural	700	900	3 200

Sources: Keppler and Kram (1996), *Energy Markets – Full Cost Pricing*, Working Paper 3 for the Annex I Experts Group, Paris: OECD/IEA. Calculated on the basis of European Commission (1995), ExternE: Externalities of Energy, Brussels; Hagler-Bailly (1995), New York Environmental Externalities Cost Study, New York; Nick Eyre (1994), Personal Communication, Eyre Energy Environment, Cambridge, UK; Oak Ridge National Laboratory – Resources for the Future (1994), Fuel Cycle Externalities, Oak Ridge, TN.

Table 12.3. **Life cycle emissions from renewable energy**
(g/kWh)

	Energy Crops Current Practice	Energy Crops Future Practice	Hydro Small-scale	Hydro Large-scale	Solar PV	Solar Thermal electric	Wind	Geo-thermal
CO_2	17-27	15-18	9	3.6-11.6	98-167	26-38	7-9	79
SO_2	.07-.16	.06-.08	.03	.009-.024	.20-.34	.13-.27	.02-.09	.02
NO_X	1.1-2.5	.35-.51	.07	.003-.006	.18-.30	.06-.13	.02-.06	.28

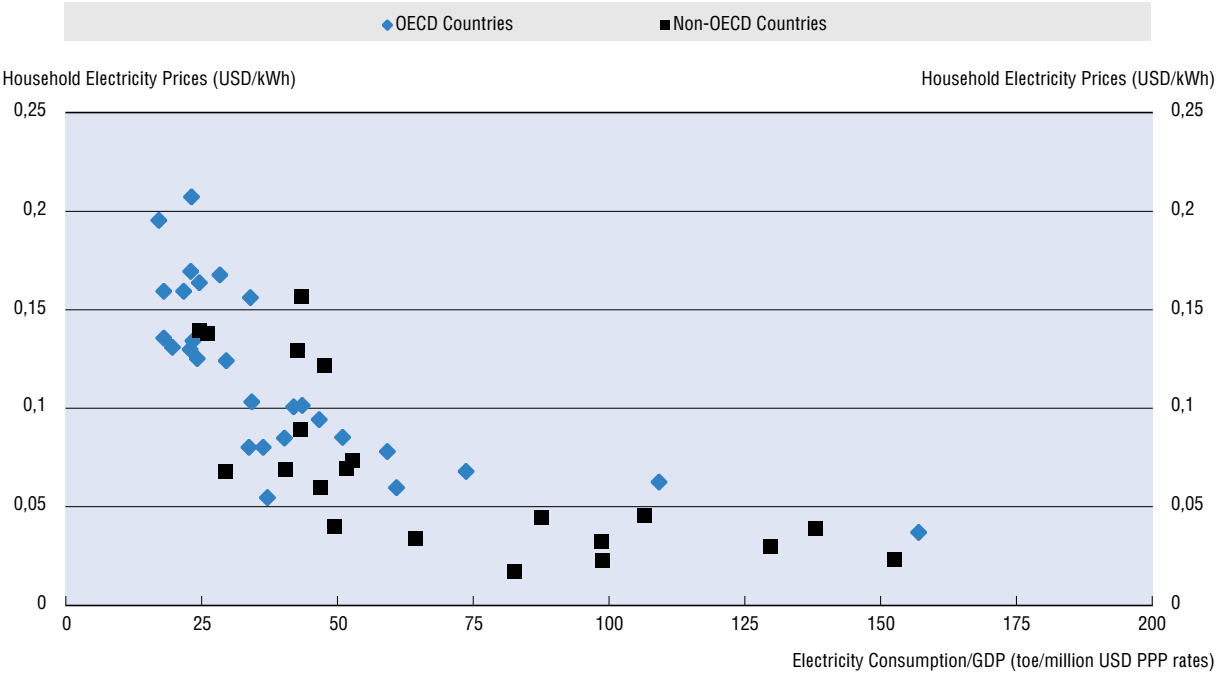
It is the nature and type of government involvement in setting appropriate policies for sustainable energy systems that need to be determined. Governments have many instruments at their disposal. These include not only direct policy intervention, but also a responsibility to provide an enabling environment that encourages markets to operate effectively and efficiently (see also Chapters 2 and 5).

Fiscal and market instruments

When market prices do not fully reflect environmental and social costs, consumers' choices are distorted. Imposing an appropriate market (price) signal to encourage environmentally rational energy use — including both reducing consumption and changing its composition in favour of more environmentally friendly goods and services — may be accomplished through a variety of economic instruments, from direct taxes to tradable permits.

If the objective of lowering energy consumption in a growing economy is to be taken seriously, relative price changes must be taken into account. Otherwise there is a threat that the "rebound effect" will offset technology-driven efficiency gains. Of course, relative price changes (e.g., through taxes) could also cause economic efficiency losses — if pollution taxes were set too high or introduced too abruptly. Figure 12.8 suggests that there is indeed a link between relative prices and energy intensity, at least as far as the household sector is concerned.

Figure 12.8. **Electricity prices and electricity use per GDP, 1996**



Note: Data refers to 27 OECD countries and 22 non-OECD countries
Source: IEA (1999), *Looking at Energy Subsidies: Getting the Prices Right*, World Energy Outlook 1999 Insights, OECD/IEA, Paris.

Moving too quickly in implementing price changes can also raise transportation costs, affecting those industries and consumers reliant on a fixed transport network. Developing alternatives (e.g. public transport) can offset some of this impact, as can addressing the concerns of those most adversely affected during a transition phase. Notwithstanding some potential problems, from a purely economic standpoint, fiscal policies and market-based mechanisms — including taxes, subsidies (and subsidy removal), and emissions trading — have proven to be the most economically efficient approaches.

Numerous OECD studies suggest that fossil-fuel subsidy removal would have rapid and beneficial effects not only with respect to GHG reductions, but also in ancillary benefits to national economies (IEA, 1999*e*).[12] For example, in the IEA 1999 study of eight of the largest countries outside the OECD — China, India, Indonesia, Iran, Kazakhstan, Russia, South Africa and Venezuela — the removal of energy subsidies could reduce primary energy consumption by 13%, lower CO_2 emissions by 16% and increase GDP through higher economic efficiency by almost 1%. The scope for reducing consumption of fossil fuels and related airborne emissions through subsidy removal is thought to be more modest for OECD countries. Various studies have demonstrated that gross energy subsidies in OECD countries are generally much smaller than in developing countries and the transition economies and, in most countries, are more than offset by taxes (IEA, 2000*a*). Most OECD countries have reduced or eliminated subsidies over the past two decades as part of a general move away from heavy government intervention in energy markets and other sectors of the economy. The bulk of remaining subsidies go to oil and coal producers, although the nuclear industry receives significant sums mainly through support to R&D.

Countries implementing energy-sector reforms reap gains as their energy industries become more dynamic through improved transparency and accountability, accelerated development of technology and more entrepreneurial approaches to energy exploration, production, distribution and supply. Of course, political constraints affect many fiscal policies as well. For example, subsidies are often provided to support certain social objectives and sectors of economies. Their sudden removal can lead to social disruption unless transitional arrangements are put in place through social support programmes.

Financial support can also provide incentives to encourage certain kinds of new or modified behaviours. Cross-subsidies in niche markets can be effective if used over a transitional, relatively short-term period to help gain experience with new, cleaner technologies — for example, highly-efficient vehicles or rooftop photovoltaic systems. National circumstances and level of technology development should determine if and when cross-subsidies should be used. However, their persistent use may result in economically inefficient and environmentally harmful outcomes, producing perverse incentives in favour of the subsidised alternatives at the expense of other types of innovation.

Regulation and voluntary initiatives

While economic analysis suggests that fiscal policies may be the most economically efficient, such analyses often assume perfect market conditions and a ubiquitous "rational actor". However, such circumstances do not always hold: market failures and barriers clearly exist, and often render other policy approaches useful; in some cases, mandates, regulations and voluntary initiatives may prove more successful than pure market-based approaches alone.

These kinds of factors help explain why the list of regulatory measures pertaining to the energy sector in IEA countries is even lengthier than the roster of fiscal policies. Even with significant energy market liberalisation, certain regulatory needs remain. For example, the network nature of energy transmission and distribution requires government to continue its regulatory role in order to avoid the substitution of public with private monopoly. The assurance of third-party access, for instance, is one of those regulatory provisions needed to ensure market competition. Regulations are also used in some cases because they have proven effective, as in the case of energy-efficiency standards for appliances.

The wide range of voluntary approaches, initiatives and agreements allow industry to customise responses, offering opportunities for early and cost-effective action. They also allow for greater flexibility to adapt to different conditions and national circumstances, particularly important for multinational enterprises. Voluntary initiatives provide an important way for governments to encourage innovative business responses to help meet sustainable development goals. However, some objections have been raised regarding the effectiveness of such approaches and whether they reflect additions to a "business-as-usual" case (Newman, 1997).

Research and development policies

Markets alone may provide insufficient incentives for long-term research and development. As competition and privatisation have been introduced into electricity markets, for example, private long-term R&D budgets have dropped significantly, although an argument can be made that some of these private investments have become more effective and efficient. Still, major technological advances may require decades from conception to deployment and there is no certainty that the original investor can capture enough of the benefit to garner sufficient returns on his investment.

Recognising that many promising technologies are not likely to be developed by the private sector, governments have traditionally played a strong supporting role in R&D. Governments have chosen several mechanisms to promote technology development including direct funding for research or demonstration projects, incentives for increasing demand for new technology (e.g. projects which provide financing for consumers of advanced technologies), and incentives for upgrades into new technologies as a way of reducing corporate risk. In addition, governments have encouraged demand management through such incentives as well as through public education programmes and product standards for energy efficiency. But public R&D funding has been dropping, making this type of support less forthcoming (see Chapter 6).

Are there 'win-win-win' opportunities?

In some cases, structural change and, in particular, technological progress permit movement on the economic, environmental and social dimensions at once. Such win-win-win opportunities cannot necessarily

be created on demand but they do arise over time and could possibly be accelerated. For example, in recent years, the convergence of a mature gas infrastructure, new gas discoveries and the advent of the combined-cycle gas turbine (CCGT) has allowed several OECD countries to combine economic efficiency gains with reductions or limitations in greenhouse gas emissions. Shifts in the economic structure towards knowledge-intensive service sectors may allow the reaping of similar benefits although this point requires further research. It is important when considering sustainable development to employ the freedom of manoeuvre thus gained by moving forward in *all* three dimensions.

In the energy sector, there are potentially three strategies for achieving "win-win-win" gains: the development of renewable energy, the improvement of energy efficiency, and the transfer and diffusion of technology to developing countries.

Renewable energy

Making renewable energy sources competitive is something akin to the guest for the Holy Grail of energy policies. Often domestically produced, without contributing to greenhouse emissions, renewable energy sources seem to offer many advantages, provided that they can be made available at competitive prices.

Renewable energy can increase diversity of energy supplies and replace diminishing fossil fuel resources over the long run. They can also make use of indigenous resources to provide cost-effective and secure supply options. They often meet the needs of rural and developing urban communities, provide energy to remote villages, and could substantially reduce greenhouse gases and other pollutants if substituted for fossil fuels. But though their costs are falling, many technologies based on renewable energy are still at an early stage of development, and technical barriers remain (Table12.4).

Table 12.4. **Development of renewable energy**

Renewable Energy Source	Established technologies and "new" technologies close to commercialisation	Possible longer-term renewable energy technology options
Hydroelectricity	Large-scale power generation schemes Small-scale schemes (including low-head and run-of-river applications	
Biomass	Energy from wastes (incineration and digestion of wastes from municipal, industrial and agricultural sources – including extraction of landfill gas) Energy forestry and energy crops (using combustion, gasification and/or digestion technologies) Bio-ethanol liquid fuel	Biomass-derived liquid fuels (other than bio-ethanol)
Solar energy	Solar architecture (passive solar design) Active solar air and water heating Thermal power systems Photovoltaic power generation	Thermochemical energy systems Photo conversion systems Thermo conversion systems
Wind	Land-based wind turbines	Off-shore wind turbine installations
Geothermal energy	Power generation from high enthalpy sources Space heating from warm aquifers	Energy from hot dry rocks
Ocean energy	Large and small tidal barrage schemes	Shoreline and large offshore wave power systems Ocean thermal gradients
Hydrogen		Fuel systems using hydrogen derived from renewable energy sources

Source: IEA (1997), *Key Issues in Developing Renewables*, OECD/IEA, Paris.

The second column of Table 12.5 lists those technologies that are already commercial (well established in the world market), or close to being so in some types of applications. Three technologies — hydropower, biomass (from wood fuel and digester liquors) and geothermal energy — are commercial now and well integrated into energy supply infrastructures in many countries. Wind turbines appear already to be cost-effective in locations with favourable wind regimes or higher-than-average cost for electricity from competing fuels. With further development and increasing production, some other "new" technologies (small-scale hydro, energy from wastes, forests and crops, and photovoltaics, for example) could become more cost-competitive and more widely deployed, particularly if externalities were reflected in the price of other energy technologies. The final column shows those technologies that are unlikely to be viable in the short to medium term, although offshore turbine installations are starting to shift into the nearer-term supply system in some countries.

Constraints to growth of renewable energy come from a number of areas. These include: the inertia of entrenched conventional technology industries; the continuing and exclusive use of production costs to compare energy options (without adjustment for environmental externalities), resulting in the perception that renewable energy are comparatively costly; the relatively recent development of marketable products based on renewable energy, and a resulting lack of consumer awareness of those products; and the costs and challenges of creating a new technical, business and human infrastructure on a global scale.

Energy efficiency

Improving energy efficiency can improve economic efficiency and reduce environmental impact. Higher energy efficiency can help lower fossil fuel imports, slow resource depletion, lessen environmental damage and lower costs per unit of output, and can be implemented in both new and existing stocks and equipment. Several studies have shown that there is significant potential for improvements in most sectors — industries (particularly energy-intensive industries), buildings, power and transport. Furthermore, there are significant opportunities for raising the efficiency of capital stock, especially in developing countries where the current level of efficiency tends to be well below industrialised country standards.

Improved technological efficiency does *not* always translate into equivalent decreases in energy at the level of the company, the sector and the economy, due to the so-called "rebound effect". Energy consumers adjust to the lower price of the energy service by demanding more of it. However, the rebound effect is generally of much smaller magnitude than the primary effect (IEA 1997*c*).

Technology

Continued research and development is required to bring new technologies to market. Yet competition and privatisation in electricity markets have led to sharp reductions in long-term R&D budgets and a focus on shorter-term objectives. At the same time, energy prices have been lower in real terms, reducing incentives to invest in new energy technologies. While OECD government budgets for energy R&D have been dwindling from the highs of the early 1980s (IEA, 1994), there are indications of a small but steady increase over the 1990s (though not to historically high levels), signalling some increased government attention. New policy approaches such as green certificates[13] and regulatory measures (including patents) are being used to supplement (or substitute) the traditional role of R&D.

Technology that improves production and engine efficiency also contributes to greater efficiencies in the use of non-renewable energy sources. Since fossil fuels are expected to continue to play a major role in the energy mix, using these resources more efficiently reduces demand and makes cleaner operations. Combined heat and power, cleaner coal technologies, and fuel cells are all examples of such new technologies.

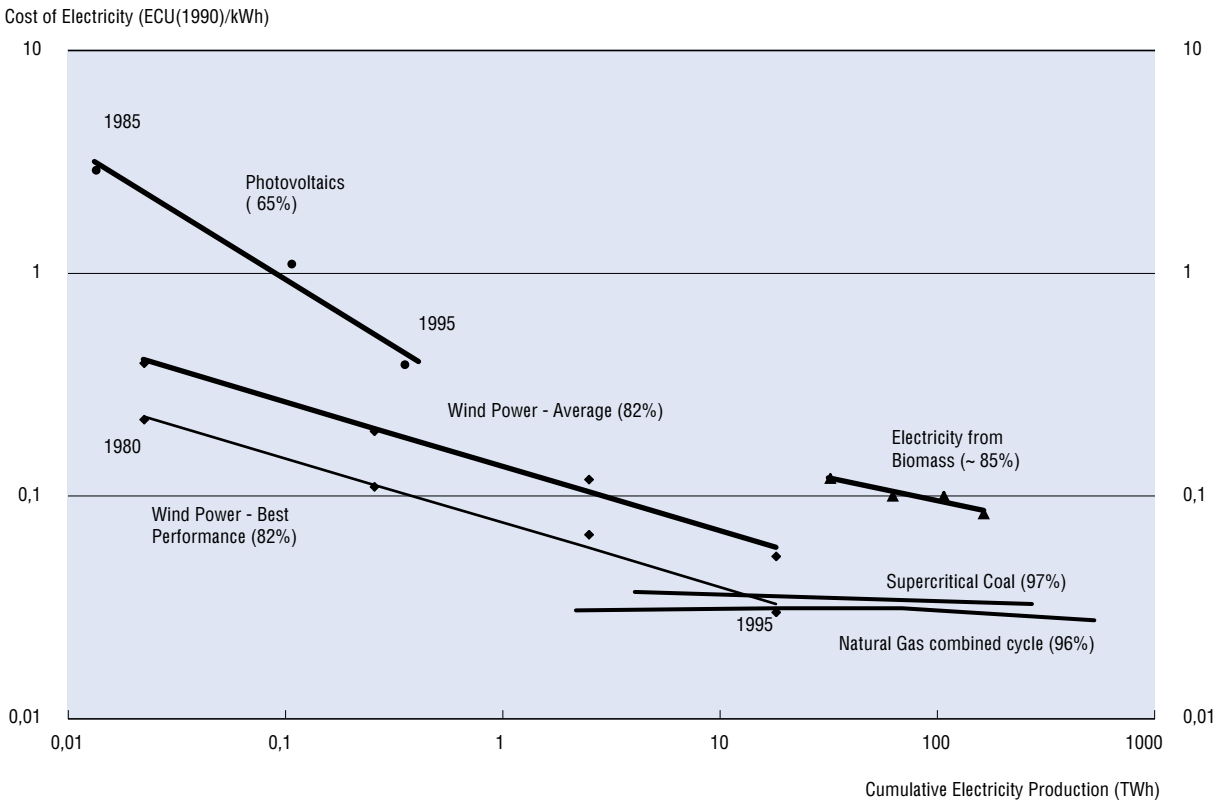
Relative to other energy sources, renewable energy receives only a small share of government or private R&D budgets. For example, renewable energy accounted for 8.1% of the aggregate IEA government funding for energy R&D in 1994, compared with 54.9% for nuclear power and 11.3% for fossil fuels. Although there is considerable variation between countries (e.g. not all countries have such high nuclear R&D budgets), these relative shares have remained substantially unchanged since 1983 (IEA, 1998*a*).

Should governments desire to increase their technology policy emphasis, they have several mechanisms available to them. These include direct funding for research or demonstration projects, incentives for increasing demand for new technology (e.g. projects that provide financing for consumers of advanced technologies), and incentives to reduce corporate risk, such as subsidised loans for upgrades into new technologies. Particularly important are policies aimed at the diffusion and deployment of newly developed technologies into markets, especially where small and medium-sized companies might otherwise lack the relevant information or capacity to adopt them.

One of the tools used most is the provision of subsidies for new promising technologies to accelerate their development towards maturity and competitiveness. The rationale is that *increasing returns to scale* over time will lower costs through learning effects, but that the foresight of private markets is not sufficient to make investments whose pay-off is either risky, a long time off, or both. Recent analyses indicate that the costs of electricity generated through renewable sources is a function of the cumulative installed capacity (IEA, 2000*b*). Thus, if a larger market could be identified, economies of scale could lower prices and accelerate demand. Penetration rates, in part related to slow capital stock turn over, may still be relatively limited. Figure 12.9 provides an overview of average costs over time for a number of technologies at different stages of reaching competitiveness with established energy technologies.

It remains to be seen whether choosing to publicly subsidise such R&D is a cost-effective way to force technological change, and whether such changes might have happened even in the absence of such policy choices if the proper economic signals were put in place. Few analyses have been able to isolate and evaluate the extent of the impact of government R&D support in speeding the development or deployment of new technologies.

Figure 12.9. **Learning curves for selected electric technologies in the EU, 1980-1995**



Source: IEA (2000), *Experience Curves for Energy Technology Policy,* OECD/IEA, Paris.

Barriers to the transfer and diffusion of technologies to developing countries

There are significant barriers to technology transfer and diffusion to developing countries. In a recent special report, the IPCC identified a number of barriers, both general and specific, to the energy sector (IPCC, 2000). Some of these barriers characterise well the key elements which hamper implementation of a more sustainable energy path.

On a general level, these include: lack of full-cost pricing; poor macro-economic conditions (e.g. an under-developed financial sector); low private-sector involvement; low, often subsidised conventional energy prices; lack of information and markets for environmentally sound technologies; lack of supporting legal institutions and frameworks; insufficient human and institutional capabilities; and high transaction costs. Barriers specifically related to energy include: lack of incentive for publicly owned utilities to operate efficiently; tariff barriers; political interference and powerful lobbies; lack of intellectual property rights; and insufficient identification of developing countries' specific needs.

National circumstances vary among the many developing countries, as they do between developed countries. The IPCC emphasises that the identification, analysis and prioritisation of barriers should be country based and action customised to the specific situation of the country and influences of different stakeholders. The transfer of energy technology to developing countries — which has often been associated with large-scale power projects financed by multilateral banks, or investments by international oil and gas companies in the extraction of crude oil — has not always been effective at transferring the kind of knowledge these countries need. For this reason, current models of technology transfer and diffusion need to be reassessed. And although governments continue to have a role in this process, the private sector contribution also needs to be tapped.

The magnitude of the investment challenge

Making electricity available to developing countries is a key challenge for governments of OECD and non-OECD countries alike, for economic as well as social reasons. A major challenge is to maintain a rate of electrification that exceeds the rate of population growth in order to reduce the number of people in the world without adequate access to minimal energy services. According to the World Bank, between 1990 and 1999 more than 600 electrification projects in seventy developing countries were executed by the private sector alone, at a cost of USD 160 billion (Table 12.5). The IEA *World Energy Outlook 2000* calculates that, over

Table 12.5. **Energy investments in developing countries**
(billions of 1998 USD)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Total
Divestitures	1.0	0.2	7.4	3.4	5.8	8.2	12.7	24.0	13.7	7.3	83.7
Greenfield projects	0.5	1.0	2.9	10.7	10.8	15.1	19.7	16.9	10.7	7.5	95.8
Operations and mgmt. Contracts	0.0	0.0	0.7	0.3	0.1	0.3	0.4	5.2	0.1	0.0	7.2
Total	**1.6**	**1.2**	**11.0**	**14.3**	**16.6**	**23.6**	**32.8**	**46.1**	**24.6**	**14.8**	**186.7**
East Asia and Pacific (%)	6.3	41.7	43.6	44.1	44.0	39.0	37.5	27.0	19.5	18.9	32.4
Europe and Central Asia (%)	6.3	0.0	0.7	0.0	7.8	18.2	14.3	6.3	6.1	6.7	8.7
Latin America and Caribbean (%)	75.0	0.0	5.4	2.5	2.7	2.9	3.0	5.0	6.7	5.1	42.3
Middle East and North Africa (%)	0.0	0.0	0.0	2.3	1.2	0.9	0.0	10.2	0.4	4.7	4.9
South Asia (%)	12.5	58.3	0.0†	8.4	18.7	13.6	14.9	5.0	3.7	16.2	10.2
Sub-Saharan Africa (%)	0.0	0.0	0.0†	0.0†	0.6	0.4	3.0	1.0	2.9	2.7	1.5

Note: Negligible amount.
Source: World Bank (2000), *Energy Services for the World's Poor: Energy and Development Report 2000*, Washington, D.C.

the next twenty years, the total expansion of global generating capacity outside the OECD and transition economies will require investment efforts of USD 1350 billion for 1330 GW of new capacity. In other words, the pace of annual energy-related investment needs to more than *triple* over the next twenty years in order satisfy demand (see also Chapter 11).

Raising sums of this magnitude for energy projects can only be done if both the public and the private sector contribute to the effort. Some elements that can generate market evolution towards universal access include: access to markets (including trade and investment liberalisation), the protection of intellectual property rights, sound environmental laws and standards, and fostering conditions to allow international financing. Governments need to set enabling legal, fiscal, economic and social framework conditions. They also need to develop multiple solutions for different circumstances, including both centralised and decentralised energy sources, fossil fuels, nuclear power and renewable energy sources. The ambitious goal of universal access to energy services may also call for modifying the level of demand through investment in cleaner, more efficient electricity generation and appliances, improved product standards and education about more energy-efficient behaviours (IPCC, 2000).

Conclusions

Are we on a sustainable energy path? Not unless we make considerable changes. Projecting the current energy situation and energy policies into the future suggests growing pressures on the global economy and the environment. Governments need to develop policies to address the projected 57% increase in the predominantly fossil-fuel based global energy demand over the next 20 years. Governments also need to take action to modify longer-term trends in greenhouse gas emissions within the framework of the United Nations Framework Convention on Climate Change. Policies will need to take into account that the energy demand of non-OECD countries will soon surpass that of OECD countries, and that developed countries' already high levels of energy demand will continue their upward trend. They will also need to address, the potential decline in energy security as the sources of oil and gas production become more concentrated in regions of geopolitical uncertainty. Capital markets and governments will need to see ways to mobilise the enormous resources to meet growing energy needs.

Sustainability demands that we change present trends. The challenge is to fuel worldwide economic growth with a secure and reliable energy supply, without despoiling our environment. This *is* possible. Energy supply needs to be further decarbonised and diversified, and the energy intensity of economic growth reduced. Global energy security can be enhanced through collective efforts, and efficient, well-regulated markets can make energy affordable. The transition to a sustainable energy future will be complex and will take time, requiring change not only in the structure of the energy sector, but also in societal and economic behaviour.

As noted, per-capita energy consumption in developed countries is considerably greater than in developing countries. Nevertheless, per-capita energy consumption in developing countries is expected to rise quickly, and to account for two-thirds of the projected increase in world energy demand between now and 2020. Developing countries without indigenous sources of energy will need to look to global markets to supply this growth. Energy diversification, increased energy efficiency, new and alternative sources of energy, and access to better technologies will enable these countries to curb demand, lower supply risks and help modify current carbon dioxide emission trends from energy use. Investors worldwide will need stable regulatory and pricing regimes and political stability, if they are to make commitments to new supply facilities.

The challenge, then, is to establish these framework conditions for investment and find ways to further decouple energy demand from economic growth. For developed countries this means reducing energy used per unit of GDP and mitigating the impact of that energy use. For developing countries it means slowing growth in energy demand and supplying that growth in a more environmentally sustainable manner than in the past. The goal is to replicate the changes in energy demand patterns that followed the oil

shocks, without the associated economic disruption. The transition to a sustainable energy system is a complex and long-term process. To make such a transition, we need to change not only the structure of the energy sector, but also behavioural priorities in our societies and economies. This will require strong government leadership, the greater use of economic instruments, reform of energy subsidies, demand-side management and widespread education programmes.

Frequently, change in one dimension of sustainable development is linked to change in another. Pressing problems that require immediate action may call for short-term trade-offs. Reducing the cost of energy may provide a wider access to energy, but will result in more consumption and hence more stress on the environment. Conversely, if energy prices are raised too quickly in an effort to combat environmental concerns, energy may be placed beyond the reach of those who need it most.

Different countries will require different policy mixes, integrating fiscal, regulatory and R&D efforts, as well as processes (such as outreach and consultation) to overcome barriers to the adoption of new approaches. But domestic actions will need to be complemented by international agreements, as many of the issues relating to energy and sustainable development are global in nature.

Economic instruments, though essential for motivating technological change in the energy sector and for promoting renewable energy, are unlikely to be the sole means to fully "internalise" environmental externalities. Consumer resistance to large increases in energy prices, together with concern over the possible loss of international competitiveness, will inevitably limit their use. Policy solutions must thus include ways to mitigate the impact on consumers and the poor in particular (e.g. through compensating decreases in income taxes, or transitional social welfare payments). They should also incorporate the use of new economic instruments such as emissions trading, and ways to encourage the development of price-competitive renewable technologies.

Countries have long experience with the regulatory approach — its environmental effectiveness, administrative processes, and political feasibility. Because of this, we may also anticipate additional regulatory policies. Markets (especially in an uncertain period of transition) may provide insufficient incentives for long-term R&D of more environmentally friendly technologies. Governments need to continue direct but judicious support for energy related R&D, and need to encourage links between R&D activities and commercial applications.

Consistent with the Shared Goals of the International Energy Agency, which call for policies to balance energy security, economic growth and environmental protection, Member Governments of the IEA seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable development. These include:

- *Safeguarding energy supplies* through diversification and co-ordination of the use of flexible response mechanisms, in the event of supply disruptions.

- *Promoting further improvements in energy efficiency,* along with further development and diffusion of non-fossil technologies, including renewable energies.

- *Ensuring that energy markets operate in a competitive and transparent manner with minimum distortions.* As prices shape behaviour and technology, price signals reflecting full costs should reach consumers. This will entail the gradual elimination of environmentally harmful subsidies and internalisation of externalities (such as environmental costs and benefits), ideally through the use of market-based instruments. Reduction of trade and tariff barriers will help markets operate openly and competitively and improve confidence in the marketplace.

- *Creating a stable framework for decision-making, one that includes clear signals to the market.* Incentives, regulatory measures, and standards will be needed to stimulate sustainable choices in a marketplace that is economically imperfect.

- *Continuing to liberalise energy markets with frameworks to protect the environment and enhance social welfare.* These frameworks should be stable and predictable, and promote open and competitive energy infrastructure.

- *Encouraging the systematic introduction of the best technological solutions where energy investments are made.* Capital stock turnover and new additions to the capital stock offer important opportunities for increasing the use of cleaner, more efficient technology.

- *Participating in a global effort to provide electricity for those currently without access,* through the development and diffusion of technology, and the development of stable legal, fiscal and energy policy frameworks, particularly in developing countries, that stimulate the flow of private capital.

- *Ensuring high safety standards* in the operation and maintenance of energy equipment, plants and infrastructure, while putting in place appropriate mechanisms to respond to potential accidents or failure.

Sponsoring energy research and development, information exchange (including data and statistics) and dissemination with a view to encouraging commercial applications and changes in consumer behaviour. Transparent decision-making processes with broad policy-making participation from transport, industry, trade, environment, finance, and other areas — as well as wider stakeholder involvement — are required.

NOTES

1. "Energy services" in this document, refers to the ultimate service that energy consumption provides, and includes: electrical services; mobility; stationary services; and fuels used in power generation.

2. Energy-specific installations include not only power plants and distribution infrastructure, such as pipeline networks, but also road networks and patterns of urbanisation — to the extent that they make certain forms of energy consumption all but unavoidable.

3. Developing regions are defined as China, South Asia, East Asia, Africa, Latin America and the Middle East.

4. Primary energy demand is used interchangeably with total primary energy supply (TPES) and refers only to commercial energy use. TPES is formally defined as: domestic production + imports – exports – international marine bunkers +/- stock changes.

5. Renewable energy is defined here to include solar power, wind power, small-scale hydroelectricity, geothermal energy, and modern biomass.

6. Information on Shell International's long-term scenarios is available at: www.shell.com/royal-en/content/0,5028,25432-56934,00.html.

7. Internationally traded coal has traditionally been cleaned and processed to a higher extent than locally burnt coal, to maximise energy content with respect to the high transport costs.

8. See also IEA (1999*d)*, page 51, with updated IEA data.

9. See IEA (1999*d*), for a more detailed analysis of electricity market reform, including issues such as consumer risk insurance.

10. Proceedings from a recent conference dealing with benefits resulting from actions to mitigate climate change (other than GHG emissions reduction — e.g. reduction in local air pollution).

11. One of the findings from this report was that land requirements, even in the "ecologically driven" scenario, were comparable or even less than currently accepted types of land usage.

12. This study of eight large non-OECD countries identified significant economic and environmental gains from the removal of energy consumption subsidies.

13. Under a "green certificate" system, electric utilities are obliged to supply customers with a percentage of renewable electricity (green quotas), but can acquire green certificates from those who produced renewable electricity above their objective.

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Chapter 13.

TRANSPORT

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TRANSPORT

Introduction

Transport contributes to economic prosperity. But given current trends, the impact of continued growth in transport services is not sustainable in the long term. Progress has been made in reducing some transport pollutants, yet transport continues to generate adverse environmental impacts. Discussing transport in a sustainable development context requires balancing its positive contribution to human well being with its negative impacts. Some of the most critical of these negative effects are environmental degradation (including the depletion of non-renewable resources), damage to human health, and the human costs of accidents.

Transport — and in particular the access to people, goods and services that it provides — was one of the principal forces behind the 20th century's unprecedented economic and social development. As production and distribution become more global, efficient international transport will become essential in global distribution chains. New communication technologies and other developments shaping the production-transport-distribution chain have given rise to industry consolidation, strategic changes in logistics, and an increase in high-value, low-volume freight movements. These changes have increased demands on transport systems for delivery with greater speed, reliability and flexibility.

Transport makes a major contribution to meeting social needs for access and mobility. In large cities, where a high proportion of the OECD population lives, land use and urban-development patterns have been influenced by available forms of transport as well as by individual and business location preferences. With greater personal wealth and technological innovation, transport costs have become less constraining, while distances travelled have increased. Development in the last century has generally resulted in more intense use of motorised transport modes for travel to work, schools and shops, and for social and leisure activities.

Transport generates adverse impacts at both global and local levels, as well as economic and social benefits. At a global level, concerns focus on fuel consumption and its impact on greenhouse gas emissions. At the local level, concerns focus on road safety, noxious emissions, noise and urban amenities (see also Chapter 16). After reviewing these impacts and the progress made in addressing them, this Chapter discusses the effectiveness of the objectives and instruments of past transport policies. It emphasises the importance of fully integrating sustainability criteria in transport policies, and of reducing environmental impact on present and future generations while addressing social mobility and access needs.

Transport demand and outlook

Transport represents some 4-8% of GDP and 2-4% of the labour force in OECD countries. It is central to economic and social development and to meeting travel needs. It facilitates efficient access to the markets and resources, which is important for trade and economic growth. Historically, overall GDP growth and growth in the transport sector have been strongly correlated. More recently, increased trade movement has meant that *freight* transport has increased at higher rates than GDP in many OECD countries. Key assumptions underlying projections of future transport demand are the growth rates of GDP, which is expected to expand

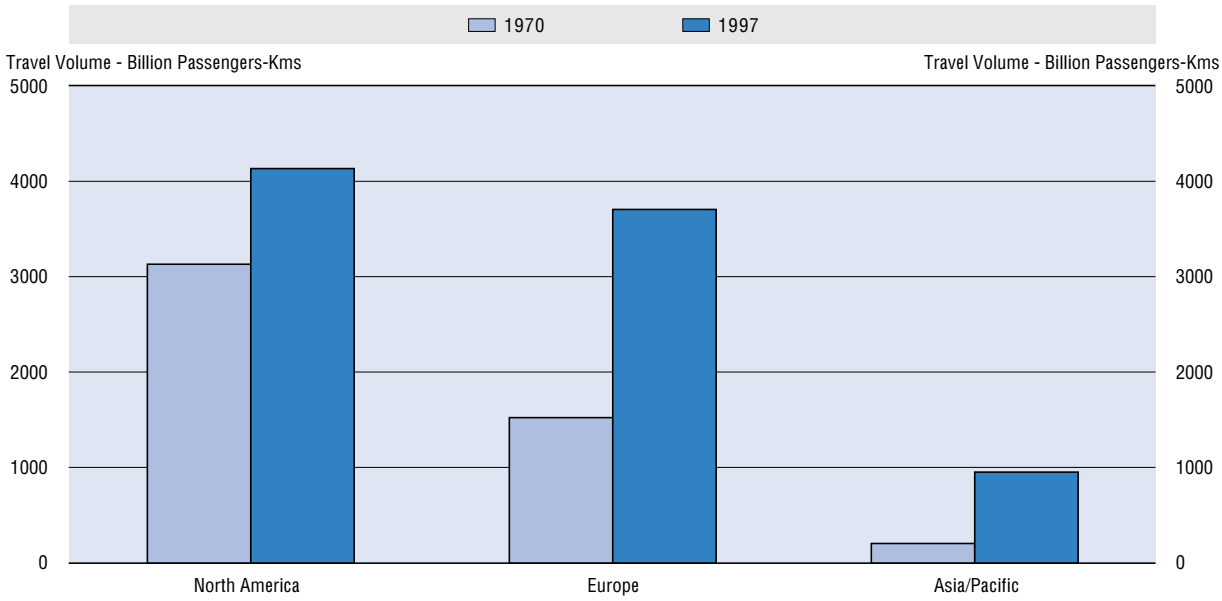
at a rate of 3.5% per year and in international trade, which is expected to grow at a rate in excess of 5% per annum over the next ten years. Also, continuing globalisation of the tourism industry is expected to have a significant effect on demand for passenger transport.

Transport growth has occurred at different speeds in different regions (Figure 13.1). All regions have witnessed the growing importance of road transport for both goods and passengers, to the detriment of rail. In absolute terms, road transport by far dominates rail, although passenger rail travel volume remains large in Asia and Europe, as does freight rail in North America. Urban freight transport is growing in line with economic growth and consumption, and is influenced by trends in logistics and e-commerce. New urban freight distribution patterns involve higher proportions of personalised deliveries of high-value products using light commercial vehicles. Not surprisingly, the increasing number of these vehicles contributes to congestion and emissions.

Seaborne freight transport has grown steadily for some decades in tandem, broadly in line with world economic growth, doubling from 1970 to 1998 (from 2.5 billion tonnes to close to 5 billion tonnes). This trend is expected to continue, with seaborne trade estimated to reach around 7 billion tonnes by 2010. With the exception of growing demand for air transport of high-value goods, and of transport over relatively short haul by road and rail routes, there are no alternatives to maritime transport for intercontinental freight transport, especially where goods are transported in bulk. Therefore, continued economic growth can be expected to generate additional maritime transport.

The level of motorisation, car ownership and total distance travelled are projected to be at substantially higher levels in 2020. The total stock of motor vehicles in OECD countries is projected to increase by 30%, from around 540 million in 1995 to around 800 million by 2020. Over the same period, the stock of motor vehicles in non-OECD countries is expected to increase by 80%, from around 250 million to close to 600 million vehicles. Globally, the number of motorcycles and heavy trucks will grow by more than 100% between 2000 and 2020. The outlook in non-OECD countries is for vehicle kilometres travelled to increase by more than 165% over the period to 2020. This substantial increase will significantly impact urban areas.

Figure 13.1. **Passenger travel by car in OECD regions**



Source: OECD Environmental Data 1999.

Aviation has also recorded a large volume increase. By 1997, passenger air travel in OECD countries represented nearly 10% of all passenger travel in OECD countries. Passenger traffic has expanded at an average rate of 9% annually since 1960, and air cargo by 11%. Freight transported by air accounts for well over one-third of the value of the world's manufactured exports. Overall, aviation is expected to grow faster than any other transport mode, with global air passenger kilometres projected to increase by 170%, to over 14 000 billion passenger-kilometres, by 2020.

More than 70% of the population in OECD countries lives in urban areas. Higher incomes and greater leisure time have extended car usage for commuter trips as well as for social, leisure and shopping activities. Private vehicles offer considerable advantages over other transport modes in terms of comfort, flexibility, and speed, characteristics highly valued by users. The number of passenger vehicles in use is increasing by around 3% a year, and trip lengths are becoming longer. As a higher proportion of the population joins the workforce, relatively fixed time budgets encourage people to combine several destinations — work, shopping and leisure — in one trip. A number of social factors are also contributing to increased car travel. These include the growing proportion of the elderly in the population (now motorised to a high degree, and with a strong propensity to keep driving as long as possible); more access to cars by women; expectations of young people to drive earlier and more often; and declines in household size leading to increasing proportions of car ownership. The preference for living in areas of lower population density (where people are willing to increase travel times and transport costs in exchange for lower accommodation costs) and business decentralisation (offering lower-cost commercial space and access to decentralised workforces) have also shaped transport patterns.

Over many years, the shares of public transport in overall volumes of urban passenger transport have fallen in most locations. Reasons include a dispersal of urban development in most cities (the proportion of residential population and business employment in central business districts and nearby areas has diminished); increasing levels of travel in areas of low population density; and financial constraints on increasing the extent and frequency of public transport services. Increases in urban population levels, rates of vehicle ownership and distance travelled per vehicle are leading to greater volumes of traffic and sometimes severe road congestion, particularly in major cities. Current trends will create major increases in road congestion for both passenger and freight transport.

The future impacts of structural changes and of improved logistics and technology on the transport intensity of OECD economies is not yet clear. As long as economic growth remains a central policy objective (and growth is achieved by increases in physically traded product and services), demand for transport of people — as well as the goods and materials required by industry, households and other sectors of the economy — is likely to increase. However, given current transport modes and land-use planning, a doubling or tripling of transport demand in the longer term is likely to be unsustainable for people and the environment. Achieving sustainability will hence require some decoupling of transport demand from economic growth.

Sustainable development concerns in the transport sector

The Rio Declaration on Environment and Development in 1992 established a number of sustainable development principles relevant to transport. Principle 17, in particular, says that national authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, and that the polluter should, in principle, bear the cost of pollution abatement. National authorities should also take the public interest into account without distorting international trade and investment. The transport sector is expected to contribute to meeting current needs — including needs for access and mobility as well as environmental protection — in both developed and developing countries, while also attending to the welfare of future generations and the habitability of the planet.

The impact of the transport sector (especially motor vehicles) on climate change is of critical concern. However, concerns are not confined to greenhouse gas emissions. Economic growth and development

have increased concerns about noise, congestion, safety and public health. Unless new technologies continue to advance and spread, adverse effects from transport may worsen, causing serious environmental and social problems for future as well as current generations.

Environmental impact

Atmosphere

Total CO_2 emissions worldwide increased by 25% over the period from 1980 to 1997. Transport is one of the major contributors to greenhouse gas emissions, accounting for around 27% of total CO_2 emissions in OECD countries in 1997. CO_2 emissions from transport are directly proportional to gasoline and diesel-fuel consumption. They are projected to rise by nearly 60% between 1990 and 2010, and by 75% between 1997 and 2020, with increases in all regions. By 2020, transport is projected to account for roughly one-quarter of global energy-related emissions (IEA, 2000*a*).

Within the transport sector, private car usage, road freight and air transport are major contributors to greenhouse-gas emissions. Road transport also generates greenhouse gases other than CO2, including chlorofluorocarbons (CFCs), which are also ozone depleting, and nitrogen/nitrous oxides. Transport-related emissions of nitrogen oxides and volatile organic compounds lead to the formation of tropospheric ozone — another greenhouse gas.

Compared with road transport, aviation represents a relatively small but rapidly growing source of greenhouse-gas emissions. Better aviation engine performance and operational changes have improved the efficiency of air travel. However, due to the increased economic activity, air transport emissions are expected to continue growing rapidly, by an average of 3.7% per year between 1996 and 2020. As a result, aviation's share of total transportation energy use may increase from 12% in 1996 to 17% in 2020. Aircraft emissions in the stratosphere have a high greenhouse impact although there is much uncertainty in quantifying this effect. Nevertheless, recent research has concluded that the global warming impact from *all* aircraft emissions (e.g. NO_X, water vapour, CO_2) could amount to two to four times the impact generated by CO2 alone (IPCC, 1999).

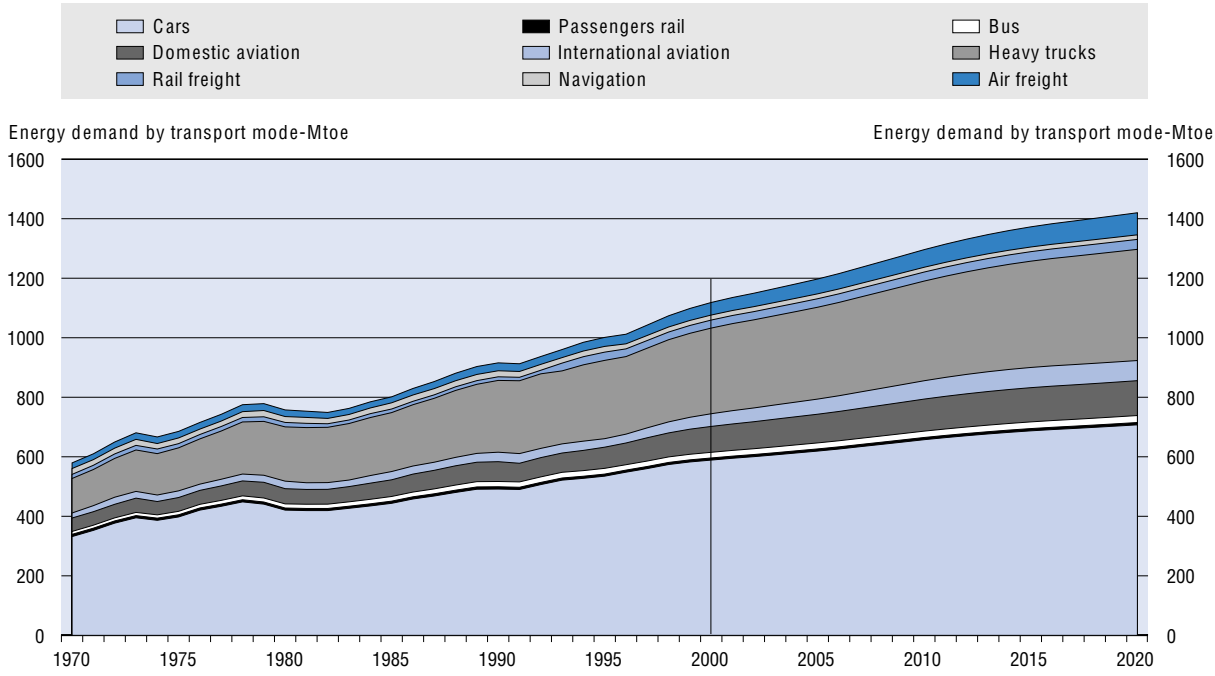
Resources

In OECD countries, transport is the major and most rapidly growing sector of oil consumption (increasing at a rate of about 2% a year) contributing to an overall increase in oil use of just less than 1% a year. In non-OECD countries, oil use is increasing at three to four times the rate in OECD countries. Current projections for OECD energy use in the transport sector (excluding maritime use) are shown in Figure 13.2. Overall transportation energy demand in OECD countries is projected to rise by around 40% over the period 1997 to 2020 (with increases in most modes, particularly truck and car consumption). An increase of over 70% is projected globally (IEA, 2000*b*).

While oil supplies are a non-renewable resource, known reserves are considerable and potential supplies of alternative fossil fuels even greater. Alternative fuels are being developed but have not yet gained widespread use (see Chapter 12). Market mechanisms, if allowed to work without distortions, can be expected to maintain supply and demand for petroleum fuels in balance and drive fuel substitution and technological innovation, as oil supply tightens in the long term.

Both transport infrastructure and vehicle operations generate waste, soil pollution, and other negative effects on biodiversity, land use and natural resources. As land transport infrastructure expands, it fragments natural environments and can affect the viability of plant and animal populations. In some cases, new infrastructure threatens destruction of valuable natural habitats and landscapes, frequently in areas of high amenity value. Development along transport corridors, which have unexpected impacts on natural resources (e.g. forests), are a particular threat to wilderness areas traversed by new infrastructure. Migrating animals and species that require large ranges to survive are most at risk.

Figure 13.2. **Transport energy demand in OECD countries**



Note: Excludes international maritime transport
Source: IEA, (2001) *Transport Energy Outlook,* OECD/IEA, Paris (forthcoming).

Other resource issues include maintenance and recycling. Transport systems, particularly on land, represent huge investments that need to be maintained. Substantial maintenance investments will be required as existing infrastructure nears the end of its useful life. Road systems in particular are affected by the damage caused by high-impact users — especially heavy vehicles. On the equipment side, excessive consumption of natural resources and large volumes of waste require action. Many industries have entered into agreements for recycling waste from transport vehicles and equipment, while vehicle manufacturers are making greater use of materials suited to recycling. But the cost-effectiveness and potential benefits of increased recycling need further study. The European Commission has developed a "Directive on End-of-Life Vehicles" that will transfer responsibility (and associated costs) for recycling and disposal of scrapped vehicles to the vehicle manufacturing industry.

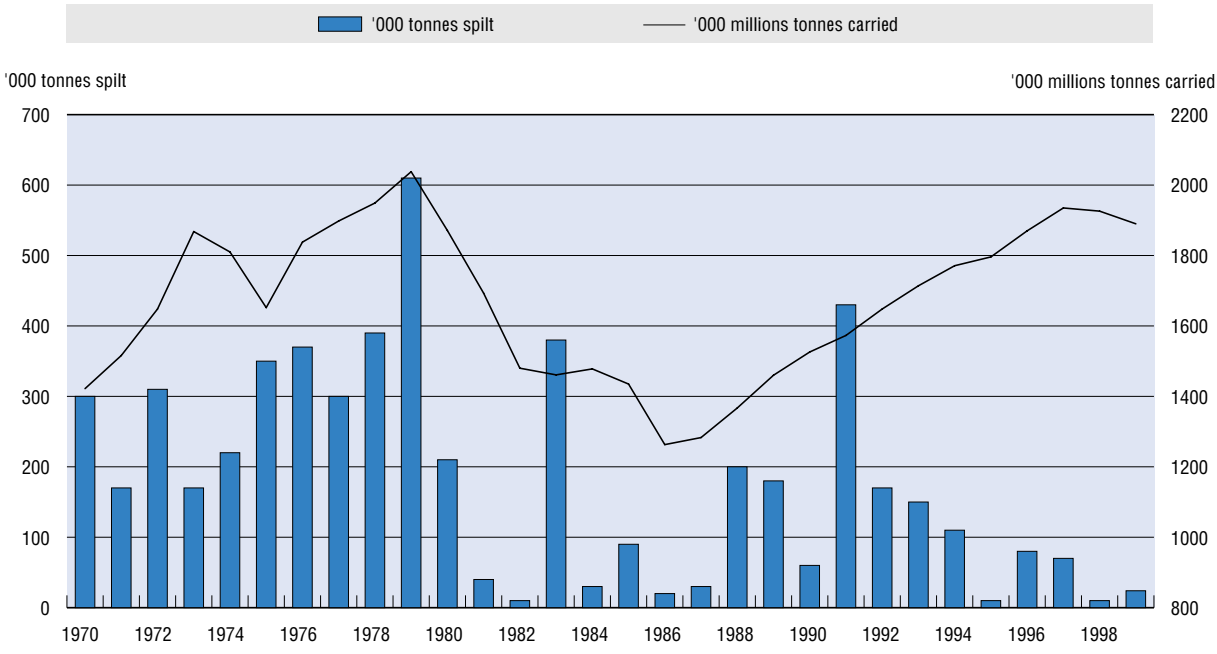
Water quality

Increasing international trade has led to greater volumes of maritime freight on international, coastal and inland shipping. While maritime trade provides considerable benefits to producers and consumers, shipping movements also carry the risk of oil spills and other forms of water pollution. Two separate issues are involved. First, all vessels carry fuel oil for their engines in quantities that, if spilt (or illegally discharged in the form of sludge from the bottom of fuel tanks) can cause substantial environmental damage. The greater environmental danger from the maritime sector stems from national and international carriage of vast quantities of crude and refined oil to meet global transport needs (some 2 billion tonnes annually). Accidents involving oil and other hazardous substances can cause environmental catastrophes, as individual vessels can carry several hundred thousand tonnes of cargo.

Major oil spills can have serious consequences, especially when coastal areas are contaminated. Oil affects marine life by either physical contamination and smothering, or by the immediate and cumulative toxic effects of its chemical components. Marine life may also be affected by clean-up operations or by physical damage to the habitats in which plants and animals live. Action to reduce this risk since the early 1990s

— through improved ship safety and containment of oil — has led to a decline in the volume of oil spills, despite an increase in the volume of oil carried (Figure 13.3).

Figure 13.3. **Marine oil spills, 1970-1999**



Source: OECD (2000), *Maritime Transport Committee Annual Report,* Paris.

To maintain stability when not carrying cargo, ships fill their ballast tanks with *ballast water*. Large ships can carry substantial quantities of ballast taken from shallow coastal waters and discharged prior to loading at the next port of call. Ballast taken from shallow water can contain organisms native to a specific region and which, when released, can cause severe ecological and economic harm. International organisations such as the International Maritime Organisation (IMO) are addressing this problem. While remedies are available, they are either potentially dangerous (such as refilling tanks in deep water) or expensive (such as the installation of heaters to raise the temperature of ballast to the point where organisms die).

Water quality is also affected by rainfall and snowmelt running off of roads, parking lots, bridges, airport tarmacs and other transport infrastructure, which produce pollutants that adversely affect local eco-systems. In particular, surface water run-off contains damaging amounts of hydrocarbons, road salts, heavy metals (from worn machinery and brake pads) and other toxic compounds. While progress has been made in reducing the sources and mitigating the impact of these pollutants, the growth in impermeable surface area occupied by transport infrastructure has eroded some of these gains.

Air quality

In urban areas, noxious emissions remain a major concern. The adverse environmental consequences from motor vehicle pollutants relate principally to fine and ultra-fine particulate matter (PM), especially from diesel fuel; carbon monoxide (CO); nitrogen oxides (NO_X); photochemical oxidants (ozone); and volatile organic compounds (VOCs). While the concentrations of most noxious emissions have decreased in urban areas, in line with tighter vehicle-emission standards, concentrations in many cities still occasionally exceed international air-quality guidelines, and in some cities, do so regularly.

Transport noise

Noise from transport can have significant effects on individuals, interfering with sleep, schooling or work, and detracting from outdoor recreation. Severe noise stress impairs learning and can be injurious to mental and physical health. In OECD countries, noise levels above 65 dB(A) are widely designated as unacceptable for residential areas; in some countries the threshold for exposure is set at 55 dB(A) for the purpose of identifying areas where action to reduce noise exposure is required. Traffic is a major source of noise in urban areas, while heavy-duty trucks are a significant source of road noise. Noise from aircraft in the vicinity of airports can be particularly severe, and is a growing issue in many locations. Noise conflicts between residential areas and mobile transport sources often require changes in the urban configuration, meaning transport noise impacts can continue for years.

Social impacts

Urban amenity

As urban populations expand, and land at the fringes of existing areas is developed, new residential and employment sub-centres emerge. The greater distance of the new sub-centres from the older urban centres, combined with low-density settlements, favours the use of private cars at the expense of other, less energy-intensive modes like walking, cycling and public transport. Cars are not only a highly personal and versatile means of transport, they may also serve as a temporary shelter, office space, telephone booth and leisure vehicle. However, increased car usage creates urban areas in which individual standards of mobility and access come at the expense of quality of life (through noise, pollution and congestion) for the community as a whole.

Once developed, the underlying physical form and functioning of urban areas may continue unchanged for generations. In a number of countries, governments have become less willing to invest in major road improvement projects in urban areas. Reasons for this include lack of space; high capital and compensation costs; concerns about the spread and sprawl of urban areas; and concerns about the impact of increasing car use on urban quality of life (see Chapter 16).

Transport safety

Safety is one of the highest priorities in transport policy. The safety of transport systems in OECD countries has improved considerably over the last 25 years, with fatalities generally lower despite increasing population levels and transport usage. However, close to 120 000 traffic fatalities occur each year. The economic and social costs of road accidents (estimated to vary from 2-4% of GDP in OECD countries) are large, and even countries at the forefront of auto safety face unacceptably high fatality rates.

Motor vehicle safety raises many issues, including personal safety associated with driving behaviour (such as unsafe speeds). Considerable research has contributed to targeted action for improving road safety, including safety standards for transport vehicles; improved transport infrastructure; safety improvements (such as seat belts), supported by public awareness and enforcement programmes; driver behaviour programmes targeted at high-risk groups; lower speed limits; technologies that help avoid accidents and reduce fatalities and injuries; and stronger enforcement measures.

Pedestrian and cycle safety are also receiving more attention. Levels of protection still need improvement, particularly for children and the elderly. Many measures known to be effective are not necessarily costly.

Public health

The public health impacts of transport pollution can be quite severe, particularly where concentrations exceed World Health Organisation (WHO) recommendations. Noxious emissions of CO, VOCs and NO_X from transport can cause cardio-vascular and respiratory problems. Exposure of NO_X and VOC emissions to

sunlight produces smog and ozone, which can cause respiratory ailments. There are also concerns about the carcinogenic risk of particulate matter from diesel exhausts. Road crashes are a major cause of fatalities and injuries and add significantly to health-sector costs. Yet the less direct health consequences of increased motorisation, and reduced walking and cycling, also have high health costs.

Objectives

Transport policy objectives in OECD countries have traditionally focused on efficiency; accessibility and community development; environmental responsibility; safety; and international competitiveness. Transport objectives now also deal explicitly with the concerns of sustainable development. Objectives adopted by governments in Member countries have drawn from the broad sustainable development concepts outlined by the Brundtland Commission and the Rio Earth Summit. However, adopting sustainable development objectives has required taking a precautionary approach to society's longer-term goals and to intergenerational equity.

Improving transport's contribution to sustainable development involves moving people and goods in cleaner, greener, healthier and safer ways — without detracting from transport's efficiency and positive contribution to the economy. It also involves changing people's behaviour in their use of motor vehicles and other modes of transport. Current transport policies and operational approaches seem inadequate in the face of increasing transport-related environmental and social consequences.

New approaches are required to ensure that transport continues to deliver significant economic and social benefits while addressing its adverse environmental and social impact. Policies need to protect natural resources, so as sustain economic growth in the long-run; to ensure that the capacity of the environment to absorb by-products and waste is not exceeded; and to make sure that transport meets social needs for access, transport services and mobility. To achieve this, institutions and regulatory frameworks need to be better integrated and deliver the incentives necessary to encourage industry and users to choose more-sustainable patterns of transport and development.

Given the international nature of many sustainable development issues, close co-operation between OECD and non-OECD governments, as well as with transport industries, is needed. As non-member countries rapidly urbanise, their transport systems are set to grow and their populations to move to greater use of motor vehicles.

Progress towards sustainable development will depend on the extent to which the impact of motor vehicle and aviation usage are satisfactorily addressed and resolved. It is not yet clear whether advances in vehicle and other technology will make transport sustainable, or whether more dramatic changes in public policy and user behaviour will be required. Hence the importance to consider whether today's problems are the inevitable consequences of the scale of transport activity, or of inadequacies in the policy and regulatory framework within which these activities take place.

An economy-wide approach to sustainability generally offers the first-best solution in terms of overall economic efficiency. Some major problems such as greenhouse-gas emissions and resource use involve several sectors at the same time, and are best addressed by a general, cross-sectoral approach. Such an approach recognises that the lowest-cost ways of achieving overall outcomes involve a balancing of measures across sectors — with contributions from all sectors appropriate to their individual circumstances and the marginal costs involved. As an example, a reduction in levels of greenhouse gases may be best achieved by combining actions in the transport sector directed at reducing CO_2 emissions with measures in the agricultural sector to reduce methane emissions from livestock and rice crops. However, some transport-specific problems, such as noise, air quality, and biodiversity loss, are more appropriately addressed within the transport sector itself.

Targets

National targets for reducing greenhouse-gas emissions were established under the Kyoto Protocol in 1997. The Protocol assigns responsibility to the Annex I parties to ensure that their emissions of greenhouse gases do not exceed specified amounts in the period 2008 to 2012; to make demonstrable progress in achieving their commitments by 2005; and to implement and elaborate policies and measures in accordance with their national circumstances in achieving quantified emission limitation and reduction commitments (see Chapter 11).

Another international environmental agreement recently concluded — the Protocol under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution — introduces innovative approaches such as critical thresholds, and integrated assessment and risk management procedures. These measures will reinforce the Kyoto Protocol directives on energy use, and thus further reduce CO_2 emissions. This Protocol, adopted in 1999 by the Parties of UNECE, sets out to abate acidification, eutrophication and ground-level ozone. The key feature of the Protocol is the mandatory emission ceilings for SO_X (-63%), NO_X (-43%), VO_X (-40%) and ammonia (-17%) to be met by the year 2010. Such targets will require countries to significantly reduce their emissions from stationary and mobile sources — in some cases by as much as 90%. An advanced compliance regime has been designed to ensure effective implementation.

Transport sectors: current strategies for improving sustainability

Aviation

International aviation services are controlled by a multitude of bilateral air service agreements, which regulate entry, capacity and tariffs, and by international conventions (such as the Chicago Convention). The International Civil Aviation Organisation (ICAO) promulgates standards and recommended practices relating to safety and the environment. At a regional level, the aviation sector is more regulated and restricted than other transport sectors (e.g. road transport) and non-transport sectors (such as telephony). However, international agreements exempt international airlines from taxation on aviation fuel, which is a significant exception to the "polluter pays" principle.

Nevertheless, improvements in the environmental performance of aviation are being achieved by market, policy, regulatory and technical changes (e.g. the development and deployment of larger and more-efficient aircraft). Aircraft engine standards are being progressively tightened to reduce emissions of NO_X and particulates. Increasing private-sector ownership of airlines and greater competition in aviation markets has made airlines focus on meeting passenger needs at minimum cost, motivating them to make more efficient use of fuel and to reduce life-cycle costs of aircraft. Recent forecasts for aviation contributions to climate change have brought more attention to strategies for addressing this issue. In particular, working groups established under ICAO's Committee on Aviation Environmental Protection have been examining market-based options and operator charges for reducing emissions.

Maritime transport

Except for technical matters, government bodies do not control maritime transport services. Safety and environmental protection are subject to international conventions agreed to at the IMO. Action by the IMO on oil spills has led to the adoption and implementation of a number of international rules and standards for maritime safety and environmental protection. Likewise, the Marine Pollution Convention (MARPOL) has dealt with the prevention of pollution from ships, and includes provisions on bulk carriage of oil. Ship inspections by flag states, port states and classification societies control the quality of vessels.[1]

Short-sea shipping has the potential to contribute significantly to reducing transport emissions. Freight transfer to short-sea shipping is most effective in regions with specific physical and economic conditions

(as found in Europe, Japan or India, which have long coastlines and navigable waterways, and long-haul road and rail routes). In such cases, the sea and inland waterways may provide a more desirable environmental substitute for road and rail transport. However, for this mode to be competitive, it will have to address issues such as multiple handling of cargo and costly port transfers. Actions being taken to improve competitiveness include the promotion of cleaner-burning engines and bunkers, energy efficiency, investment in intermodal links, as well as removal of impediments to each transport mode's ability to compete on equal terms.

Land transport

The interactions between land transport and sustainable development are dynamic and long term. Land-use planning interacts with — and has a durable impact on — transport, commercial and residential development (see Chapter 16). This interaction also shapes the operation of long-distance and local transport systems, influences environmental outcomes, and affects social considerations such as regional access and mobility. Despite the policy attention devoted to multimodal and intermodal transport, most transport systems function along well-defined modal lines that operate independently of other modes.

Road transport can meet freight transport demand flexibly, providing door-to-door services at a relatively low cost to users. Road transport has adapted well to the changing nature of the freight transport task. It is well suited to the increasing demand for small freight loads over relatively short distances (often less than 100 kms) and to situations where shippers or purchasers place a premium on speed and reliability.

Design of land transport policies has to take several factors into consideration: rapidly growing demand; adverse impact from road freight transport (road damage, energy consumption, emissions, noise and congestion); inadequate road transport pricing, taxing and charging systems; harmful subsidies; the need for effective demand-management strategies; and land-use planning. Other problems include budgetary restrictions — exacerbated by an over-reliance on government funding for roads — and, in some cases, a shortage of physical space to build the facilities required to meet demand. In a number of areas (such as Europe), road transport is constrained by regulations which aim to reduce environmental and social impacts by transferring freight from road transport to alternative modes.

Measures to reduce the impact from road transport include: progressive tightening of vehicle standards to address air pollution from road freight vehicles; defined heavy-vehicle routes to address noise and other direct impacts; road transport reforms which take advantage of changes in vehicle technology to increase mass limits; and harmonising legislation across jurisdictions to achieve consistency. A number of countries are pursuing alternative compliance programmes and performance-based standards for road transport, to provide incentives for improved performance by operators. These will assist in realising productivity gains through innovation and new technology. Information also plays an important role — a significant proportion of trucks travel empty or under-loaded because of insufficient inter-firm knowledge of available transport capacity. An important share of firm-level transport activity can also be avoided by better logistics and geographic optimisation and management of the transport tasks across locations. The Netherlands's Transport Avoidance Assistance programme is one example of how information on superfluous and costly travel may be brought to firms' attention.

Implementation of economic instruments in the transport sector has been relatively slow. Most efforts have focused on price regulation, operator licensing, and the level of taxes and charges imposed on industry. Infrastructure access charges and road pricing are under consideration in many OECD countries, while some authorities have introduced direct mass-distance charging. In other locations tolling of interstate highways and national roads generates funds that can be used for investment in transport infrastructure. For efficient outcomes, any new infrastructure construction needs to be accompanied by demand-management strategies.

A number of countries, particularly in Europe, are reforming their tax systems to provide incentives for reducing the external environmental and accident costs of transport. Many countries have differentiated existing taxes to favour less-polluting vehicles. A number have also shifted taxes from fixed to variable charges, especially with fuel taxes. For example, Switzerland will in 2001 introduce distance and weight based road-

charging systems for trucks that reflect external costs. In many countries, overall levels of general taxation imposed on private road freight and passenger transport approximate infrastructure costs and levels of external costs. Yet these tax structures rarely reflect the distribution of private and external costs between different categories of road users, or differentiate by time of travel or location. This limits the feedback from taxation to behavioural change. Reform in this area is urgent.

Rail has traditionally been suited to transporting large and regular loads of freight over long distances. While the market for large and regular loads of freight has declined over the past 50 years, the demand for long distance freight has generally increased in Member countries. The net result is that, in absolute terms, rail freight traffic has increased in the OECD as a whole, but rail's share of the total freight market has declined considerably in most countries (primarily due to strong competition from road haulage). Changes in market demand towards smaller loads, and speed and reliability of delivery, have favoured road transport. Heavy investment in road infrastructure, combined with relatively early deregulation of the road transport industry, has enabled road transport to provide higher levels of service and increase its market share.

A wide range of issues needs to be addressed in making rail services better able to contribute to sustainability. Rail freight operations are often inefficient and therefore less attractive than road-based alternatives. Rail ownership and operational structures are also often geographically fragmented and tied to national or state boundaries (as in Europe). In spite of measures to remove restrictions on access to rail track and to favour competition from new train operators (for example, through the EU package of Directives), significant barriers to entry into rail freight haulage markets persist in OECD countries outside North America. In many countries, rail also suffers from low productivity. With the exception of North America, even in markets where roads have no overwhelming technical advantage, the industry has often failed to capitalise on its unit-cost advantages for large loads and long distances. Experience shows that large cost savings and more sustainable outcomes can be achieved with a regulatory framework that gives rail management the freedom to optimise investments and network size. If existing structures can be reformed, rail transport offers the potential to carry an increasing volume of consolidated and bulk freight over medium and long distances.

Actions on urban transport reflect involvement of the different levels of government, a diversity of circumstances and different policy frameworks and approaches. Many actions aimed at making better use of existing transport infrastructure exert some influence on demand and provide incentives for use of alternative (non-car) transport, particularly for travel to congested centres. Many governments are actively encouraging development patterns that reinforce the vitality and viability of urban centres, and that discourage dispersal of new developments into the countryside. Land-use planning objectives and policies in some countries also aim to reduce the need to travel, especially by car.

Specific actions being taken to reduce transport problems within and from urban areas vary considerably. Some of these are: tighter parking control (by way of parking restrictions and charges); road pricing of heavily travelled routes; priority high-occupancy lanes or major new infrastructure such as freeways; smoothing traffic flows (to improve fuel conservation); development and use of information technology; improvement of urban public-transport provision and attractiveness; and promoting "active" transport (i.e. cycling and walking). Other initiatives include: teleworking (e.g. Japan); incentives for the introduction of clean energy and low-emission vehicles; and privatisation of some public transport systems in an effort to re-vitalise them and win back customers. Many city administrations are considering action to address road taxing and charging deficiencies. For example, a congestion tax is planned for vehicles entering the city of London during business hours. An innovative approach being considered in Seoul is to assess the environmental capacity of roads and use taxes to manage road transport flows.

Reducing emissions impacts of motor vehicles

Governments and industry have devoted major resources to reducing the vehicle-specific environmental impact of motor vehicles. These efforts have focused primarily on vehicle technology and fuel consumption. Many countries are putting in place regulatory and fiscal measures that encourage consumers to purchase

more fuel-efficient cars and to use vehicles in a more fuel-efficient manner. As an example, the United Kingdom's annual registration tax (Vehicle Excise Duty) for new cars puts cars into four bands based on their CO_2 emissions.

The oil crises in the 1970s and 1980s have contributed to a shift in demand towards more fuel-efficient vehicles. Unfortunately, these shifts stalled in many OECD countries in the mid-1980s, due to low oil prices and increases in vehicle size, engine power and weight. The average fuel consumption of car fleets in many OECD countries has since stabilised, but in some countries is still high.

In the United States, the Corporate Average Fuel Economy standards programme (CAFE) and the "gas guzzler" legislation were early moves to improve fuel efficiency. The effectiveness of these approaches has been diminished by the higher market share of — more heavily polluting — sport utility vehicles and by new energy-draining vehicle features. More recently, the "Big Three" auto makers and the United States Government's Partnership for a New Generation of Vehicles (PNGV) have announced the goal of building cars that can achieve 80 miles to the gallon while meeting tighter emission controls by the year 2004. However, because of slow fleet turnover, the impact of such new vehicles on fleet averages will take time to materialise.

In Japan, evaluation criteria for manufacturers in terms of improvement of fuel efficiency for passenger cars and light trucks are based on the "Toprunner" programme, which sets performance criteria based on the most-efficient fuel consumption performance in the market. Automobile manufacturers are required to meet these criteria by 2010 (in the domestic market) for all gasoline-fuelled automobiles by engine displacement category. Diesel-powered automobiles must meet them by 2005.

In Europe, progress on fleet fuel efficiency and CO_2 emissions is driven by national and international voluntary manufacturer agreements. In 1995, the European Council of Ministers of Transport (ECMT), the *Association des Constructeurs Européens d'Autobmobiles* (ACEA) and the *Organisation Internationale des Constructeurs d'Automobiles* (OICA) confirmed — through a Joint Declaration on the reduction of CO_2 emissions from new cars — the importance of continued improvements in fuel efficiency. The subsequent 1998 ACEA voluntary agreement concluded with the European Commission reinforcing the industry's commitment to clearly identified targets. Monitoring under the ECMT agreement suggests that the trend in average emissions from new passenger cars is currently on course to meet the target of 140g of CO_2 per km in 2008 (a 25% reduction compared with 1995). This represents the largest contribution from transport towards meeting the commitments made under the 1997 Kyoto Protocol. Equivalent EC voluntary agreements have since been reached with Japanese and Korean manufacturers. The Commission estimates suggest that average car fuel consumption will decrease by 16% by 2010. While the resulting 16% decrease in average vehicle-related CO_2 emissions is significant, its impact on CO_2 emissions from transport could be offset by the expected increase in overall vehicle travel.

The United States, Europe and Japan are making steady progress in reducing air pollution problems. Globally, the use of advanced pollution control technology, especially catalysts, has been growing, and there is now widespread use of unleaded gasoline. Southern California's Los Angeles Basin — where the most aggressive motor vehicle pollution-control programme in the world has been in place over the past 40 years — provides a striking example of the results that could follow from more-ambitious policies. From 1955 to 1993, peak ozone concentrations were cut in half; the annual number of days above the Federal standard for carbon monoxide fell from 30 to 4.3, and lead levels are now 98% lower than in the early 1970s.

Large reductions in the emission of air pollutants from new vehicles have been achieved over the last decade, as a result of technological change and tighter vehicle standards. However, continued growth in motor vehicle use has resulted in lingering air quality problems, especially with toxic emissions. In response, the United States, Europe, and Japan in particular are introducing tighter emissions controls over the coming years. Tighter emission standards will be introduced in several steps in Europe (European Union Euro III and IV standards). Many other countries are gradually adopting controls introduced in major vehicle manufacturing countries. While new vehicles will emit only a fraction of the pollutants of current models,

the relatively slow turnover in the vehicle fleet will slow improvements in air quality. Moreover, improvements in air quality as a result of more-efficient vehicle technology have not always been as large as expected. This is partly due to divergences in the emissions between test cycles and real driving conditions; and partly to the complex relationships between vehicle speeds, the amounts of each pollutant emitted, chemical reactions between the different gases involved, and gas transport in the atmosphere. Further improvement is possible, particularly through downsizing of engines and bodies.

No further tightening of EURO IV standards for CO or HC emission limits is expected. Although developments in commercial particle traps are promising, it is not yet clear if limits for particulate matter will be sufficient to contain emissions of the finest particles to acceptable levels. There is also some conflict between measures to reduce emissions of NO_X and CO_2. ACEA manufacturers expect "lean burn" engines to form an important part of their strategy to meet commitments to higher fuel economy under the voluntary agreement with the EC. These engines improve fuel consumption by increasing the air-to-fuel ratio in combustion above the level at which three-way catalytic converters work efficiently. In order to keep NO_X emissions within the EURO IV limits, an additional catalyser has to be installed on the exhaust pipe. However, many refiners are unwilling to make the investments needed to produce the low-sulphur fuel required for the functioning of these devices, arguing that it is not a cost-effective way to cut CO_2 emissions compared with opportunities available in other sectors of the economy.

Industry is devoting considerable resources to research and development of new technology — especially alternative-fuel and hybrid-vehicle technology that could help reduce the environmental impacts of increasing numbers of vehicles, particularly in urban areas. After many years of research into electric vehicles and battery technology, electric-powered vehicles are now available and have been adopted in demonstration programmes in a number of urban areas. However, the weight, performance and range limitations of electric vehicles remain. Commercial versions of electric/petrol hybrid vehicles have been developed for wider markets and are also currently available. Many countries have facilitated the successful uptake of Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) vehicles whose environmental performance compares favourably to standard gasoline-powered vehicles. Gasoline, methanol and hydrogen fuel cells are under development and a number of major manufacturers plan to market vehicles using fuel cells in the next five to ten years. Fuels cells burning hydrogen would cut tail-pipe emissions of noxious gases to zero, but a hydrogen fuel distribution network would be expensive and slow to develop, especially when externalities of traditional fuels are not correctly priced. These vehicle technology improvements could make substantial contributions to sustainability objectives over the next ten to twenty years, particularly if their commercialisation were to be supported by government incentives to stimulate demand. A number of countries are providing incentives or planning pilot projects to favour the introduction of clean-energy and low-emission vehicles (IEA, 2000*a*).

Potential energy and emissions savings from changes in transport modes

There is significant potential for savings in energy and emissions if more freight can be carried by modes other than road and air transport. The lower environmental impacts of rail, short-sea and inland shipping makes these modes attractive from energy consumption and pollution viewpoints. However, for users to voluntarily choose these modes, they need to be reliable and competitive, particularly in comparison with road transport. Efforts have been made in a number of countries to facilitate integrated transport services and improve intermodal transfers in locations where there is a sufficient level of demand, with the aim of capturing some of these potential environmental benefits. However, the potential for such benefits appears to be quite limited. A United Nations/Economic Commission for Europe (UN/ECE) study of Europe's railways found that only shipments over a distance of more than 500 kilometres could be carried out by combined transport in an economical and environmentally friendly way. At low to medium fuel costs, the potential for transfer from road to rail in this market segment is quite low, as only 3-4% of Europe's total goods are transported for distances of more than 500 kms. Another factor to consider is that even a doubling of rail capacity (requiring massive infrastructure investment) would absorb only a few years of expected growth in road freight. However, if the price structure for freight transport changes to more accurately reflect the external impact of both rail and road transport, or if fuel prices increase, rail could gain greater market share.

Economic instruments

For many years, transport economists have advocated the wider use of economic instruments to achieve more-efficient use of infrastructure, moderate demand and deal with externalities. These instruments include road-pricing, mass-distance charging for heavy vehicles, variable congestion charging, and charges or taxes on environmental externalities such as air pollution. One advantage of market-based instruments is their ability to equalise the marginal costs of abatement measures across different market segments. A second advantage lies in their dynamic efficiency — they can encourage innovation and provide incentives for the development of low-cost abatement measures to cut pollution. However, despite their advantages, market-based instruments are fully effective only in situations in which the polluting activity can be monitored or where trading systems are set up.

Many external impacts from transport could be reduced by implementing the correct pricing signal, whereby each user pays the social marginal cost of his or her journey. At present, charges for road systems are not structured this way. Given the fuel taxing and average-costing regimes that are generally in place, even the costs that road users pay are not properly allocated across different road users. Better differentiation of charges (e.g. correlating vehicle charges more closely with the damage done by different types of vehicles and/or shifting the burden of taxation to pollution rather than possession of vehicles) is a strategy adopted by some OECD countries.

Governments have used fuel taxes more for revenue-raising purposes than to achieve specific environmental outcomes. Fuel taxes provide an administratively convenient form of levying taxes and charges on motorists and road freight carriers. Fuel use is directly correlated to CO_2 emissions and so is well-suited to internalising climate change impact. However, fuel taxes should not be the sole or main means of charging for road infrastructure development and use, congestion and other externalities. At best, they reflect average, rather than location-specific costs imposed by different users, and generally involve significant cross-subsidies. Moreover, when confronted by rising petroleum fuel prices, governments generally feel pressure to reduce fuel taxes used for general revenue-raising purposes.

To be most effective, fuel taxes need to be coupled with other instruments. Smart cards, mobile phones and satellite technologies offer opportunities to introduce charging systems better related to the external costs generated by the use of individual vehicles, particularly trucks, allowing charging according to type of vehicle, location, time of journey and distance driven. Where appropriate technology is available, charging systems could be improved by charging high-impact users on a location-specific basis; revising fuel taxes to relate more directly to CO_2 emissions; developing measures to deal with congestion; and retaining differentiated fixed charges to influence vehicle purchase decisions.

In sum, economic instruments are well-suited to dealing with a range of sustainable development concerns, but have not been fully implemented. This implementation gap is due principally to a lack of popular support and political will. However, one barrier to the introduction of new charges is that they can have major effects on individuals with limited ability to modify their behaviour. Consequently, consideration of transitional issues will need to form part of the policy responses.

Subsidies

One rationale for government transport-related subsidies has been that, without intervention, the pricing of transport infrastructure at commercial levels would lead to losses in welfare (because average costs are above the marginal costs of using infrastructure). Pricing at average-cost levels would result in smaller networks. On this basis, maximising collective social benefits has been used as a rationale to justify subsidies to the provision of transport infrastructure. Increasing private-sector involvement in infrastructure financing has been accompanied by more commercial approaches to infrastructure development. To avoid a distorted modal split, roads and railways ought to be subject to similar financial and economic requirements — either relaxing the cost coverage hurdle for rail investments or increasing it for roads — while external costs should be taxed on a consistent basis for both sectors.

Governments have also provided large public subsidies to air and seaports, in the belief that these are an effective means of promoting regional economic development and export competitiveness. Non-infrastructure related subsidies have also been awarded to some transport operations provided by urban transport or rail operators. Governments typically provide operating subsidies for reasons of social equity, to provide transport services to people without access to cars. In many cases, such arrangements are covered by contracts under which the government purchases defined services in order to prevent leakage of the subsidies into other aspects of railway operations.

In the future, governments are likely to further withdraw from detailed involvement in commercial transport operations and to rely more on private financing and management of transport infrastructure (e.g. through privatisation of airports and other transport facilities). Consequently, remaining subsidies should be targeted at those most in need. It will also be important to resolve the ongoing conflicts between, on the one hand, the benefits of transport subsidies in contributing to the social and mobility needs of communities and individuals and, on the other, the undesirable impact of subsidies in embedding inefficiency in transport operations and, if not well-targeted, in inflating transport demand.

Regulation

Regulatory approaches continue to be favoured for ensuring minimum standards; these can be supported by performance-based standards to provide incentives for on-going improvements over time. In the case of motor-vehicle standards, the UN/ECE and the world vehicle manufacturing industry association (OICA) are co-operating to harmonise regulatory approaches on a global scale and provide the opportunity to achieve consistent outcomes. If successful, this effort will also end the use of regulatory standards to protect markets in the vehicle industry.

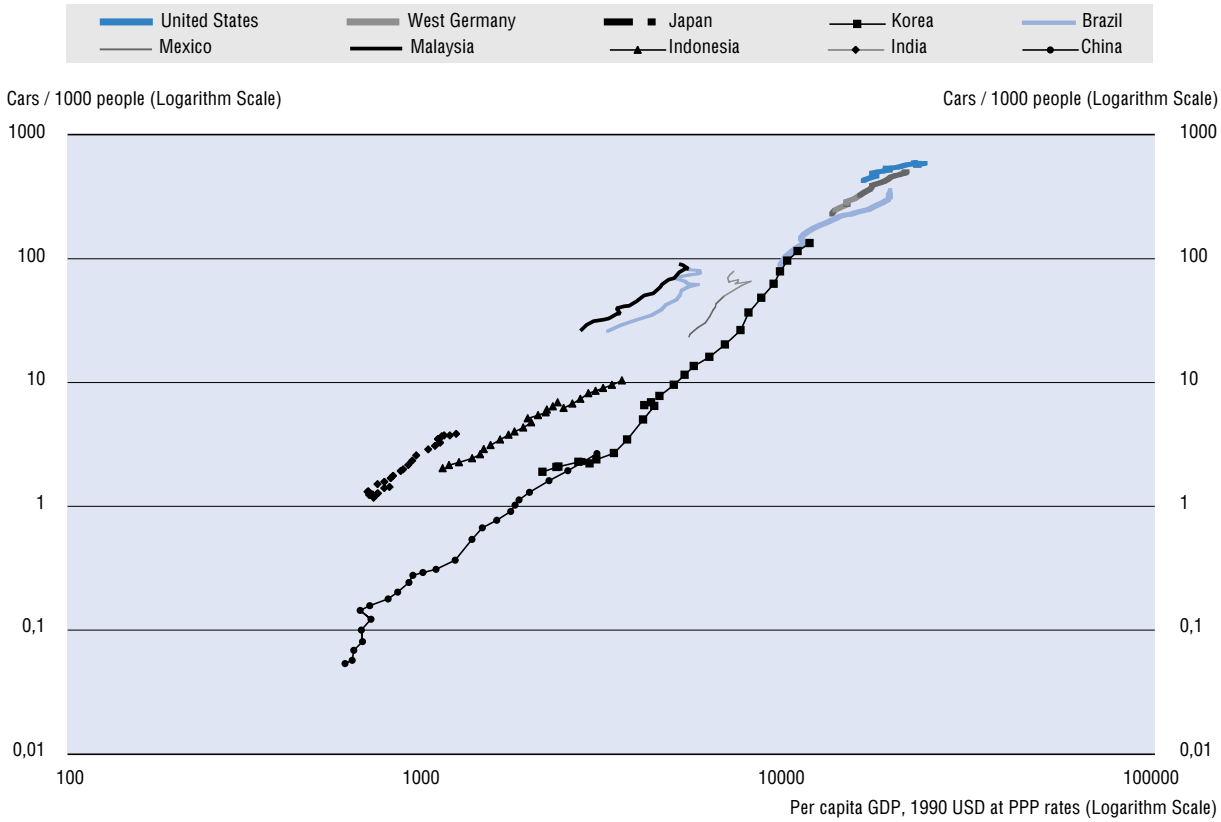
In summary, current strategies for improving sustainable development through actions in OECD countries can be expected to ameliorate some transport impacts through improved modal choice and better management of travel demand. However, greater emphasis on user charges, fuel and vehicle pricing and other demand-management strategies are urgently needed (see Chapter 12). Over the period to 2010 and beyond, improved technology, already available but yet not widely disseminated, will make an important contribution, as will technical developments such as increases in logistics efficiency. If coupled with planned regulatory changes, as well as pricing and taxing measures, these developments could bring substantial reductions in adverse transport impacts. However, current strategies alone will not be sufficient to adequately deal with the most-acute sustainable development concerns arising from the transport sector.

Longer-term considerations

To make a significant difference in the demand for transport services, OECD countries will have to create opportunities for lifestyle, behavioural and technological changes. Certain prospects of technological advances (such as e-commerce) are leading to changes in the way community needs for access and services are met. It is uncertain, though, just how these changes will affect transport. New technology such as fuel cell vehicles (which are expected to be commercialised over the next ten years) offer the long-term prospect of meeting transport demand without CO_2 emissions. Further advances could result from changes in relative prices of renewable or non-renewable resources (e.g. for fossil and alternative fuels) and from taxing and charging measures.

Adverse impacts from transport are already severe in non-OECD countries. The rapid economic growth projected for these countries raises serious concerns about the effects of further increases in transport demand. Environmental and social consequences will be accentuated if their transport systems continue to develop along the lines of those in OECD countries. The IEA has analysed increases in the level of motor-vehicle ownership as a function of increasing per capita income, as an indication of possible trends for non-OECD developing countries. Results are shown in Figure 13.4.

Figure 13.4. **Motor vehicle ownership per capita**



Source: Schipper, Lee, Marie-Lilliu, Céline; Lewis-Davis, Gareth (2001), "Rapid Motorisation in the Largest Countries in Asia: Implication for Oil, Carbon Dioxide and Transportation", *Asia Pacific Journal of Energy*, spring.

Given the time required for new lifestyles and patterns of demand to develop, and for new technology to replace existing technology, fundamental changes in behaviour seem unlikely to reduce levels of demand over the period to 2010. However, behavioural and technology changes could make an increasing contribution to reducing demand for cars over the period from 2010 to 2020. Researching the issues and possible contributions to demand reductions will, in the short term, help assess the more fundamental changes needed to deal with global greenhouse gas emissions trajectories.

It would be unwise to defer ameliorative action until all uncertainties associated with longer-term issues are resolved. In addition, there are cost advantages to taking action now (see Chapter 11). Current and future consumption patterns and related transport demand indicate the need for more fundamental changes in lifestyles and development patterns in OECD economies to deal with key sustainable development issues (such as the increasing levels of transport fuel consumption, increasing transport CO_2 emissions and urban congestion). Finding effective solutions to these issues will necessitate more creative approaches.

Recognising that many of the issues discussed above cannot be resolved by changes in the transport sector alone, a more strategic and long-term approach will need to involve all relevant sectors. Within such economy-wide approaches, governments need to consider, develop, and implement more sustainable transport strategies that can effectively counter foreseeable increases in adverse transport impacts, and do so in ways that improve transport efficiency and address social equity concerns.

Action priorities, rationale and approach

Sustainable development requires a coherent and comprehensive strategy in order to break with "business-as-usual" practices and policies that are too often the result of incremental and uncoordinated actions. Ideally, this strategy should be flexible and adapt itself to new information as it arises. Recent work carried out by the OECD has sought to determine what such a sustainable development strategy might look like for the transport sector. This work has pointed out that sustainable development means not only moving away from unsustainable present conditions but towards sustainable practices. Progress towards sustainable development will be facilitated if countries have a relatively clear idea of where they want to be vis-à-vis future economic, environmental and social conditions. And if they determine appropriate objectives and targets by which to measure their progress. An approach to determining these objectives and organising transport policies for the environmental aspects of sustainable development is outlined in OECD work (BMLFUW/OECD, 2000) and presented in Box 13.1.[2]

Box 13.1. Guidelines for environmentally sustainable transport (EST)

1. *Develop a long-term vision* of a desirable transport future that is sustainable for environment and health and that provides the benefits of mobility and access.

2. *Assess long-term transport trends, their health and environmental impacts*, and the economic and social implications of continuing with "business as usual".

3. *Define health and environmental quality objectives* based on health and environmental criteria, standards, and sustainability requirements.

4. *Set quantified, sector-specific targets* derived from the environmental and health-quality objectives, and set target dates and milestones.

5. *Identify strategies to achieve EST and design judiciously constructed combinations* of measures to ensure technological enhancement and changes in transport activity.

6. *Assess the social and economic implications of the vision, and ensure they are consistent with social and economic sustainability.*

7. *Construct packages of measures and instruments* for reaching EST milestones and targets. Highlight "win-win" strategies incorporating, in particular, technology policy, infrastructure investment, pricing, transport demand and traffic management, improvement of public transport, and encouragement of walking and cycling; capture synergies (e.g., those contributing to improved road safety) and avoid counteracting effects among instruments.

8. *Develop an implementation strategy* that involves the well-phased application of packages of instruments capable of achieving EST taking into account local, regional, and national circumstances. Set a clear timetable and assign responsibilities for implementation. Assess whether proposed policies, plans, and programmes contribute to or counteract EST in transport and associated sectors using tools such as Strategic Environmental Assessment (SEA).

9. *Set provisions for monitoring implementation and for public reporting on the EST strategy*; use consistent, well-defined sustainable transport indicators to communicate the results; ensure follow-up action to adapt the strategy according to inputs received and new scientific evidence.

10. *Build broad support and co-operation for implementing EST*; involve concerned parties, ensure their active support and commitment, and enable broad public participation; raise public awareness and provide education programmes. Ensure that all actions are consistent with global responsibility for sustainable development.

Atmosphere and resources

Two priority issues in OECD countries require urgent action. First, transport demand is increasing rapidly, eroding gains in vehicles' specific environmental performance. Secondly, despite the efforts of vehicle manufacturers to produce more fuel-efficient and lower-emission vehicles, consumer preferences continue to favour higher fuel consumption, high-emission vehicles. The effect of current patterns of consumer demand is to slow the improvement in the overall fuel efficiency of motor vehicle fleets. Taken together, these two issues contribute to increasing transport fuel consumption as well as CO_2 and other greenhouse gas emissions. Current research indicates these trends are likely to continue to 2010 and possibly beyond. If they do, transport will not contribute greatly to the economy-wide targets/reductions in greenhouse-gas emissions agreed to in the Kyoto Protocol; in fact, they will move society away from, rather than towards, these targets. To avoid this, cost-effective actions (such as differentiated charges and taxes consistent with economy-wide approaches) will be needed to increase the proportion of fuel-efficient vehicles in the fleet and reduce vehicle movements, resulting in a shift to more energy-efficient modes of transport. Because of aviation emissions' disproportionately large contribution to global greenhouse gas emissions, addressing this mode of travel is especially urgent.

Water quality

Considerable progress has been made in addressing transport-related water quality issues. One issue of widespread concern is the prospect of major oil spills in environmentally sensitive locations, the consequences of which can be extraordinarily damaging to the natural and human environment. While shipping standards have been tightened, there is a special duty of care to avoid such spills in the future. Measures used to protect environmentally sensitive areas — maritime safety, environmental standards, and operating practices — should be as cost-effective as possible. Uncontrolled and illegal discharges of fuel oil also require attention, as does the spread of non-native species via ballast water. Transport-related, land-based, sources of water pollution pose an additional challenge to preserving ecosystem vitality.

Urban amenity

Without more appropriate policies to improve land use and transport integration, current patterns of urban development, including urban sprawl, are likely to continue. A better balance between urban development on the outskirts of cities and land conservation must be found. The same is true for the balance between inner city decline and urban renewal. The outlook for transport in urban areas points to increasing levels of car ownership, usage and congestion and relatively stable or possibly falling levels of public transport usage. This outlook is not likely to satisfy urban populations — whether in their role as road or public-transport users or as residents affected by congestion and other consequences of increasing transport levels. Apart from causing a loss of both productive and leisure time, urban congestion contributes significantly to CO_2 emissions. To improve these conditions, governments at all levels of policy design and implementation in urban areas must formulate integrated approaches to urban development and transport. Such measures should achieve a better balance between environmental quality and use of transport infrastructure and services, including smoothing vehicle flows, reducing emissions and using existing infrastructure capacity more efficiently.

Transport noise

Transport noise has major impacts on a large proportion of the population. Despite the considerable progress made in reducing engine noise, there is a need to reduce overall transport noise in high-noise exposure zones (where measures are feasible at acceptable costs). Both motor-vehicle noise (especially during night-time periods in residential areas) and aircraft noise (in the vicinity of airports) should receive particular attention. Given the longevity of urban infrastructure, urban development and transport patterns that cause less noise disturbance will benefit not only current but also future generations of residents. Measures to address these are an important part of the policy mix.

Transport safety

Current approaches to transport safety have achieved significant improvements but clearly need to go further to adequately protect current populations. Future urban development and transport patterns need to significantly reduce safety risks. In the case of safety, the costs of altering fixed capital investment in buildings, roads and other infrastructure are high, limiting the extent to which it is possible to improve the safety of transport systems once they are developed.

Public health

Exposure to concentrations of pollutants above World Health Organization (WHO) guidelines could lead to adverse health effects. In the case of particulate emissions, there are concerns about the health impacts associated with very fine particles. However, currently there are no WHO standards for these, as there is no agreement on what are safe limits.

Transport demand

Underlying each of these issues is the projected increase in transport demand in OECD countries. Available pricing measures could both moderate demand and address transport externalities, but their use has been quite limited to date. Reasons for this lack of use include equity concerns, opposition from affected groups, and a lack of community support and political will. Given the importance of such measures to sustainable development, further consideration needs to be given to addressing barriers to implementing direct pricing systems.

Broad approach: economic, pricing and regulatory measures

A high level of policy consistency will be important in pursuing necessary improvements. At present, the policy environment is often complicated by policy inconsistency (within the transport sector and between it and other sectors) and contradictory requirements. There are very few instances across the transport and energy sectors where opportunities for pricing and subsidy reform are being taken up. This policy incoherence is being exacerbated at territorial levels of government by inadequate land-use planning and transport-related decisions. Policy reviews provide an opportunity to re-consider not only consistency within transport policies but also the balance between economic, environmental and social considerations in assessing policies in different sectors. Assessing competing strategies for cost-effectiveness will help considerably. The package of measures chosen should have clarity of purpose, and should provide industry, communities and individuals with more appropriate incentives than currently exist to modify their behaviour and contribute to more sustainable transport outcomes.

Evaluation methodologies

Good economic and environmental evaluations are essential to designing the policies discussed below. Economic evaluations need to be robust, with appropriate values attached to externalities, including greenhouse emissions. These are best achieved through economic estimations based on utility, generally measured in terms of willingness to pay. However, taking no account of external costs yields extremely bad approximations. For example, in the absence of an emissions trading regime for CO_2 emissions, a substitute value can be based on estimates of the costs of measures to reduce emissions to levels set for Annex 1 countries by the 1997 Kyoto Protocol.

Sound evaluation methodologies call for a detailed assessment of each major project and their distributive impacts. A framework for arriving at reliable results in the face of market failures has been developed for the UK government (SACTRA, 1999) to identify the economic circumstances in which additional analysis is appropriate according to the degree to which there is distortion in either transport prices or the prices of products on the market. The distributive aspects of the benefits from investments are likely to be of overriding political importance, particularly in respect to regional development policy.

Other aspects of transport evaluations such as social time preference (discount rates), to value benefits accruing to current and future generations, need to be re-assessed and tested in a sustainability context. The emphasis on intergenerational equity in sustainable development policies suggests using lower discount rates than is current practice in the government sector when addressing matters with long-term consequences. This would make projects that show a high net present value with longer-term benefits even more attractive. Of course, any such lowering would widen the gap between public discount rates and the very high discount rates (up to 20–30% per annum) often applied to commercial projects by the private sector. Further attention needs to be given to these issues.

Conclusions

The approaches outlined below build on current strategies being pursued by national and local governments, as well as by industry, in OECD countries. Many of the detailed measures have been tested in one or more OECD countries, often with promising results. They are outlined here for consideration and further development. There is no expectation that all measures should be pursued by all governments or that they all can or should be implemented immediately. Some measures may be more appropriate to one OECD region than another.

In many cases, close co-operation between governments internationally will also be required, to ensure consistent policy responses and to avoid a patchwork of different measures that could lead to cross-border difficulties. Listed are those measures likely to be the most effective and to make a significant difference to the environmental and social impacts of transport, while seeking to preserve the economic benefits that efficient transport systems can provide. They are intended to provide guidance on the best choices among the many options available. Reflecting the political priority attached to reductions in greenhouse gases by most OECD Governments, policies and actions need to focus on improvements in motor-vehicle fuel consumption, to achieve significant reduction in CO_2 emissions. Given the lead times involved, it is important for early action to be taken.

Short-term and precautionary action

Integration of transport and environment policies

A fundamental prerequisite for more sustainable development is a more-integrated approach to policy and decision making. For transport this implies integration of transport, energy and environment policies, and integration of spatial planning and transport planning. Much road congestion can be attributed to failures to appreciate the impact on the transport system of planning decisions taken outside the sector.

Many governments are developing more integrated institutional frameworks and planning processes: e.g. Integrated Assessments and Multi-Modal Studies in the United Kingdom, France's Interior Transport Law as amended by the Clean Air Act (LOTI, *Loi sur l'Air*) and the TEA-21 framework for transport planning in the United States. OECD Countries will need to use integrated planning tools to secure improved outcomes. Integration also requires that transport, energy and environment ministries be involved in fiscal policy relating to transport charges and taxation. Economic instruments are an important part of the measures that can be used effectively to influence private decisions towards more-sustainable patterns of transport demand, but will only be successful if they form part of a coherent policy towards fuel and vehicle taxation.

One of the key tasks in making transport sustainable will be to continue to improve institutional and regulatory frameworks and to develop decision-making tools to help present the results of economic and environmental assessments in ways that are simple and transparent.

Transport charges and taxes structured and set at levels that promote the efficiency and sustainability of transport

Charges and taxes will be most efficient when based on marginal social costs so as to provide incentives to reduce these costs to optimal levels. The relevant marginal costs need to include the external costs of

environmental and health impacts and accidents. Initially, the structure of charges will be more important than the precise levels of individual charges, which will need to be adjusted over time.

Fuel taxation has been a key element in strategies to relate transport taxes to external environmental costs. However, except for CO_2 emissions, fuel taxes are a relatively blunt instrument for tackling many elements of the social costs of transport. Existing transport tax structures in Member countries can be made more efficient by:

- Shifting from national taxes (and charges, including fuel taxes) and other tax revenues for infrastructure funding towards a combination of taxes related to environmental externalities and location-based territorial charges (such as electronic per-kilometre charges or tolls). This would mean restructuring and reducing some taxes to compensate for the new tax structure to ensure a revenue-neutral outcome. Technological progress is now making the introduction of location-based charges feasible and more cost effective. Electronic charges per kilometre for trucks are an example. The introduction of such marginal cost-based charges is recommended and could partially replace existing fuel excise duties.

- Ensuring that taxation regimes do not distort inter-modal competition represents an important challenge. Ideally, it will mean that cost-recovery targets and user charges for infrastructure are consistent between roads, railways, airports and ports, with external costs for transport services taxed on a consistent basis in each mode.

Cutting CO_2 and other greenhouse gas emissions from transport

Economic efficiency dictates that greenhouse-gas emissions should be addressed on an economy-wide basis, targeting reductions on the basis of cost effectiveness across all sectors and indeed across all countries. Strong co-operative action will be needed by governments, industry and users to reverse the current strong growth in transport-related CO_2 emissions. Incentives for consumers and industry to buy more fuel-efficient vehicles are important, particularly given the number of high-fuel-consumption vehicles increasingly being purchased at present in some regions. Differentiation of purchase taxes based on emissions is likely to provide the strongest influence on consumer decisions. Though OECD countries currently contribute two-thirds of global CO_2 emissions, rapid growth in motorisation in countries such as Brazil, China, India, Russia and Indonesia will have a major impact. The following reduction measures should have a significant impact over the period to 2020:

- Implement supply-side agreements with vehicle manufacturers and suppliers on a consistent international basis to ensure significant and continuous improvements in the fuel intensity and fuel consumption characteristics of new motor vehicles. The Joint ECMT/OICA/ACEA Declaration on reducing the emission of new passenger cars could be the basis for globally consistent voluntary agreements in other regions. Light commercial vehicles could be the object of similar agreements.

- Intervene in new vehicle markets selectively, to sharpen the distinction between low and high fuel consumption vehicles at the time of purchase. Governments can take effective measures to complement industry action on the production of more fuel-efficient vehicles. Options to modify demand include using fuel-consumption-based vehicle registration fees or revenue-neutral purchase "feebates" based on emissions. Increasing the price differentials could make fuel-efficient vehicles more attractive and quickly increase the proportion of low-fuel-consumption, alternative fuel and advanced technology vehicles in circulation. Providing better information on fuel efficiency and related costs to consumers also reinforces the market for more fuel-efficient vehicles.

- Identify the part of fuel taxes intended to internalise the costs of CO_2 emissions. This should correspond to the shadow price of CO_2 emissions implied by the Kyoto targets. To avoid market distortions, the same tax on CO_2 emissions should be applied to all transport fuels (including aviation fuels) and be consistent with taxes in other sectors.

Strengthen existing measures to protect water quality from transport-related pollution

Governments need to build on past actions and implement more-stringent global measures to reduce the risks of major oil spills, particularly in the vicinity of sensitive environmental locations, and address land-based sources of water pollution. Governments (through appropriate fora) should:

- Implement enhanced standards for vessel safety and containment of oil and other hazardous substances, as well as improved crew quality, combating substandard shipping by involving all players in the maritime transport chain and encouraging industry self-regulation.

- Strictly enforce internationally agreed safety rules, regulations and standards to enhance the quality of ships and reduce the risk of oil spills, especially in sensitive environmental locations. This also requires more resources, on a user-pays basis where possible, for enforcement.

- Develop strategies and set targets to reduce other transport-related sources of water pollution.

Encourage metropolitan and local governments to develop new policies and programmes, on a user pays basis where appropriate, that can make substantial improvements to transport in urban areas

In urban areas, development patterns often encourage use of private vehicles at the expense of public and non-motorised forms of transport. Individual choice predominantly favours individual transport. Experience has shown that it is not possible to meet aggregate levels of private transport demand in many large cities without reducing the amenity of urban areas for the communities involved. Existing policies are not well adapted to resolving these dilemmas. Governments —national, state and local— should:

- Promote land-use and transport programmes to revitalise urban areas, provide more transport choice and make urban areas with less-road-based transport attractive to communities and individuals. It is important to work with the public to identify the improvements and benefits they are seeking. Measures could include infrastructure improvements (e.g. for freight distribution), more space and facilities for active transport (e.g. pedestrian areas and separate lanes or routes for cyclists) and, where transport intensities require, higher volume transport modes (e.g. light rail tram and bus systems operating at ground level) being given priority over road traffic, including at intersections and along high-density and congested corridors.

- Improve road transport management programmes. The improvements required include improving safety for road users, containing congestion and facilitating traffic flow. Creative measures are needed to spread traffic demand over time and across the network. Market-based approaches include area-parking schemes at key locations. More commercial public operations and private-sector involvement could bring innovative urban road-system management programmes.

- Undertake vehicle emissions inspection and maintenance programmes on a selective basis, to ensure vehicles are maintained to appropriate emissions standards. These can be targeted at high-risk vehicles, including those over a certain age. Studies have shown that over 50% of noxious emissions problems stem from the 20% of vehicles that are not well maintained.

Optimise transport safety across all transport modes

Transport safety is an important part of sustainable development. Current levels of fatalities and injuries, particularly on roads, are not acceptable. While transport safety — and road safety in particular — needs to be improved everywhere, in some western and eastern European OECD countries it could benefit most from additional measures. Priorities include promoting improved driver behaviour, and enforcement programmes, on a consistent basis for alcohol, drugs and speeding (specific circumstances and measures may differ from country to country). Lowering legal limits for driving speed and permissible blood alcohol levels for drivers should dramatically reduce fatalities and injuries. Governments (at all levels) should:

- Pursue behaviour modification programmes targeted at high-risk groups on a consistent international basis to meet identified safety performance targets. This would include promoting enforcement and penalty regimes for alcohol, drugs and speeding that reflect safety risks. It could also involve raising levels of enforcement of existing road regulations in urban areas in countries where there is insufficient respect for these laws.

- Promote emerging safety technologies that can help avoid road crashes and reduce fatalities and injuries and ensure that speed limits reflect safe speeds — and promote the safety of non-motorised modes. This includes taking road space from cars (including for parking) to provide wider pavements for pedestrians and protected bicycle lanes.

- Develop new road-safety measures that would dramatically reduce road fatalities and injuries, involving: a Blood Alcohol Concentration (BAC) limit of 0.02% (or lower with community support); lowering the general urban-area speed limits (other than for selected urban arterials) to no more than 50 km/hr or less where communities favour doing so; and stricter and consistent road-safety enforcement regimes for speeding and BAC levels in both urban and non-urban locations.

Implement pro-competitive regulatory frameworks and reform transport operations to improve the efficiency of transport on a regional basis

More-efficient transport operations offer opportunities for sustainable development. Progress towards pro-competitive regulatory frameworks has been relatively slow in many Member countries. These should ensure that transport infrastructure is provided and managed on an integrated regional basis (seamlessly across national boundaries) and that transport services are provided on a seamless basis, wherever possible, by commercial transport organisations operating within a competitive transport policy framework.

Efficiency will be improved by allowing transport operations to provide competitive and complementary transport services free of artificial barriers. In many cases, these changes will be implemented most effectively and quickly by reform of currently government-owned transport organisations. One advantage of a transition to commercial transport operations is that it ensures the operations are subject to competition policy. Transport externalities would still be taken into account. Governments (international, national/state and local) should:

- Promote internationally consistent transport regulations to facilitate transport and logistics integration, allowing international and national operations to become fully efficient. This includes ensuring more seamless transport services and facilitating technological development (interoperability, e-commerce, GPS etc).

- Reform road transport operational regulations with a degree of flexibility that encourages operators to realise productivity gains through innovation and the adoption of new technology. Alternative compliance schemes and performance-based standards being pursued in road transport by a number of OECD countries offer significant potential in this area.

- Reform government rail operations, allowing rail services to operate on a commercially competitive basis. In Europe, for example, an international rather than nationally-structured rail system based on competitive rail operators — and clearer priorities between passenger and freight — could substantially improve international rail freight efficiency. Such reforms would most likely shift the current balance of contestable freight carriage from road towards rail carriage and improve the sustainability of freight transport outcomes.

- Continue aviation liberalisation, including of air cargo. The efficiency of air-freight transport needs to progress on the basis of liberalised regimes, which offer freedom to provide services on a commercial basis, subject to meeting their full costs (including emissions costs). Infrastructure capacity limitations may require Air Traffic Management measures.

- Continue the transition from government ownership of commercial and potentially commercial transport operations. In most cases, government involvement in transport operations is no longer necessary; except in the case of transitional and public goods, it is often undesirable. Greater private-sector involvement could improve transport system efficiency in many areas and make more funds available for infrastructure investment and maintenance. Appropriate regulatory frameworks will be needed to provide certainty for private investment while promoting competition, avoiding monopoly abuses, containing transaction costs, ensuring high safety and addressing environmental and social externalities.

Better use of transport infrastructure with information technologies and intelligent transport systems

During the twentieth century, governments invested heavily in transport infrastructure in response to rapidly increasing levels of transport demand. Much of this infrastructure is now used to its capacity during peak periods. Generally, there is capacity available across transport networks, which is under-used for a significant proportion of the time. This provides scope to improve the use of existing transport infrastructure and reduces the need for major new infrastructure investment. Demand-management measures can help ensure the efficient use of existing infrastructure and reduce the externalities associated with prevailing levels of transport demand.

In particular, implementation of Intelligent Transport Systems (ITS) can help achieve optimal use of existing transport networks, deferring or removing the need for additions to the stock of existing infrastructure. However, government policies that provide road operators with the capacity to charge road users are necessary before commercial applications can be developed.

Increase knowledge and support for sustainable development policies within the transport sector and among consumers

Improving the transport sector's contribution to sustainable development is a long-term task requiring important changes in industry, community and individual attitudes and behaviour. In many cases, the issues are not well understood by the community and there is ambivalence over the need for action. It is therefore important for governments to take action to prepare society for the changes required in the short term and the additional measures that may be required in the longer term. Governments should:

- Promote community and industry awareness through public campaigns and involvement in public policy formulation to increase community knowledge of, and involvement in, new approaches. Important lessons can be derived from road-safety campaigns that have helped change community attitudes towards drunk driving, speed and the wearing of seat belts.

- Target user behaviour and develop a sense of shared responsibility and accountability for more sustainable transport outcomes, with positive reinforcement where appropriate.

- Ensure policies address social issues related to transport of concern to the community.

Fully involve the transport sector in major developments that impact sustainable development

In the future, it will be increasingly important both to transport outcomes and to sustainable development generally that the transport sector is involved at an early stage of major proposals and policy changes impinging on transport. For example, the transport and sustainable development consequences of major regional and urban development proposals need to be fully taken into account at the project planning stages. Sustainable development will not be achieved unless transport decision-makers have a significant involvement in other sectoral decisions (e.g. finance, taxation, housing and urban and regional development). Governments (national/state and local) should:

- Co-ordinate with other sectors to ensure the measures proposed for the transport sector reflect the lowest marginal-cost means of achieving the changes and improvements required.

Longer-term measures

Physical limitations on the space available for infrastructure in locations of high demand growth must eventually restrict the ability of infrastructure providers and transport operators to meet unconstrained demand increases. Even in locations where infrastructure could be provided and funding is available, the extent and intensity of increased traffic are likely to impose unacceptable levels of environmental and social stress, unless there are dramatic advances in technology or major behavioural changes.

There is a range of possible developments — and possible measures for addressing them — that could influence transport in areas of high growth. Changes in resource and consumer prices can bring about behavioural change. Ongoing developments such as e-commerce and the Internet may result in some substitution of communications for access and mobility. Well-researched policy measures may lead to some decoupling of transport growth from growth in GDP. There is also scope for significant technological advances in infrastructure, vehicles and operations. Well-founded research and assessments will help develop additional measures to address the adverse aspects of the longer-term outlook. Governments (through international bodies, national and local action) should:

- Co-ordinate policy research with technology research and development to explore the most effective long-term measures to promote sustainable transport.

- Explore additional measures to address areas where unsustainable increases in the demand for consumption of transport services are expected.

Prerequisites for success

Domestic Co-operation. Governments, industry and the general public need to work co-operatively in addressing the range of sustainable development concerns related to transport. Such co-operation will need to encompass:

- More involvement of industry in policy planning. Industry can not be expected to take appropriate decisions on matters such as location and product distribution or provision of passenger services, unless the costs and charges of the alternatives fully reflect transport costs, including environmental externalities and sustainability. The transport industry is well placed to determine which improvements are required and can, in some cases, make the behavioural changes that actually have the most significant impact. In the critical areas of motor vehicles performance, emissions, technological development and alternative fuels, the transport industry is making a major contribution to moving towards sustainable development

- Informing consumers more thoroughly about the consequences of their individual choices relating to transport use. Like business, consumers will need the right policy framework, supported by incentives where necessary to favour sustainable choices.

- Community support. Policies will be most successful where they reflect community values and meet travel demand (where possible), while pursuing sustainability objectives.

- Evaluation methodologies which ensure that the myriad planning, operational and infrastructure decisions reflect the wider objectives of the new policy framework.

- Regular consultations with other sectors to ensure the measures being proposed by governments and industry reflect the least-costly ways of achieving economic, environmental and social sustainability outcomes.

International Co-operation. Greater international co-operation is required given the global scope of transport and the trans-national nature of required policy actions. Discussions with non-OECD countries should aim to increase the level of consistency and co-ordinated action between OECD and non-OECD countries on transport measures to improve sustainable development.

NOTES

1. Since 1990, the United States has required that only double hulls be used for deliveries to United States terminals, and the IMO has set a timetable for the gradual phase-out of single-hulled tankers from the world fleet. Some major oil companies also operate their own vetting schemes to investigate the suitability of vessels for oil transport. Also, efforts are being made to increase transparency within the industry and to make information about ship quality known to decision-makers.

2. These guidelines for moving towards Environmentally Sustainable Transport have been discussed and endorsed by the OECD Conference on Environmentally Sustainable Transport – EST Futures, Strategies and Best Practices, in October 2000 in Vienna, Austria.

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Chapter 14.

AGRICULTURE

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AGRICULTURE

Introduction

Agriculture is the sector that produces most of the world's food, beverage crops, and leather; much of its fibres, and a number of its chemical feedstocks. Its relative *economic importance* in OECD countries has been steadily declining over the past century, but it still contributes around 3% to Member countries' GDP on average, and three to five times that percentage in Greece, Iceland and Turkey. A much larger proportion of economic activity is directly dependent on agriculture, however, as suggested by the share of food in total consumer expenditure — which ranges from around 7% in the United States to over 20% in the Czech Republic, Hungary, Mexico, Poland, Slovakia and Turkey. Despite its modest size as a sector, total support to agriculture was equivalent to 1.3% of GDP (USD 340 billion) for the OECD as a whole in 1998-2000 (OECD, 2001*a*).

Agriculture's *social significance* has remained in many ways more visible than its economic significance. Its origins are contemporaneous with those of civilisation itself; it is reflected in cuisine, art and literature and figures of speech. Gone are the days when it was the majority occupation of people living in what are now OECD countries; for the region as a whole, only around one working person in twenty is engaged in farming. In six OECD countries, however (Greece, Korea, Mexico, Poland, Portugal and Turkey), the share of agricultural workers in total civilian employment still exceeds 10%. And while agriculture continues to shed labour in most countries, it still manages to attract new entrants.

Agriculture's *environmental significance* owes much to the 40% of the OECD land area it occupies and the biomass that grows upon it, the tremendous volume of water that falls on or is diverted to it, and the minerals and gases that cycle through it. Agriculture is the leading consumptive use of water in the OECD; an important source of nitrate, phosphate and pesticide pollution; and a source and sink of greenhouse gases. In much of the OECD, farmland dominates, and to a large extent shapes, the landscape. It serves at some point in their life cycles as a home or feeding place for a significant percentage of wild flora and fauna, particularly vascular plants, insects and birds (OECD, 1997). In short, agriculture and the ecosystems of which it forms a part, controls or interacts with various stocks of natural capital — stocks that are of value not only to the sector but to the rest of society as well.

How the agricultural sector manages these stocks is crucial to sustainable development. With proper market signals, policies and management, agriculture can make more positive and fewer negative contributions to the overall welfare of society. To do so, however, many of the policy measures currently influencing agriculture need to be changed. The risks to agriculture's resource base of delaying reforms will grow even larger in future years, as pressures on agriculture increase in line with rising populations and competition for other uses of the resources on which agriculture depends.

Demands on agriculture

Food

The primary function of agriculture is to produce food. Meeting nutritional needs in a quantitative sense is paramount, but the quality of the food itself — particularly its safety — forms part of the equation.

It is also not sufficient that food be available on average, but that people have access to enough of it to avoid malnutrition and starvation.

Growth in nutritional needs

According to projections undertaken for the OECD's *Environmental Outlook* report, per-capita consumption of food (measured in kilocalories) on a global basis is expected to grow at a rate of 0.4% a year, at least through 2020 (taking into account post-harvest distribution losses, which can be expected to improve with developments in transport[1]) — reaching something in the neighbourhood of 3350 Kcal/person/day by 2050. The net effect of this trend, combined with population projections, is that total world demand for food can be expected to rise at a faster rate than population growth over the next several decades, implying a total global nutritional requirement some 80% greater at mid-century than at present. Though some of this growth will occur in OECD countries, most of it will take place in developing countries, particularly those with per capita annual incomes above USD 2000. Even then, several hundred million people—mainly in sub-Saharan Africa — may still not be receiving adequate nutrition.

As people's real incomes rise, they can be expected to demand proportionally more, higher-quality and diverse foodstuffs (and to place a higher value on rural resources, whether for housing, recreation, or for the intrinsic value of landscape). Generally, the demand for wheat, rice and other cereals for human consumption is expected to parallel population growth. By contrast, the demand for oilseeds, feed-grains, and animal protein is expected to rise considerably. The increase in consumption of animal protein could have a large bearing on the overall demands placed on agriculture, to the extent that grain is consumed in the process of converting cereals to meat. Conversion ratios range from around 2 kilograms of cereal to produce a kilogram of poultry meat, to a ratio of 7:1 in the case of beef. Such ratios have led some observers (e.g., Lappé, 1975; Brown, 1995 and 1999) to issue warnings that a continued shift towards greater meat consumption in the developing world (which currently obtains more than 20% of its animal protein requirements from fish[2]) would compound the pressures on food production caused by population and income growth.

Many developing countries have the capacity to increase food production — by making greater use of chemicals and high-yield technology packages or by opening up new lands to agriculture in others. However, some of the growth in global demand will invariably be met through trade. According to projections carried out for the *OECD Environmental Outlook* (OECD, 2001*d*), over the next 20 years all OECD areas that are currently net exporters of cereals (Australia, Canada, the EU, Hungary, and the United States) are expected to experience large increases in exports; those OECD countries that are net importers will remain so, but their requirements will not increase dramatically. Similarly, those that are currently net exporters of meat (Australia, Canada, New Zealand) and other livestock products will probably continue to expand production for export. All signs are that these same trends will continue for several decades after 2020. The upshot is that over the next half-century OECD countries will likely witness a significant increase in production of major food commodities — anywhere between 50% and 100%— before it stabilises or declines in line with global demographic trends.

Increasing food safety

In addition to producing a greater quantity of food, the OECD's agricultural sector is expected to ensure that food is of high quality and, especially, safe to eat. This is not a new issue: people have been concerned about the quality and safety of their food since ancient times. Rapid strides have been made in food safety standards since the first-half of the 20th century, paralleling technological advances in food preservation and handling. Lately, however, the incidence of some other food-borne diseases, most notably those associated with emerging pathogens, appears to be on the increase. Whether such rises in reported cases reflect underlying trends, or simply better reporting of food-borne illnesses (in part due to increased public awareness) and improved monitoring procedures, is not easy to determine. Changing dietary patterns have also increased the need for more effective and flexible food preparation systems. And, in some OECD countries, other factors, such as trade effects and ethical considerations not directly related to food safety, continue to influence government actions in this area.

Many countries are examining how national food safety systems can be improved to protect public health, in particular to restore public confidence in the wake of such crises as BSE. Governments are continuing to search for ways to make food safer, and are requiring improvements in standards along the food-production and processing chain. (What is considered an acceptable risk is much more difficult to quantify, however.) The demands by consumers for ever-higher standards of food safety, particularly in industrialised societies, is not likely to abate, and will place more pressure not only on domestic agricultural industries but also on those in countries hoping to export to OECD countries. The main implication for policy makers is that food safety must form an integral part of the whole chain of farm, food production and processing and that it will require constant attention, education and, above all, effective regulatory mechanisms at all levels.

Uncertain demand growth for non-food commodities

Industrial products

The range of non-food products that can be obtained from agricultural is practically boundless. Agriculture has long been a source of medicines; inks; fibres for textiles and skins for clothing, footwear and sails; oils for soaps and cosmetics; and leaves for smoking and brewing. New products from domesticated — or domesticable — plants and animals are being developed every year. Fibres and oils from industrial hemp (*Cannabis sativa L.*), for example, can yield products as diverse as particle board, beer and baby nappies. Advances in biotechnology could lead to an explosion of new compounds grown on farms — e.g. biodegradable plastics from plant-derived oils, sugar and starch. Some industrial products, such as tobacco, starch and certain specialty oils, can be obtained only from agriculture; but none, in spite of their commercial importance, are necessities of life in the same sense as food. Of all the (non-energy) markets for industrial productsm the market for fibres used in the manufacture of textiles will perhaps have the greatest bearing on issues relating to the sustainability of agriculture. Currently, cotton accounts for 98% of the world's consumption of non-wood plant-derived fibres; wool from sheep commands a similar share of animal-derived fibres. Together, cotton and wool account for over half of the world markets for apparel and home textiles, and a large share of the world market for fibres used in carpets — the three largest end-uses of natural fibres. While consumer demand for natural fibres remains buoyant, that market is vulnerable to new developments in technology, as well as consumer tastes. Looking beyond the next 50 years, it is extremely difficult to predict with confidence what the demand for these fibres will look like.

Energy

Currently, agricultural land is used for the production of biomass (used either directly or converted into gaseous or liquid fuels) and wind-generated electricity.[3] Production of biomass typically takes place on arable land, wind energy predominantly on moor and pastureland. These different technologies place quite different demands on natural resource inputs, and differ as well in their impacts on biodiversity and landscape values. Generally, wind power requires relatively small amounts of land to be diverted from agriculture, mainly for the actual turbine structures and access roads. Production of biomass from crop residues and biogas from animal wastes also pose no significant additional demand on agricultural resources, though it can affect the markets for both agricultural inputs and products, and alter the cycling of nutrients back to the soil. Production of biomass expressly for energy, by contrast, directly competes with other land uses, including food production.

According to the International Energy Agency (IEA, 1998), in 1996 biomass accounted for around 2% of total national energy production within the OECD as a whole. Waste products from pulp and paper processing are believed to have accounted for about two-thirds of the total, leaving less than 1% accounted for by agricultural biomass. Most of that was derived from crop residues, with a very small proportion coming from dedicated energy crops.[4] The bulk of the energy crops were used to produce maize-based ethanol, rapeseed esters (biodiesel) or woody biomass for the production of heat.

IEA projections expect non-hydro renewable energy (NHRE) sources (mainly geothermal, solar, wind, tide and biomass) to be the world's fastest growing primary energy source up to 2020, at nearly 3% per annum

(IEA, 2001). OECD countries will account for most of this growth. Several OECD countries now provide support to energy crops through tax breaks, investment loans and grants, price support, and government-funded research and development. In the future, concerns over climate change, rural employment, the diversification of sources of farm income, and the ability of land to reduce flooding may lead governments to further encourage the production of energy crops, but absent substantial policy interventions they are unlikely to become competitive with fossil fuels. Projected growth rates by 2020 would therefore depend both on the amount of government support and the introduction of measures to discourage CO_2 emissions.

If the demand for biomass is allowed to be driven by market forces, the pressures created on land by energy crops are likely to be minimal. Even if, for example, governments bring in modest carbon-based taxes and encourage the development of new conversion technologies, such as cellulose-to-ethanol processes, the production of biofuels is likely to take place primarily at the margins, rising and falling in response to prices in the agricultural and energy markets. In most countries, other technologies for producing energy from renewable resources will be available and, in many cases, cheaper.

Demands relating to public goods and externalities

Because it requires large areas of land, agriculture gives rise to both positive and negative spillovers of an environmental or cultural nature that have the characteristics of public or club goods: landscape, habitat for non-agricultural flora and fauna, and various aspects of the hydrological cycle (OECD, 1997; OECD, 2001*c*). For example, water flows more slowly across, vegetated land, including farmland, than unvegetated land. If the land is not already saturated, some of the water will run off (unless prevented from doing so by dykes, as in upland paddy fields), but some of it will also be absorbed by plants, percolate into the ground, or evaporate. This "water retention and filtering" function of vegetated land plays an important role in recharging aquifers, buffering acidic precipitation and reducing the risks to humans of flooding.

Determining the level and type of demand for some environmental services and amenities, like the cultural, aesthetic and recreational components of landscape, is complex.[5] A mountain dominated by pastures has a different character and offers a different recreational experience to most people than does one dominated by trees. Evaluating the impact of a change in landscape, which as an aesthetic and cultural resource has the characteristics of a public good, thus requires arbitrating different personal preferences and cultural values and not simply measuring elasticities of substitution. Measuring those preferences, usually with contingent valuation methods, requires careful survey design and stratification of the sampled population: urban and rural populations may feel differently about transformations to a particular landscape.[6] Forecasting such preferences into the future is even more problematic (OECD, 1995*a*).

Similarly, society has an interest in conserving the diversity of wild and semi-wild species and ecosystems that depend on or interact with agriculture, as well as farm animals and plants at risk of extinction. But that interest cannot easily be separated from its wish to conserve nature generally. By virtue of the large share of most countries' space that it occupies, agriculture plays an important role in determining whether societies' objectives regarding biodiversity can be met. Most species interact with agricultural systems, even if their primary habitat is in natural areas, such as adjacent forests (OECD, 2001*b*). But it is ultimately the ecological balance that matters: while in some areas overall biodiversity might be improved by the conversion or reversion of agricultural land to other uses, in other areas it could be diminished.

Nevertheless, it is probably safe to speculate about the general direction of future demands on agriculture relating to the environment: as confirmed by public-opinion surveys, citizens of OECD countries expect less pollution from the sector. They also expect to retain or even increase the environmental and recreational amenities provided by the countryside, which in some countries are closely related to agriculture. These expectations are consistent with rising incomes, greater leisure time, heightened public knowledge of the issues, and increased use of rural areas for recreational activities.

Finally, people hold varying views relating to the welfare of living factors of production in agriculture — namely, farmers, farm workers and farm animals. Consumers and consumer organisations in a number

of OECD countries have urged that livestock be raised under what they consider to be more "natural" conditions, which has spurred a growing market for meats and eggs differentiated according to certain animal welfare criteria.

Factors affecting the supply capacity of agriculture

In order to supply ever-greater quantities of food and fibre, farmers have in the past expanded along two margins: the extensive (bringing new land under cultivation) and the intensive (increasing yields). In many OECD countries, most of the land that could be farmed *is* being farmed, so future growth will mainly have to be accomplished through productivity gains. If current trends continue, the capacity of OECD countries to meet the demands placed on agriculture will be increasingly determined by the informational and technological component of manufactured capital — the stock of embodied knowledge — rather than simply its mechanical or chemical force. Some producers in OECD countries, particularly those in areas deemed to have high nature-conservation value, may continue to use extensive farming practices or reduce the amount of capital and intermediate inputs they use on their farms, as they respond to incentives to practice "low-intensity" or similar types of farming systems. But the majority of producers will continue to adopt new technologies and techniques, many of which have the potential to conserve resources more effectively while maximising returns from farming.

Given the wide diversity of production systems employed in OECD agriculture, the possible developments in technologies and farming practices that are likely to have a bearing on the future demand for land and other resources are vast. The generic classification given below can at least give an indication of the direction, potential, and limits of some of these possibilities.

Technologies that improve biological potential. For millennia, agriculture has been subtly changing the genetic code of crops and livestock through selective breeding aimed at achieving higher yields, enhanced nutritional quality or flavour, improved disease resistance and tolerance of stress, and superior ability to compete with non-domesticated species. In the early part of the 20th century the process was refined through hybridisation — the crossing of animals or plants of dissimilar genetic constitution. And the potential for further improvements through hybridisation has not yet been exhausted. By combining conventional plant-breeding techniques with "genomics" — the ability to map the genetic make-up of organisms — seed companies expect to be able to produce varieties especially tailored to particular farming conditions. Genetic modification, which began to be used commercially in the early 1990s, offers an even more potent tool for increasing biological potential. However, concerns about the possible risks of genetically modified organisms (GMOs) to human health and the environment will have to be addressed to the satisfaction of scientists, policy makers and concerned consumers before the technology can be applied more widely. Concerns have also been expressed over "genetic erosion", which have led to private and public "gene banks" (Box 14.1). The same applies to the use of synthetic hormones to accelerate muscle growth or milk production in livestock, which have been challenged by some governments.

Technologies that make crops and livestock more resistant to pests and diseases. Until the late-1800s, selecting for disease resistance (through breeding) and isolating crops and livestock from exposure to pests and disease (through quarantine and inspection) were about all farmers could do to protect their crops and livestock. To some extent the development of pesticides, vaccines and more sophisticated medicines took pressure off the need to develop natural resistance. However, as consumers in OECD countries start demanding products that use fewer or none of these agents, a renewed stress on developing natural resistance can be expected. Some of that resistance will come from ancient animal breeds and crop varieties.

Technologies and techniques that more precisely target pests and diseases. The need for medicines and pest control agents in agriculture is not likely to disappear any time soon. Technological advances in the science of pest control are expected to produce chemical control agents that are less toxic, less persistent and less mobile through the soil. The greater application of monitoring and knowledge-based systems — aided by reductions in the costs of electronic sensors and computers — should also enable farmers to be more

Box 14.1. **Managing genetic resources**

One category of resources relied on by farmers requires a somewhat different approach to its management than that used for other resources. Since the 1940s plant breeders have increasingly dropped traditional varieties in favour of more genetically uniform hybrids. While the development and spread of hybrids has enabled farmers to boost yields, it has reduced the genetic diversity of planted varieties and increased the dependency of farmers on seed suppliers. This concern, over what is sometimes referred to as "genetic erosion", focuses on the vulnerability of hybrid crops and animal breeds to pests and diseases. In response, private companies and foundations, as well as governments have established extensive collections of gene-plasm (or "gene banks") in order to ensure a secure and diverse supply of genetic material.

Seed companies that produce hybrids have a strong self-interest in discovering and preserving genetic material, and most of them have been systematically collecting and preserving samples of crop strains for many years — seeking out older landraces or closely-related wild species in order to find genes that are more disease-resistant (Budiansky, 1999). A number of OECD governments and non-profit foundations have also set up gene banks of their own, often in co-operation with private companies. The largest, the United States' National Germplasm System (NGPS) — a co-operative effort involving public (State and Federal) and private organisations — was established almost 100 years ago and now has a collection of over 600 000 plants. Germany's two gene banks contain between them around 150 000 samples. In addition, there are a number of international gene banks, such as the Nordic Gene Bank, a joint effort of the five Nordic countries (30 000 samples), and the 11 gene banks of the Consultative Group on International Agricultural Research (more than 500 000 samples). Collections in these gene banks continue to increase.

Finally, in addition to maintaining *ex-situ* collections of genes, many countries have also sought to promote gene conservation through other, *in-situ* means, such as establishing farms for the growing of rare crops or livestock breeds.[7] In short, genetic erosion seems to have been anticipated by governments and industry, who responded by establishing gene banks, and therefore for the time being does not appear to threaten agriculture's long-run potential.

parsimonious in their use of pest control agents: applying them only when and where necessary, rather than following predetermined dosages and schedules. Research into the use of biological pest control agents (such as parasitic wasps against moths and other insect pests) is also expected to reduce the need for chemical pesticides in the future.

Technologies and techniques that administer nutrients more efficiently. Nitrogen-phosphorus-potassium (NPK) fertilisers, first sold commercially in 1908, enabled farmers to restore the levels of two of the most crucial minerals for plant growth and, with nitrogen, to dramatically raise crop yields. By allowing separation of crop production from animal husbandry, they also contributed to the development of livestock production based on grain and other off-farm feed ingredients. Research into the specific needs of particular crop-soil combinations and livestock has led over the years to more scientifically formulated fertilisers and feeds. Wider application of integrated nutrient management techniques, which make use of technologies that administer fertilisers only at the times and in the amounts needed, can be expected to increase crop yields further while reducing leaching and runoff of nutrients.

Technologies that administer water more efficiently. Many of the technologies still used for irrigating crops are as old as civilisation itself. The problem — today just as in ancient Mesopotamia — is that conveying water through open channels and furrows is wasteful: much of the water evaporates before it reaches the root zone. In OECD countries, where much of the water used in agriculture is delivered to fields by pipes, technical efficiency could still be improved through more accurate measurement of actual crop needs and more efficient delivery. In Italy, for example, water consumed in growing rice was reduced when laser technology was used to level paddy fields.

Technologies that reduce wastage following harvesting. Technologies used in OECD countries to harvest, transport, store, process and distribute farm commodities are already highly efficient, and result in much lower levels of food wastage than in countries where the requisite capital and infrastructure is in much shorter supply. Virtually every part of most crops and animals are recovered for some commercial use — generally for feed, fertiliser or energy. A study of U.S. consumption patterns (Kantor *et al.,* 1997) showed that of the 27% of edible food available for human consumption that was not consumed in 1995, nearly all of it was lost by the food service industry and final consumers in the form of leftover portions of meals, and trimmings from food preparation. Reducing these losses will probably come as a result of changing consumer habits rather than from new technology.

Advances in these areas would contribute positively to sustainable development in so far as they reduce the amount of resources needed to produce a given level of products, and therefore often agriculture's environmental impact. But with intensive production often comes increased environmental pressure, especially on a local scale. That means that farmers will also need to adopt appropriate techniques that conserve resources (e.g., no-till cultivation) or treat or prevent pollution (e.g., those that render waste streams from piggeries more innocuous). In some cases, technological developments elsewhere may create new opportunities. The commercial development of power plants that are able to generate electricity from poultry litter, for example, suggests that there may be other integrated approaches to dealing with some of agriculture's more acute pollution problems that could emerge, given the right incentives.

Recent trends in the performance of the sector

Making the transition to a situation where agriculture is contributing optimally to sustainable development requires first of all having an idea of what that contribution is currently, and to where existing trends are taking it. Is it economically efficient? What is happening to its human and social capital? Are negative externalities being reduced and public goods being maintained or augmented? Are forces that threaten to degrade the resource base on which agriculture depends being lessened? Because of data limitations, these questions cannot be answered definitively. But thanks to recent efforts by OECD countries and the OECD itself to develop agri-environmental indicators (OECD, 2001*b*), a clearer picture is starting to emerge.

Economic trends

The agricultural industries of OECD countries as a whole have succeeded in meeting not only the growing demands of the OECD countries for food and fibre, but also demand growth in other parts of the world. Overall, output has continued to expand — by 15% since the mid-1980s, despite a 1% decline in total agricultural area. Moreover, because of rising productivity, this growth has occurred without corresponding real increases in commodity prices. As a consequence, much less of the value-added in the chain between farm and final food consumer is contributed by farmers — 22% in the United States in 1995, compared with 57% in 1950 (Henderson, 1998). The situation differs markedly among OECD countries, however, due to differences in the degree of processing applied to foods.

The economic performance of the sector has been affected by high levels of support, which currently (average 1998-2000) accounts for about 35% of total farm receipts for the OECD as a whole — a reduction from the 39% recorded for the mid-1980s. Concealed behind this average figure are wide national differences in levels of support, which currently ranges from around 1% in New Zealand and 6% in Australia, to 23% in the US, 40% in the EU, and over 60% in Iceland, Japan, Korea, Norway and Switzerland. On a commodity basis, the highest levels of support generally go to producers of sugar, milk and — in Japan and Korea — rice. On average across the OECD, two-thirds of support to producers is provided via agricultural and related trade policies that raise farm-gate prices above those for equivalent products sold on world markets (OECD, 2001*a*). This diverts resources, penalises consumers, especially poorer households, and other sectors of the economy, and by depressing international prices prevents food-exporting nations, including those in the developing world, from fully exploiting their comparative advantage and thus hindering their sustainable

development. Moreover, the wide variations in the level and composition of support that exist among commodities further distort production decisions and resource allocation. The analysis of agricultural policy reform on the sustainability of agriculture is discussed later in the chapter.

Social trends

Internationally comparable information on trends in the social situation in farming is at an early stage of development. Most of the data pertain to employment, demographics, and the level and distribution of farm and total-household income. Overall, the trends point to a need for further structural adjustment and the improvement of skills and education of those remaining in the sector. Agricultural now accounts for less than 7% cent of total employment in most OECD countries, and continues to decline. Nevertheless, the agricultural labour force in many countries still exceeds by a large margin what would be required to produce current levels of commodities using efficient combinations of land, labour and capital. The major exception is horticulture (Box 14.2). Exit from farming has been most difficult for older farmers, which has skewed the age distribution of farmers: in many countries the majority are over 55 years old. Meanwhile, the average age of new owners of farms remains significantly above 35 years old in most countries. This latter statistic is significant, to the extent that a younger, well-educated workforce may be more likely to adapt rapidly to changing economic and environmental conditions (OECD, 2001*b*).

Box 14.2. **Horticulture and immigrant labour**

As the most labour-intensive, and in some ways least-mechanised, segment of agriculture, horticulture requires large numbers of unskilled or semi-skilled people, often for very limited periods of time. Today, that labour is increasingly being supplied by immigrants, both legal and illegal.

But rules relating to immigrant agricultural workers are often less restrictive than those for workers employed in other areas of OECD economies, and their enforcement more lax. A typical practice is to allow seasonal farm-workers in to a country and then to send them home after the harvest is over.[8] In some countries, neither the employer nor the employees of seasonal immigrants are burdened by the same social charges that are applied to other workers.

Undocumented, or illegal, immigrant farm workers play an important role in the fruits and vegetables sectors in several OECD countries, but gauging their participation is naturally much more difficult than for immigrants working under official schemes. In the United States it has been estimated that around 600 000 of the nation's farm workforce of 4 million are illegal immigrants.[9] Official estimates are not available for the EU, but the numbers of immigrants (legal and illegal) involved in the harvest of horticultural crops may be of a similar magnitude, especially if temporary workers visiting from neighbouring countries under tourist visas are included.

The increasing reliance of growers on immigrant labour in some OECD countries points to an important sustainable development issue. The demand for labour in some countries' horticultural industries is higher than it would be were domestic producers not as protected by tariff and phytosanitary barriers that raise the domestic prices of their fruits and vegetables above those of competing imports. Immigrant labour is accepted or encouraged chiefly because it reduces producers' costs. A recent study by the Cato Institute (Moore, 1998), for example, estimated that the cost of fruits and vegetables in the United States would rise by 6% without illegal workers. Yet were agriculture subjected to the same labour and immigration rules as other sectors, and markets for horticultural products more open, some of the horticultural production currently taking place in OECD countries would shift to those countries with a comparative advantage in that area. Ironically, it is often these same countries that are the main sources of immigrant labour working on OECD farms.

Departure from the industry has coincided with a gradual improvement in the quality of *human capital* in farming. Nonetheless, there are still only a small number of countries where more than 40% of farmers receive even basic agricultural training. Measuring the stock and quality of *social capital* on which OECD agriculture can draw is even harder to pin down. But one can point to both negative and positive trends. It can be argued, for example, that the trend towards increasing size of arable farms and ranches, and the depopulation of some of the most rural areas of the countryside, reduces opportunities for social networks and therefore reciprocity to form among farmers, or between farmers and their suppliers. But at the same time, modern technologies have opened up new pathways for social interaction, allowing new types of networks to form. And with greater awareness among farmers and ranchers of the need to protect shared natural capital, farmers themselves are forming new community-based, farmer-led groups in a number of OECD countries expressly for the purpose of protecting or improving local environmental resources (OECD, 1998*b*).

Mirroring the trends in agricultural employment, numbers of farms have declined in most OECD countries with a corresponding increase in farm size, and concentration of production in a small number of larger farms. The share of small farms is, at the same time, increasing. The trend toward increasing farm size can entail consolidation of fields with a consequent loss of boundary features (such as hedges and stone fences).

Trends in real net farm incomes from agricultural activities have been variable over the last 10 years, rising in some countries but sharply declining over recent years in other countries, largely reflecting changes in macro-economic conditions, farm costs and support levels. Nowadays, farm household incomes are on average comparable to incomes in other households in most OECD countries. The degree to which this situation can be attributed to government support policies, however, is unclear. Some support is provided indirectly through government transfers to rural areas. And a small, but increasing, amount of support is being provided through agri-environmental payments. But the bulk of agricultural support is still linked to output or factors of production. Such support tends to benefit the relatively fewer large producers more so than the many small and medium-sized producers. Moreover, to the degree that support becomes capitalised into the value of farmland it has a negative impact on the incomes of farmers who do not inherit their land and must purchase or lease it instead, as well as encouraging more-intensive farming practices. Finally, many farm households reach incomes that are comparable to those of other households because they have diversified their sources of income and do not rely on farm income alone.

Environmental trends

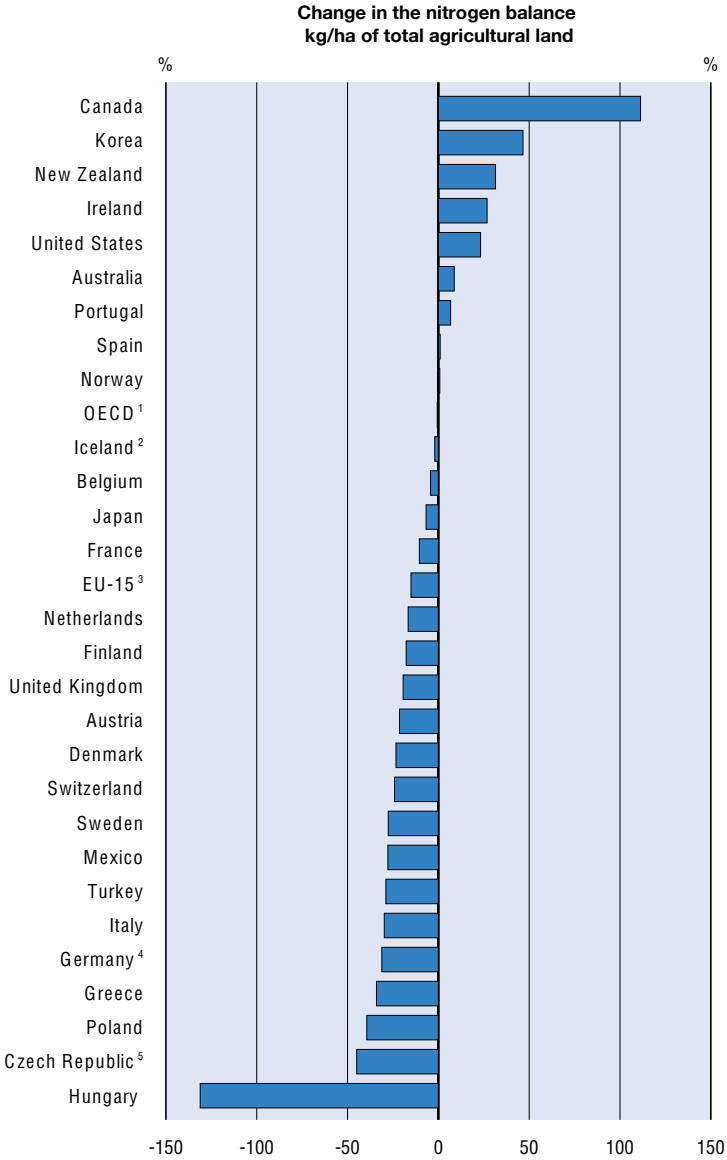
Interpreting the overall environmental performance of agriculture over a large geographic area is not a simple task. The results of the OECD's indicator work to date suggests that for many regions within OECD countries, pollution levels (e.g. nitrogen and pesticide loading in water) remain relatively high, and threats to natural resources — particularly soil, water and biota — persist. But these negative results have been offset, to some extent, by improvements in increased efficiency in the use of farm inputs, such as fertiliser (OECD, 2001*b*).

The most significant progress in reducing agriculture's impact on the environment has occurred where environmental pressures were and still remain the greatest. Since the mid–1980s there has been a decrease of over 10% in both nitrogen (Figure 14.1) and pesticide use in many European countries and Japan, with corresponding improvements in water quality and greenhouse gas emissions. Soil erosion rates have declined in Australia, Canada, Denmark and the United States, and progress has been made in adopting farming practices that enhance environmental performance (such as nitrogen management plans, integrated pest management and conservation soil tillage), though "hot-spots" — areas with surplus nutrient loading — remain. In the United States, small wetland areas that were filled in and used for arable farming are being returned to their prior state. Indeed, except in a few OECD countries, more aquatic ecosystems are now being restored than are being converted to agriculture.

The conversion of conventional farms to those certified as organic has accelerated in recent years. The share of total agricultural area occupied by organic farms is already 4% or greater in Austria, Finland, Italy,

Sweden and Switzerland (OECD, 2001*b*). This shift has been encouraged by changes in consumer demand, and in some countries by government support, usually in the form of transitional grants. An expanding proportion of consumers regard food produced through organic or "biological" means as safer to eat, and the methods used to produce it as less polluting[10], better for the soil, respecting the welfare of animals, and

Figure 14.1. **Soil surface nitrogen balance estimates, 1985-87 to 1995-97**



Nitrogen balance
kg/ha of total agricultural land

	1985-87	1995-97
Canada	6	13
Korea	173	253
New Zealand	5	6
Ireland	62	79
United States	25	31
Australia	7	7
Portugal	62	66
Norway	72	73
Spain	40	41
OECD	23	23
Iceland	7	7
Belgium	189	181
Japan	145	135
France	59	53
EU-15	69	58
Netherlands	314	262
Finland	78	64
United Kingdom	107	86
Austria	35	27
Denmark	154	118
Switzerland	80	61
Mexico	28	20
Sweden	47	34
Turkey	17	12
Italy	44	31
Germany	88	61
Greece	58	38
Poland	48	29
Czech Republic	99	54
Hungary	47	-15

Notes: While these calculations have been derived from using an internationally harmonised methodology, nitrogen conversion coefficients can differ between countries, which may be due to a variety of reasons. For example, differing agro-ecological conditions, varying livestock weights/yield, and differences in the methods used to estimate these coefficients. Missing from the calculation is the atmospheric deposition of nitrogen which is mostly independent from agricultural activities.
1. OECD averages, excluding Luxembourg.
2. The 1995-97 average refers to 1995.
3. EU-15 averages, excluding Luxembourg.
4. Including eastern and western Germany for the whole period 1985-97.
5. Data for the period 1985-92 refer to the Czech part of the former Czechoslovakia.

Source: OECD (2001), *Environmental Indicators for Agriculture, Volume 3: Methods and Results*, Paris.

more hospitable to wildlife, than food produced through conventional means. However, the overall long term effects of organic methods of food production on the sustainability of agriculture require more investigation, given the use of more land to produce a given quantity of food, the greater skills required of farmers, and higher costs of food to consumers.

On the other hand, the environmental performance of agriculture has also deteriorated in some areas. Parts of Europe, North America and New Zealand that have experienced regional concentration of livestock farming have witnessed rising levels of nutrient surpluses, ammonia and greenhouse gas emissions, with consequent increases in water and air pollution. There is also growing competition for scarce water resources, not only between agriculture and other users, but also for meeting the water needs of aquatic ecosystems for recreational and environmental purposes, particularly in the drier regions of Australia, the United States and southern Europe. And problems of soil salinisation continue to accumulate in several countries. In Australia, for example, at least 2.5 million hectares (5% of the country's cultivated land) is currently affected by dryland salinity; the affected area could rise to 12 million hectares (22%) if nothing is done to stop its progression.

Another threat to soil quality is the build-up of heavy metals. Research has shown that applying fertilisers, manure and sewage sludge, pesticides and water that contain toxic heavy metals can negatively affect certain soil microbes (such as nitrogen-fixing bacteria) earthworms, and plant growth, thereby affecting overall productivity.[11] Heavy metals themselves could also pose a long-term health problem in a few areas because they can be absorbed by plants and thereby enter the food chain. Information on the scale of the problem is hampered by lack of data, however. The problem of heavy metal contamination in soils is exacerbated by acid rain and snow, chiefly through the exposure of atmospheric water vapour to sulphur and nitrogen oxides emitted in the combustion of fossil fuels. In areas where soils are naturally alkaline, increased acidity can actually benefit plant growth by making iron and zinc more available. But in many parts of the OECD, increased acidity accelerates the leaching of minerals necessary for plant growth (such as calcium and magnesium) while amplifying the effects of those that are detrimental to it. Fortunately, measures in OECD countries to reduce pollution from point sources are slowing down the rate at which acid precursors are being pumped into the atmosphere. But that is not always the case in non-OECD countries.

Other soil contaminants, though less of a threat to soil fertility *per se*, can enter the food chain and be absorbed by humans, rendering the affected land unsafe for food production. Two important categories of contaminants are dioxins and radionuclides (notably hydrogen-3 (tritium), carbon-14, potassium-40, caesium-137, strontium-90, radium-226 and thorium-232), both of which are suspected agents in many human cancers. Dioxins have on occasion entered the food chain directly through contaminated feed, as was discovered in Belgium in 1999. More often they enter it through atmospheric deposition onto plants, which are then consumed by livestock and accumulate in their fatty tissues and in milk fat. Dioxins are formed as inadvertent by-products during the production of certain herbicides, and have been detected as contaminants in these products. They are also emitted when chlorine is used to bleach paper pulp, and in thermal processes such as waste incineration and metal processing. Radionuclides, once dispersed widely following aboveground nuclear bomb tests, are now a health threat mainly in connection with accidental releases from nuclear power plants.

Trends related to soil and water are particularly significant because of their long-term, sometimes irreversible, nature. While the rate of increase in agricultural pollution to water bodies appears to be slowing over much of the OECD, the accumulative effects of the downward movement of pollutants through the soil will continue to impose costs on society for many years into the future. Denmark, which obtains nearly all its public water supply from groundwater, at one time could draw on that water with little treatment beyond simple filtering. By the 1980s, however, its groundwater quality had deteriorated to such an extent — mainly from nitrates — that it had to invest in many new, expensive water-treatment facilities (OECD, 2000*c*); even if its agricultural sector manages to reduce nutrient leaching to a minimum, it will take decades before the groundwater returns to anywhere near its original quality. In Denmark, as elsewhere where nutrient loading remains high, the composition of plant species in areas adjacent to farms is also changing, generally towards more nitrogen-tolerant species.

Long-term concerns also arise from groundwater abstractions for irrigation, growth of which has been partly responsible for water withdrawals that in some areas exceed those at which the aquifers are recharged — clearly a practice that cannot be sustained indefinitely — and in some coastal areas salt-water intrusion. In the southern prairie region of the United States — one of the largest irrigated areas in the OECD dependent on ground-water — unrestricted access to the massive Ogalalla aquifer during the second half of the 20th century led to the rapid development of farms (some as large as 10 000 hectares) specialising in crops such as maize and alfalfa that could be efficiently grown under centre-pivot irrigation systems, generally for supplying cattle feed-lots (Saito, Yagasaki and Futamura, 1999). With rising electricity prices and falling water tables, the future of these operations looks increasingly threatened. Similar problems have appeared on a smaller scale in other parts of the United States (California and Florida), Australia, Mexico, and southern Europe. Even The Netherlands, which traditionally has been more concerned about keeping water at bay rather than retaining it, has become concerned about the effects on native, hydrophilic flora of falling groundwater tables, particularly from the draining of pastures for agriculture.

Climate change looms large over all these trends. Opinions differ on the likely climate outcomes for agriculture under different GHG stabilisation and reduction scenarios. But generally, altered rainfall patterns, and changes in humidity and temperature, could affect the growing conditions of plants and the abundance of pests. The OECD's own forecasts of the sectoral impacts on agriculture are summed up in its report in 1999 on *Action Against Climate Change:*

> In most OECD countries (Australia may be an exception) warmer weather is likely to mean higher crop yields unless water availability is a constraint. … The rate of photosynthesis increases quite substantially in many crops (and trees) as the atmospheric CO_2 concentration increases. Drier and hotter conditions in some areas may nevertheless result in losses of agricultural land, but the northern retreat of tundra and permafrost zones in Canada, northern Europe and Russia will presumably extend the northern margin of cultivated land. For the United States and Canada, and possibly for most of Europe, Japan, Korea and New Zealand, agricultural yields seem on average (with much local variation, no doubt) more likely than not to increase in response to climate change. Any increase in the frequency of extreme events (storms, floods, heatwaves, droughts) might work against this.

Information on changes in the quality of *agricultural landscapes* is limited, for the most part, to features such as farm buildings, hedgerows and stone walls. Here, there are signs that the long-term tendency towards increasing homogeneity of landscape structures could be slowing down in several countries, as public pressure and specific policy measures to preserve or restore landscape features become more prevalent (OECD, 2001*b*). On the other hand, new features continue to be added to agricultural landscapes, such as electric power lines and wind turbines. The intrusion of wind turbines into rural landscapes raises questions about the coherence of national policies to promote wind power on the one hand, and those that seek to preserve agricultural landscapes on the other.

While information on the impact of agriculture on *wild species using agricultural land as habitat* is also limited, it appears that populations of native species have declined in most cases over the past decade (continuing a longer-term trend), though there has been a deceleration in population declines for some species in recent years (OECD, 2001*b*). Even so, considerable numbers of wildlife species using agricultural land as habitat (especially certain rare birds and arable weeds) are still in danger of disappearing. This problem is especially critical in areas where agriculture covers most of the land area.

Meanwhile, threats from outside the sector have been added to those from within. The spread of the varroa bee mite (*Varroa jacobsoni*), for example — a parasite of the Asian honeybees that is lethal to bee varieties in other parts of the world — has cost agriculture billions of dollars of damage world-wide, and in many areas has led to the elimination of wild bee colonies. Invasive species are estimated to have cost the United States more than USD 100 billion over the past century — much of it borne by agriculture and associated ecosystems.[12] Another persistent pest is the nutria (*Myocastor coypus*), a large, semi-aquatic rodent native to South America, which was introduced into North America and Europe during the middle of the 20th

century for its fur. Some nutria escaped or were turned loose, and in several countries they have become serious pests, damaging crops and earthen dikes, and competing with native wildlife.

For some agri-environmental areas, the data, and understanding of the underlying processes, are insufficient to establish trends. Information is incomplete, for example, concerning the degree of groundwater pollution or rate of aquifer depletion resulting from agricultural activities, and the human health and environmental risks associated with the use of pesticides. Also, for a number of areas, notably biodiversity, habitats and landscape, the knowledge and measurement of these impacts is still at a preliminary stage of research. The OECD's work on developing agri-environmental indicators is intended to help resolve some of these problems.

Meeting sustainability objectives for agriculture

The over-riding policy objective should be to maximise agriculture's net benefit to society. These benefits derive from contributing efficiently (including through trade) to satisfying current and future demands for adequate, safe and reliable supplies of food; non-food commodities; and environmental services. In order to meet these demands, the sector has to be able to respond efficiently and innovatively to market signals; to take into account external costs or benefits it imposes on or provides to other segments of society; and to maintain sufficient flexibility to cope with change. These requirements in turn are most likely to be fulfilled if:

- markets for inputs and commodities are not distorted by inappropriate government policies or excessive market power;

- the resource base on which agriculture depends is maintained in a state commensurate with the demands that it is likely to fulfil;

- clear and consistent signals from markets and policies are provided to producers and consumers of agricultural products and services as to the environmental consequences of their actions;

- farmers can benefit from gaining access to research and knowledge on how to make more efficient use of the natural resources used in agriculture, while at the same time avoiding degradation of both those and other resources with which agriculture comes into contact;

- opportunities are available for resources (including farmers) to move in and out of the sector.

In 1998, OECD Ministers of Agriculture agreed that policy measures should meet a number of operational criteria, which would apply in both the domestic and the international context, and should be:

- *transparent*, having easily identifiable policy objectives, costs, benefits and beneficiaries;

- *targeted* to specific outcomes and as far as possible decoupled from production decisions;

- *tailored*, providing transfers no greater than necessary to achieve clearly identified outcomes;

- *flexible*, reflecting the diversity of agricultural situations, be able to respond to changing objectives and priorities, and applicable to the time period needed for the specific outcome to be achieved; and

- *equitable*, taking into account the effects of the distribution of support between sectors, farmers and regions.

The following discussion examines how public policies may help in the attainment of sustainability objectives relevant to agriculture, bearing in mind the operational criteria for good policy outlined above.

The main elements of any action plan should rest on a foundation of: agricultural policy reform; maintaining the resource base through an ecosystem approach; taking account of environmental externalities; improving dissemination of information to farmers; and structural adjustment. Progress in these areas will also require greater policy coherence. Putting agriculture on a more sustainable path will require policy makers to review and, in many cases modify, not only these traditional approaches to supporting agriculture, but also some of the policies, such as those in the sphere of land-use planning, that are not normally or exclusively identified with the sector.[13]

Agricultural policy reform

Current levels of support for agriculture are a drain on the economy and, in countries where price support is heavily used, effectively impose a regressive tax on consumers. Domestic markets are insulated through agricultural trade barriers, export subsidies, and production-linked domestic support in OECD countries, which have limited the potential benefits of free trade in agriculture for food-exporting developing countries. OECD countries have been aware of these problems for some time and agreed to reform agricultural policies as far back as 1987. A few countries began to undertake fundamental reforms as early as the 1980s. Overall, progress has been much slower, and at times it has regressed. The level of support to producers declined gradually between 1986-88 and 1997, and part of the burden of support to farmers has shifted from consumers to taxpayers. In 1998, however, the earlier trend towards a gradual reduction of support was reversed, and in 1999 support to producers again reached the high levels of a decade earlier; there was a small reduction in support in 2000. These policy responses underline the fragility of the reforms and the willingness of governments to reverse course when markets and macroeconomic conditions turn unfavourable for their producers. Deeper and more fundamental reforms are needed, particularly with respect to policies that directly influence commodity production and the use of inputs. And environmental and social objectives need to be targeted in a more cost-effective way.

Agricultural policies have contributed to the environmental impacts of agriculture. On the one hand, output-increasing policies have encouraged the expansion of farming on to environmentally fragile land and to farming practices often detrimental to the environment. On the other hand, some policies have retained resources in agriculture that contribute to the provision of environmental benefits. Increasingly, agricultural policies deliver support to farmers conditional on meeting environmental performance standards. But some agri-environmental payments have only had the effect of offsetting the environmental damage caused by agricultural policies that have encouraged higher input use and farming on environmentally fragile land.

On the input side, the main types of inputs that are subsidised are energy, water and credit. Subsidies to chemical inputs (fertilisers, lime, pesticides and medicines) are no longer widely used by OECD countries. The main exceptions are Korea (fertiliser), Poland (lime) and Turkey (fertilisers and pesticides). Several countries also supply energy or raw materials used in the manufacture of fertiliser at subsidised prices. Subsidised credit is significant mainly in the newer OECD countries and in Turkey.

Tax concessions related to energy are more prevalent. A few countries offer preferential charges for electricity used to pump water for irrigation, for example. And most countries exempt liquid fuels used on farms, along with other off-road uses of these fuels, from the taxes normally paid by motorists. While there may be some good reasons for exempting off-road users from the road user-fee element of such taxes, there is much less justification for exempting those portions of the taxes that are considered general revenues, or are intended to discourage emissions of CO_2 and other products of combustion.

Water subsidies are most common in countries where irrigated crops are grown. The prices farmers are charged for water are almost always far below those paid by other users (Figure 7.1). Some caution is required in making comparisons between sectors because water supplied to agriculture is usually of lower quality than provided to households and industry, while the costs of water conveyance are often lower for agriculture than for other users. Nevertheless, the difference in the cost of water to industry and to agriculture is almost certainly greater than could be explained by these differences alone (OECD, 2001*b*). Typically, part

of the cost of the infrastructure is paid by government and, where dams are also used to generate electricity, by non-farming consumers of electricity. Where farmers have access to groundwater they are often not charged for private withdrawals or, if they are, they pay less than other users. Some countries also provide grants or subsidised credit to farmers to help install on-farm irrigation and (in fewer cases) drainage structures.

Reforming water pricing policies in OECD countries is in some ways a greater challenge than reforming output-related policies — mainly because of the complicated laws, traditions and property rights that have to be disentangled in many cases before water reform can move forward. Because of these difficulties, several countries and local jurisdictions have reckoned that an important first step is to create property rights over water withdrawals (often based on historical entitlements), to separate water rights from land title where they are currently linked, and then to allow trading in those rights. Diversion of water in one point of a river is not equivalent to diversion in another point. For example, the further upstream a water entitlement is moved, the less secure is the supply for downstream users. And the environmental consequences of withdrawals may differ according to where they take place. Ways can be found around such problems by, for example, applying different environmental coefficients to traded volumes. Technical advice can play an important role in helping farmers improve the efficiency of their on-farm irrigation systems.

An advantage of markets is that they encourage water conservation by farmers by raising the opportunity cost of its use. An alternative method of encouraging water conservation is being applied within the context of the EU's Framework Directive on Water. Rather than raise prices for all volumes used, this approach establishes reference consumption levels for users, beyond which they are charged a surtax. Administrative allocation can of course mimic the behaviour of the market, but it is less likely than the market to ensure that water will be allocated to its highest-value use. Over the longer term, governments cannot avoid the issue of how to ensure that sufficient revenues are being collected to operate, maintain and replace water-related infrastructure. That may require — as several countries have concluded — moving over time to a pricing system that recovers full replacement costs from users.

Rather than being provided through price guarantees or other measures linked to production or to factors of production, income support to farm households — to the extent that it is necessary — should be sought through better-targeted payments, preferably in line with broader social policy goals. Of course, income support is not the only objective of public policy relating to agriculture. Governments may also wish to support environmental and other public goods and services provided by farmland, and to address structural adjustment and other domestic policy issues, such as animal welfare, food security and so on. The challenge is to pursue these objectives in ways that are compatible with the ongoing process of reform and trade liberalisation.

With implementation of the Uruguay Round Agreement on Agriculture from 1995, most non-tariff barriers on agricultural products were converted to tariffs, and will have been reduced by 36% from base levels (24% for developing countries), with a 15% minimum (10% for developing countries) cut per tariff line, by the end of 2000.[14] Even with these reductions, however, tariffs for agricultural products continue to be, on average, far higher than those for most other goods (OECD, 2001e). The current WTO multilateral negotiations on agriculture offer an important opportunity to further reduce protection and distortions in agricultural markets around the world, thus furthering the process of agricultural trade liberalisation begun under the Uruguay Round. And, as some OECD countries have done, governments can reduce support and protection by undertaking agricultural policy reforms unilaterally.

Agricultural reforms would permit resources to be used more efficiently as market signals, not government allocation rules, would guide producer decisions and stimulate income and employment growth in the rest of the economy. Equally, fewer trade restrictions could widen consumer choice at competitive prices. Such reforms would also allow more-specific targeting of individual policy measures to clearly defined outcomes and intended beneficiaries.[15] Developing country exporters stand to gain from greater access to OECD country markets and from reduced competition with subsidised exports. As importers, some of them may be faced with higher prices. But this potential cost could be outweighed by

improvements in the allocation of domestic resources and the fact that some developing countries are net importers because of import barriers preventing them from exporting commodities in which they have a comparative advantage.

In many cases, agricultural trade liberalisation can also contribute to overall improvements in environmental performance. The direction and magnitude of the overall impact will depend on several factors, including the trade liberalisation-induced changes in agricultural production patterns; the state of the environment at the time of the trade policy reform; and the environmental regulations and policies in place to preserve and improve environmental quality (OECD, 2000*b*). Also, because of the considerable diversity of agricultural production systems and natural conditions, the differing regulatory approaches within and between OECD countries, and the fact that many environmental effects are site-specific, the environmental impacts will vary from one location to another. A reduction of trade barriers could therefore end up increasing environmental quality in some countries, but reducing it in others, in particular if the trade policy reforms in the latter lead to changes in patterns or levels of production that, because of insufficient safeguards, lead to major increases in negative environmental externalities or reductions in positive externalities. Mechanisms for addressing such externalities are discussed in the next section.

An ecosystem approach

In past decades, the management of natural resources used in and affected by agriculture was chiefly oriented to improving on-farm productivity. While such approaches may have fulfilled their primary objective — e.g., conserving soil — other objectives, such as preventing polluted run-off, if considered at all, were paid less attention. Today, however, many OECD countries are beginning to adopt a broader, ecosystem approach to the management of natural resources. An *ecosystem approach* refers to an integrated strategy for the management of land, water and living resources that promotes conservation and sustainable use, by both current and potential future users. It stresses the application of scientific methods focused on levels of biological organisation that encompass the essential processes, functions and interactions among organisms and their environment. Humans are an integral component of any ecosystem approach.

Adopting an ecosystem approach implies a change not only in the institutions of management but also their objectives. In the case of agriculture or any other sector, such an approach requires consideration of alternative uses of resources, as well as substitutes for the goods or services that they render, such as environmental amenities and services. The question is not, therefore, *how should we maintain resources in existing agricultural activities?* but *how can society ensure that resources are allocated to their highest-value use in contributing to sustainable development?* It may turn out that the highest value use may continue on most farms to be the production of food and fibre, as well as the provision of various ecosystem services. But policy should not be approached with that starting assumption.

In order to apply an ecosystem approach to the management of natural resources associated with agriculture it is vital that other signals — such that those that work against the achievement of conservation goals — do not interfere with those that land managers need to heed. That means in particular eliminating those output- and input-linked policies that encourage farmers to take risks with the resource base — i.e., policies which encourage farmers to depend on governments for their long-term economic security rather than their own human, social, manufactured and natural capital. Farmers and farming communities that have to rely largely on their own resources are more likely to be attentive to the ecosystem services that affect agricultural productivity (McGauchie, 1998). However, as discussed below, certain information and market failures may need to be corrected through some form of collective action, depending largely on the nature of the problem.

Internalising environmental externalities

Many of deviations from a sustainable path can be explained by policy, information or market failures. The main *policy* failures derive from inappropriate agricultural support policies, and their reform is a necessary, though not always sufficient, condition for dealing with market failures. *Market failures* affecting

agriculture include those that impose costs (or confer benefits) on the sector itself, and those that impose costs (or confer benefits) on other sectors.

Like a number of other sectors, agricultural activities give rise to both negative and positive externalities. The main negative externalities relate to off-farm sediment dispersal by wind and water (soil erosion), pollution of water from nutrients and pesticides, salinisation of soils from excessive water abstractions, gaseous emissions (especially of methane and N_2O), and diseases that can be transmitted to humans. Agriculture can also induce significant changes in the reflectivity of the land, with consequences for global temperatures (Sellers *et al.*, 1996; Mahfouf *et al.*, 1995). The main positive externalities relate to what can be broadly categorised under the heading of ecosystem services: water retention, waste reduction, habitat for non-agricultural flora and fauna, landscape and recreational amenities. This division between negative and positive externalities reflects widely held, though not always precise or consistent, societal and legal views regarding property rights, which traditionally allow farmers a free hand over the management of their on-farm resources, but which restricts their rights to impose costs off the farm, for which farmers are not charged. Thus a farmer who fills in a marshy area on his property is usually regarded as acting within his rights; one who does not disturb the marsh may be providing a service to others, such as habitat for migratory waterfowl. In practice, the property rights of farmers are neither unambiguously defined, nor static. Categorising the effects on the environment as "positive" or "negative" thus requires careful consideration.

Several characteristics of agriculture's externalities make their internalisation especially challenging. First, the nature and level of most externalities generated by agriculture are highly variable, depending on a wide range of factors, including local weather, the geographic situation of the farm, its soil type, its commodity mix, its production methods, and its proximity to other ecosystems. Second, in many cases those externalities stem from diffuse processes, like the percolation of water over a field or the eructations of a herd of ruminants, rather than from large, discrete, point sources. Third, any given farm can be generating both negative and positive externalities simultaneously. And fourth, obtaining an optimum mix of externalities typically involves making trade-offs. For example, changing to a cultivation method that reduces soil erosion may require applying greater volumes of herbicides to control weeds. Similar trade-offs have been noted between landscape and biodiversity: while the two may be compatible up to some level, they are not always perfect complements: in some agri-ecosystems "what is good for biodiversity and environmental health may not look good, and what looks good may not be good" (Nassauer, 1997).

Agriculture's negative externalities

Governments in OECD countries are trying to reduce the harmful effects of land and water management practices in agriculture, and have been for some time. These effects arise from the movement of soil through wind and rain, changes in local hydrology (which in areas with saline groundwater can affect concentrations of salts on farms many kilometres away), and the run-off and leaching of pollutants. But it is fair to ask both whether the levels of negative externalities from agriculture are optimal from a societal perspective — i.e., marginal damage costs are aligned with marginal abatement costs — and whether the means being used to reduce such damages are the most cost-effective. It is beyond the scope of this chapter to answer the first question, except to note that the general perception is that in many areas the negative externalities being generated by agriculture *are* in excess of socially optimal levels. However, some brief observations can be made with respect to some generic approaches currently being used to control pollution from agriculture, and their alternatives.

To the extent that pollution is closely correlated with levels of production or the use of inputs, providing support in ways that are strongly linked to outputs or inputs drives up the cost of controlling pollution (OECD 1998*a*). Some countries have tried to get around this problem by requiring recipients of farm support to apply certain prescribed conservation practices. Bundling such "cross-compliance" regulations with support, however, does not necessarily reduce incentives to engage in the activity that gives rise to the pollution, and makes attainment of the environmental objective effectively a hostage to the support policy.

Subsidising the reduction of pollution more directly, as is done in a number of OECD countries through cost-sharing grants for the purchase of pollution control equipment, suffers from a number of the problems identified in Chapter 5. As with cross-compliance measures, such subsidies do not reduce incentives to engage in the polluting activity, and to the extent that they discriminate according to farm type and commodity (e.g., benefit only pig producers) may actually facilitate the continuation of the activity. Sometimes, the preferred alternative may be to prevent the pollution in the first instance by allowing a different type of farming, or an altogether new economic activity, to take its place.

The first-best approach to reducing pollution is normally to apply a charge or to create a system of tradable pollution rights. A system of pollution charges is being tried, for example, in The Netherlands to control surplus off-farm emissions (especially to groundwater) of nitrates and phosphates. But such an approach requires detailed book-keeping by farmers, and a certain minimum level of skill. The nutrient cycle on a farm is complicated, and depends on the crops grown, how they are used (i.e., fed to livestock on the farm or exported), and so on — implying high transaction costs for some countries. Even where pollution charges are feasible, other measures — such as those that regulate the storage of manure, and when it can be spread onto fields — may be needed to minimise nutrient run-off and the formation of ammonia.

Some externalities, such as those related to the use of potentially dangerous chemicals or communicable diseases, do not readily lend themselves to the use of economic instruments. For these sorts of reasons, regulations — which can take a multitude of forms, including such measures as standards for manure spreading; a requirement to apply integrated pest management (IPM) practices; and restrictions on the contents of animal feed — remain the instrument of choice in many situations, at least until more accurate and cheaper monitoring methods and equipment enable economic instruments to be more widely applied.

Whatever instrument is used, the long-term goal of governments with respect to agriculture's negative externalities should be to make farmers integrate these costs into their production decisions — i.e., to apply the polluter pays principle (PPP). While it may sometimes be difficult to apply the PPP to agriculture, especially for pollutants that do not originate from an easily identifiable point source, the acceptance of the principle has been viewed as a useful tool for co-ordinating pollution policy in OECD, and for avoiding distortions in international trade and investment (OECD, 1998*a*).

Agriculture's positive externalities

Many countries, particularly those that currently provide the highest rates of support to their agricultural sectors, are concerned that full implementation of the kind of agricultural policy reforms described above could lead to a reduction in agricultural area, and a consolidation of farms within the agricultural area that remains. These effects could lead to a sub-optimal provision of positive externalities generated by agriculture, especially those that contribute to the supply of public goods. Public intervention may be warranted to address these externalities, but the challenge is to design those interventions so that they do so in cost-effective and welfare-enhancing ways.[16]

The nature of any government intervention in the face of such a prospective market failure should depend on the characteristics of the non-commodity output (positive externality) in question. Some outputs, such as the conservation of biodiversity and habitats, may exhibit strong public good characteristics. But there exists a broad spectrum of other types of goods — e.g. club goods — which are neither entirely public, nor entirely private. Many are locally important, such as flood control or the use value of a landscape. Different degrees of excludability or rivalry allow some possibility for voluntary provision, for the creation of markets, or for the charging of user fees. These factors should inform decisions about when it is appropriate for governments to intervene and what the nature of those interventions should be.

Some countries grant high levels of price support to rice or milk, which are associated with particular landscape features that are highly valued by the population as a whole. If the "supply of landscape" and water-retention services is adequate,[17] and the government then reduces domestic prices and imports rise, then whether or not a market failure occurs depends on how farmers adjust to the lower prices. If the least-

efficient, highest-cost farmers go out of business, but more efficient producers acquire their land and continue to farm it — perhaps less intensively, the supply of the cherished landscape features may not necessarily fall below what is demanded. If, however, the land goes out of production altogether, or is converted to production of alternative crops with different or no landscape value, there may be under-supply and hence a market failure. But any intervention is likely to be area- or region-specific — the non-commodity outputs of terraced paddy fields and mountain pastures are valued more than those from their lowland equivalents — and should be targeted to reflect these differences.[18]

The concern is not just about satisfying the current demand for the non-commodity outputs of agriculture, but of maintaining the potential to supply some uncertain, possibly larger demand for them in the future. Shifts in the type of agricultural production are generally reversible at relatively low cost. Even allowing a change in land-use out of agriculture need not pose a serious threat to agricultural potential, if the alternative use to which the land is put is forestry. Indeed, the agricultural history of many OECD countries is one that until recently could be characterised by frequent, and occasionally large-scale, shifts in land use in and out of forestry (Pyne, 1997). Large areas of eastern North America that were cleared in the 18th and 19th centuries for farming, for example, have reverted back to forests, either managed or natural, losing only a part of their potential for agriculture in the process, if at all. While some cost would be incurred in clearing the vegetation from them to prepare them again for farming, the potential of the soil is usually little diminished from the day when farming was abandoned. Much the same could be said regarding the land on which agricultural activities have been halted or reduced for the express purpose of creating nature reserves. However, where agricultural land has been converted to urban and industrial use, the costs of reconversion to agriculture would be much higher.

Whether or not such shifts are substantial enough in particular cases to threaten water retaining capacity, biodiversity, recreational opportunities and the quality of the landscape depend on the nature of the affected land and the marginal benefits foregone compared with those gained as a result of the land-use change. Policy makers need to weigh the value of the loss of the positive externality against the gain to consumers from lower prices, and other gains or losses related to changes in other externalities — both positive (e.g., wildlife habitat) and negative (e.g. pollution). The main response of government to land abandonment may need only be to ensure that the land has sufficient vegetative cover to prevent erosion — if need be by paying to establish such cover through seeding. However, in some circumstances the effects of land abandonment on hydrological conditions, biodiversity or landscape values may be sufficiently negative to merit other interventions, such as payments for maintaining the land in a certain way.

But even when there is justification for maintaining a particular agri-ecosystem threatened with abandonment, consideration should be given to alternative means of achieving the same objective, and whether there exist economies of scope. It is usually assumed in the case of grasslands, for example, that grazing can only be carried out by domesticated, meat–, wool– or milk-bearing animals. But experiments using ancient breeds (e.g., Dennis, 1999; Kampf, 1999) demonstrate that the environmental benefits of grazing are not dependent on the harvesting of a marketable product. In some areas, non-domesticated herbivores could, in theory, carry out the task. A proposal was floated almost 15 years ago (Popper and Popper, 1987), for example, to reintroduce the North American bison (*Bison bison*) to grazing lands currently leased to cattle ranchers, thereby creating an immense "buffalo commons". In such situations, the economic trade-offs involved depend on the costs and benefits of continued agricultural production compared with those from expanding the population of much less common or even endangered species.

Where the threat to agricultural land comes from urbanisation or intensification, the public interest in preventing such land-use change may be served by paying landowners for giving up the option to develop their properties. Such conservation easements (as in North America, where they have been used most), or land covenants (as in Australia) are designed to preserve open space and farmland without placing intrusive restrictions on property rights. Because of the strongly local nature of the benefits, charitable trusts, local governments, or both have financed many of these easements. But often central governments, interested in preserving features of land that are deemed to have value beyond the communities in which they are situated, have contributed funds as well.

An approach that is more commonly used in Europe, but which shares features with conservation easements, is to incorporate farmland into regional or national parks or reserves. France's system of *parcs naturels regionaux* (regional nature parks), for example, is now helping to protect 38 agriculturally dominated areas — around 10% of the land area — in that country. These parks work mainly through self-imposed restrictions on development. In 1998 France's central government contributed less than 30% — FF 300 million (USD 60 million) — of the regional natural park system's budget; the rest came mainly from regional, departmental and township budgets. Most of the money went towards employing specialists (e.g., ecologists, archaeologists, planners) and disseminating information.

Negative externalities on agriculture from other sectors

Some of the externalities that raise the cost of farming and could over the long run degrade natural resources associated with agriculture have already been mentioned: heavy metals, acid precursors, dioxins, radionuclides, greenhouse gases, exotic pests and diseases. Ensuring that these costs are taken into account by those responsible for generating them is as much an issue of policy coherence as it is of policy design (see Chapter 4). Priority areas in need of greater efforts to achieve coherence include waste disposal, electricity generation, land-use planning (including the siting of structures that affect the quality of the landscape), transport and social policy. The example of land-use change serves to illustrate the point.

One of the concerns often expressed by people is that conversion of agricultural land to urban uses threatens to permanently reduce the agricultural potential, along with the supply of any public goods associated with that land.[19] This is a valid concern if some policies are in fact encouraging the inefficient conversion of farmland to urban and industrial use. A recent study of land-use changes in the United States (Stanley, 2000) suggests that this may indeed be occurring in some jurisdictions. The study identified a number of policies where greater coherence is needed. These included targeted, business-specific subsidies and tax-incentive programs that distort the market price for land; and zoning rules that discourage flexible development and increase the pressure to develop outward, often at the expense of farmland. Reforming such policies is clearly a first step towards ensuring that an efficient level of land retains its agricultural potential. Privatising infrastructure and incorporating full-cost pricing for new infrastructure, for example, would help ensure that all developments pay their fair share of land costs (see chapter 13).

Dissemination of information to farmers

The foregoing discussion underscores the importance of providing farmers with the right signals and incentives so that they incorporate into their decision-making the spill-over effects of their actions. Farmers, except for those operating the highest-intensity glasshouse horticulture and intensive livestock production systems, also depend *themselves* on the integrity of ecosystem services — such as the nutrient recycling services of earthworms and soil micro-organisms, and the pollinating services of insects and birds — which provides them with a self-interest in environmental stewardship. Helping farmers understand and recognise this self-interest can help over-come resistance to needed changes and in the end reduce monitoring and enforcement costs. For that to occur most efficiently, however, farmers need to have access to good information and be able to assimilate it.[20]

Most farmers understand full well how to manage the soil, water and biological resources under their disposal so as to maximise commodity output, at least in the short term. But some may be unaware of the long-run consequences of their current farming practices on these resources, or of the alternatives available. Sometimes scientific understanding of the underlying agri-environmental relationships may be incomplete, or the advice contradictory. And communication channels between the scientific community, advisory services and the farming community may be inadequate. In short, as in other sectors, there may be information shortfalls that need to be corrected (OECD, 2000*a*).

Essentially, the policy challenge can be conceived as one of strengthening the links all along the chain between the creation of knowledge and its application. Technology — essentially embodied knowledge

— and its adoption play a central role in this dynamic. As summed up at an OECD-sponsored workshop on the *Adoption of Technologies for Sustainable Farming Systems* held in 2000:

> Farmers have always looked to new technologies as a way to reduce costs. In addition to this, higher incomes, greater knowledge and improved channels of communication are leading consumers to demand low-cost food of higher quality, increasingly produced through organic methods in many countries, with more variety, consistency and year-round availability. At the same time, consumers are increasingly demanding that their food be produced using techniques that conserve natural resources, limit environmental pressures and pay greater attention to rural viability and animal welfare. Meanwhile, the process of trade liberalisation is widening the sources of supply and the degree of competition. These changing demands are reflected in policies and are powerfully transmitted to farmers via the media, pressure groups, food retailers and processors.

All farming systems, from intensive conventional farming through to organic farming, have the potential to contribute to sustainability. But whether they do in practice depends on farmers adopting the appropriate technology and management practices in the specific agro-ecological environment within the right policy framework. There is no unique system that can be identified as sustainable and no single path to sustainability. There can be a co-existence of more-intensive farming systems with more-extensive systems that overall provide environmental benefits, while meeting demands for food. However, most sustainable farming systems — even extensive systems — require a high level of farmer skills and management to operate.

Education and training should form part of the basis of any government's strategy to promote adoption of appropriate technologies and farm-management practices. Government programmes are not the only vehicles for providing farmers with the information and skills they need to make informed choices: given the right incentives, educated farmers should have a strong self-interest in seeking out the technologies and practices most suitable for their farms. But farmers in countries with comparatively low levels of educational attainment, like Greece, Spain, Korea, Mexico, Poland, Portugal and Turkey, may need extra help, although even in high income countries such as France and the United States, over 50% of farmers have no post-school training (OECD, 2001*b*). Education and training is important not only to help farmers farm better: it can also improve their lifetime options, making them more likely to be able to shift into other activities (or become pluriactive) if need be. Government money spent on education and training should match society's needs across all sectors.

Publicly funded research should also form part of that foundation. In the past, research was often directed at solving technical problems; now it is also aimed at defining research priorities for developing technologies and farming practices to address current and future demands by society. Those priorities include biological pest control, biotechnology, information technology, bioremediation, precision farming, integrated and organic farming systems. The level of public funding of research on agricultural sustainability issues can only be determined by the countries themselves. But in general, because public funds are limited, whatever is spent needs to be concentrated more on addressing issues related to public-goods than to the marketing of new technologies.

New methodological and analytical tools and procedures may be needed to bridge the link between those who design new technologies and those who adopt them. For example, it is not always clear in advance which technologies will be profitable for any given farm to adopt and which farm practices will improve environmental performance or conserve resources. Such choices are often made in a climate of uncertainty with a large element of "trial and error" and "follow the leader" during the early stages of application. Undertaking rigorous *ex-post* assessments of results could help ensure that corrections can be made before too much is invested in a wrong technology. Coping efficiently with this and other tasks will represent a challenge for agricultural extension services over the coming decades; yet some countries are concerned that the current capacity of their services needs to be improved. Upgrading that capacity is also likely to require substantial resources.

There is also a need to engage a wide range of stakeholders (scientists, manufacturers, farmers, and members of the agri-food industry, consumer groups and NGOs) in dialogues over technologies used in agriculture. The recent, often strongly negative, public reaction in some countries to foods made from

genetically modified crops shows the critical necessity of conducting such dialogue in an open and transparent manner. In order to take into account the wide range of objectives related to moving towards a more sustainable agriculture, compared with those related to solely targeting farm production, many more disciplines will have to work together.

Facilitating greater co-operation within farming communities may also help overcome barriers that in the past have hindered adoption of improved technologies and practices. Several OECD countries are now encouraging the formation of community-based groups — variously known as landcare groups, or eco-co-operatives — to tackle common resource-management problems in rural areas. Support is typically provided in the form of technical advice and limited funding for projects expected to yield collective benefits. As a recent OECD study (1998*b*) showed, such groups seem especially well-suited to addressing issues that are local in nature but which extend beyond the borders of a single farm. Examples of activities in which these groups engage include managing pests, planting trees, repairing and maintaining earthworks, working together to prepare farm plans, and even constructing nature inventories. In some countries, leaders of these groups are themselves starting to work together to address issues at a larger geographic scale, such as an entire river catchment. Landcare and similar groups can be seen as a form of social capital[21] — a way of leveraging human capital and increasing its effectiveness.

Structural adjustment

The types of policy changes that may be required in some countries to place the agricultural sector onto a more sustainable path could have major implications for the structure of agriculture and agriculturally dependent communities. Inevitably there will be some households or segments of the industry that are adversely affected by policy reform. These impacts of reform will, moreover, vary across OECD countries. Temporary structural adjustment assistance may be necessary to enable those who can become viable to remain in the sector, and to assist those who cannot, to exit. However, structural adjustment should not be viewed as a one-time event: changes in technology and other variables bearing on how farming is prosecuted will continue to require adjustments in the relationship between the natural resource base, manufactured capital and labour. A long-run goal of government policy should be to facilitate a situation wherein the sector is largely capable of undertaking such adjustments itself, without major government interventions.

In dealing with the employment impacts of the transition to a more sustainable agriculture, policy-makers will find themselves confronted with three main challenges. First, they will need to address the social welfare implications of changes in production levels and any redistribution of water or pollution rights, especially in those rural communities and households that are hardest hit by these changes and who have the fewest options of adjustment. For them, some form of social assistance (if they are not already covered by normal unemployment insurance) may be warranted, in addition to job placement and counselling services. One of the most important policy priorities will be to deal with the particular problems posed by the high average age of farmers, low educational attainment and the sometimes different treatment afforded to non-wage-earners under social insurance schemes. In this respect, special efforts will be required to find alternative employment for these people, if only through wage subsidies or public service. Early retirement may be the only feasible option in some cases, but it should be regarded as a last resort, preferably offered in the form of a one-time payment.

Second, they will need to smooth the path of structural adjustment — not only to facilitate the transition to more sustainable patterns of farming, but also to reduce the need for costly adjustment programmes in the future. Most workers can benefit from countries' active labour market programmes, especially to retraining and job-creation programmes. The resources committed to these programmes, and the degree to which they are tailored to the special needs of farmers and dependent communities, varies considerably, however. While it is difficult to assess the effectiveness of programmes of a general nature in helping displaced farm workers they will no doubt continue to play important roles in a balanced portfolio of adjustment measures, as will community-led investments in educational and cultural infrastructure. In all but the most isolated areas, such infrastructure would not only increase local employment, both directly and indirectly, but also improve the ability of rural communities to retain employment by raising the quality of life (OECD, 1994).

The third, and perhaps most difficult, challenge for governments will be to redefine the roles (or even give up certain ones) that they have traditionally played in the sector in attempting to enhance the wealth and well-being of farming communities — without fostering dependency. As a start, they should work to develop the productive and innovative capacities of their rural communities, and to foster an environment in which these capacities can be fully realised. New ways to encourage industry and community-led structural adjustment efforts should be considered.

Conclusions

Collectively, the agricultural sectors of OECD countries have managed to achieve unprecedented growth in the output of food and non-food commodities since the middle of the 20th century. They have done this with fewer workers and on slightly less land, but using more water, chemicals and machinery. Increased levels of pollution, however, have often accompanied agricultural growth, as well as greater homogenisation of the landscape, and destruction of wildlife habitat. Problems of soil degradation, loss of genetic resources and water depletion persist in some areas. But agricultural activities have also maintained ecosystem services, and traditional landscapes in some areas. Many agricultural and associated trade policies have depressed world prices and market access, reducing agricultural sustainability, especially in the developing countries. However, a combination of international commitments, market and public pressure are beginning to contribute to new policy initiatives that aim to address sustainability concerns.

The analysis in the *OECD Environmental Outlook* (OECD, 2001*d*) suggests that a 50% increase in the projected demand for food and fibre could be met with no increase in real prices in the next two decades, largely through yield growth from the application and dissemination of existing and new technologies. However, projections by the FAO suggest that growth in both population and per-capita consumption mean that global food output will need to nearly double by 2050. This will place enormous pressures on resources, especially land and water, and will present significant challenges for research and technology. Key requirements for achieving increased output in a sustainable way are the implementation of appropriate agricultural and other policies, in tandem with markets and the adoption of best practices by farmers.

Drawing on the analysis in this chapter, four major environmental issues in the context of sustainable agriculture will require the attention of policy makers.

- *Climate change* — minimising the net effect of agriculture on climate change, and vice versa. Agriculture is not a major contributor to carbon dioxide emissions, but it is of methane and nitrous oxide. Importantly, agriculture is also a carbon sink, and can ease pressure on fossil fuel markets through production of biomass. But global warming will affect agriculture through altered growing conditions, and the greater risks of violent weather events.

- *Water* — ensuring a sufficient supply of clean water across and within countries. Agriculture is the major consumer of water, and that share could well increase. Yet the demands for water from other sectors will grow in line with population and even more so with wealth, with potentially significant economic, environmental and social implications.

- *Technologies and farm practices* — harnessing new technologies and adopting farm practices to provide enough food safely, while protecting the environment. Agriculture is increasingly a capital- intensive industry, embodying new technologies. Technology has a major impact on the structure of the whole agri-food industry. But in many countries there are public concerns regarding the impacts of new technologies on farm practices, environmental quality and food safety.

- *Land use* — ensuring that scarce land can be best used to meet the diverse and changing economic, environmental and social demands between agriculture and other sectors. Agriculture is a major user of land, but in many areas is competing for urban, industrial, leisure and environmental use.

These issues have trans-boundary and trade implications, cutting across OECD and non-OECD countries. They can have significant effects on the supply and quality of food, the structure of the agri-food sector, employment and the evolution of rural and urban areas. They involve many uncertainties for the sustainability of agriculture. But they present enormous challenges for the role of markets and policy to ensure its economic efficiency, environmental quality, and desired social outcomes.

Government policies have played a major role in the economic, environmental and social development of the agricultural sectors in OECD countries. While agricultural policy reform and trade liberalisation will contribute positively to sustainable agriculture, policies to address structural adjustment issues in the sector may be needed. Targeted social welfare measures, asistance, active labour market programmes and community-based approaches would help to facilitate that adjustment.

The analysis in this chapter suggests that in order for agriculture to take a sustainable path in the future, policy makers should consider undertaking the following actions:

- *Ensure that market signals guide production decisions.* A central requirement is to further reform agricultural and trade policies so that market signals play a greater role in allocative decisions, encourage the more efficient use of scarce resources, and thus reduce pressure to farm in environmentally damaging ways. Markets provide key information for the agricultural sector to adjust and adapt to changing conditions of supply and evolving demands, which is an essential element to achieve sustainable agriculture in a dynamic context.

- *Facilitate the creation of markets to take account of externalities.* Externalities and public goods arising from agriculture need to be taken into account in farmers' decisions. That means, for one, that the polluter-pays principle should be applied to deal with negative externalities. It means also developing innovative ways for markets to return to farmers the extra costs that they incur in providing the public goods and services that people want but currently do not fully pay for through market transactions. Where markets cannot be created to deal with these problems, the challenge will be to identify who causes pollution and who generates public goods, and to find targeted, more cost-efficient policy measures to provide them. Policies will be more effective in achieving sustainable agriculture if they are designed to work *with* and not *against* market signals.

- *Strengthen the agricultural knowledge system.* Research and development, education, training and advisory services in agriculture continue to evolve to meet the increasing opportunities from emerging technological developments, and the demands and concerns of a well-informed and discriminating public. A key aim should be to encourage farmers to take initiatives to adopt sustainable farming methods, and to develop new market opportunities. Particular consideration needs to be given to the needs and perspectives of developing countries, and for targeted capacity building.

- *Improve policy coherence.* Moving towards sustainable agriculture has to be viewed in the wider context of sustainable development. In several countries there are often conflicting policies — some result in environmental damage that lead to other policies to redress the damage, while others lead to unintended distributive effects within agriculture and on society. Improving the coherence of policies within agriculture and with other areas is crucial. Providing better data on, and scientific understanding of, the processes that are shaping the long-run potential of agriculture and the natural resources with which it interacts, and the effects of changing patterns of production and technologies on the environment and social conditions could aid policy makers. Achieving greater policy coherence requires entering into dialogue with stakeholders, with the aim of elaborating better policy measures, and identifying where institutions might need improvement. A corollary is the need for better indicators on trends in the sustainability of agriculture, and associated analytical tools. Establishing regular monitoring and evaluation procedures and building in greater flexibility to adapt and change policies is also essential.

NOTES

1. Although conditions of transport and storage result in a relatively small percentage of losses in OECD countries, the same cannot be said of some non-OECD countries, where huge amounts of food are lost to spoilage, pests and other causes. Reducing such losses, by improving the efficiency and security of the distribution chain, could clearly have an enormous impact on agricultural production, easing some of the pressure caused by population growth.

2. FAO, "Fish is food for the brain as well as good protein" <www.fao.org/focus/e/fisheries/nutr.htm>.

3. Agricultural land is also used for the transmission of electricity via high-voltage power lines.

4. These are estimates. Statistics on the current production of biomass fuels in OECD countries generally relate to the end product, and do not distinguish between whether they were derived from agricultural residues, energy crops, forest products, or other sources, such as landfills.

5. OECD is developing indicators of agricultural landscapes (OECD, 2001*b*).

6. A further complication is introduced by the notion that preferences between the various functions possibly performed by agriculture may not be entirely separable – i.e., that there may be "jointness in consumption". In simple terms, the value consumers place on a bundle of goods and services may be considerably greater or lesser than the sum of each of the goods or service in isolation. See OECD (2001*c*). A review of valuation methods for agricultural landscapes is also given in OECD, 2001*b*.

7. In order to better assess the effectiveness of these conservation efforts, the OECD is developing indicators of genetic resources in agriculture, see OECD (2001*b*).

8. "Europe's Immigrants: A Continent on the Move", *The Economist*, 6 May 2000, pp. 21-25.

9. Charles Pares and Henry Tricks, "Illicit Angels of America's economic miracle", *Financial Times*, 3 February 2000.

10. When properly managed, crop production by organic means can be less polluting than by conventional means, but it is not intrinsically less polluting of nutrients (depending on how, for example, animal manure is applied). It is also allowed to use pesticides that, while generally safe for humans, can be harmful to non-target species (e.g., fish in the case of rotenone).

11. See, for example, <news.bbc.co.uk/hi/english/sci/tech/newsid_594000/594695.stm>.

12. See the U.S. Office of Technology Assessment <www.ota.nap.edu/pdf/data/1993/9325.PDF>.

13. Not all market failures in agriculture may necessarily be improved by government intervention. Some problems may be dealt with more effectively through community-led collective action. See OECD(1998*b*).

14. Agricultural goods have been treated differently from other goods in multilateral trade agreements since the 1947 General Agreement on Tariffs and Trade (GATT); see OECD (1995*b*).

15. At present only about 25 cents of every dollar spent on market price support is estimated to be retained as an increase in producer incomes. The balance of the support is either capitalised into asset values, particularly land, or is transferred up or down the food chain to input suppliers or processors and distributors.

16. Frey (1997) suggests yet another consideration for policy-making, though not specific to agriculture: the need to avoid incentives that weaken (or "crowd out") people's intrinsic motivation to behave in an

environmentally responsible manner, especially where the cost to the individual of behaving in the desired way is relatively low.

17. These two services differ in important ways: while a farm's hydrological characteristics can be estimated scientifically, its aesthetic, cultural and recreational values are to a large degree subjective and therefore much more difficult to measure.

18. The supply and demand for landscape has been explored by Bromley (1997).

19. Not only the quantity of affected the land is important; so is its quality. While land subject to abandonment often has a low agricultural potential, the same cannot always be said of land that is converted to urban use or industrial use — indeed, such land is often highly productive. Unfortunately, statistics on land-use changes involving farmland rarely reveal the land's prior agricultural potential.

20. There is of course a considerable overlap between the changes in agricultural practices that need to take place in order to reduce negative off-farm externalities (and stimulate positive externalities) and those that promote the conservation of resources. Reducing off-farm sediment flows normally means protecting the soil from run-off.

21. Defined by Putnam (1995) as "the features of social organization such as networks, norms, and social trust that facilitate co-ordination and co-operation for mutual benefit."

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Chapter 15.

MANUFACTURING

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MANUFACTURING

Introduction

OECD industry is becoming more proactive in addressing sustainable development concerns. In particular, many enterprises in both manufacturing and services are developing corporate environmental strategies to reduce negative impacts on ecosystems. Such efforts are a product of the growing desire within industry to enhance public image and comply with corporate codes of conduct without sacrificing improved performance and commercial opportunities. In the knowledge-based economy, OECD enterprises are adopting new organisational and managerial practices to better deploy and adapt new technology, particularly information and communications technology (ICT), to enhance productivity. Environmental strategies are a key aspect of such organisational change, and more innovative, diversified and market-based environmental policies are needed to achieve fully sustainable practices in industry. "Going green" through innovative organisational and technical approaches is an important path to enhanced firm performance, and a significant contribution to the sustainable development agenda.

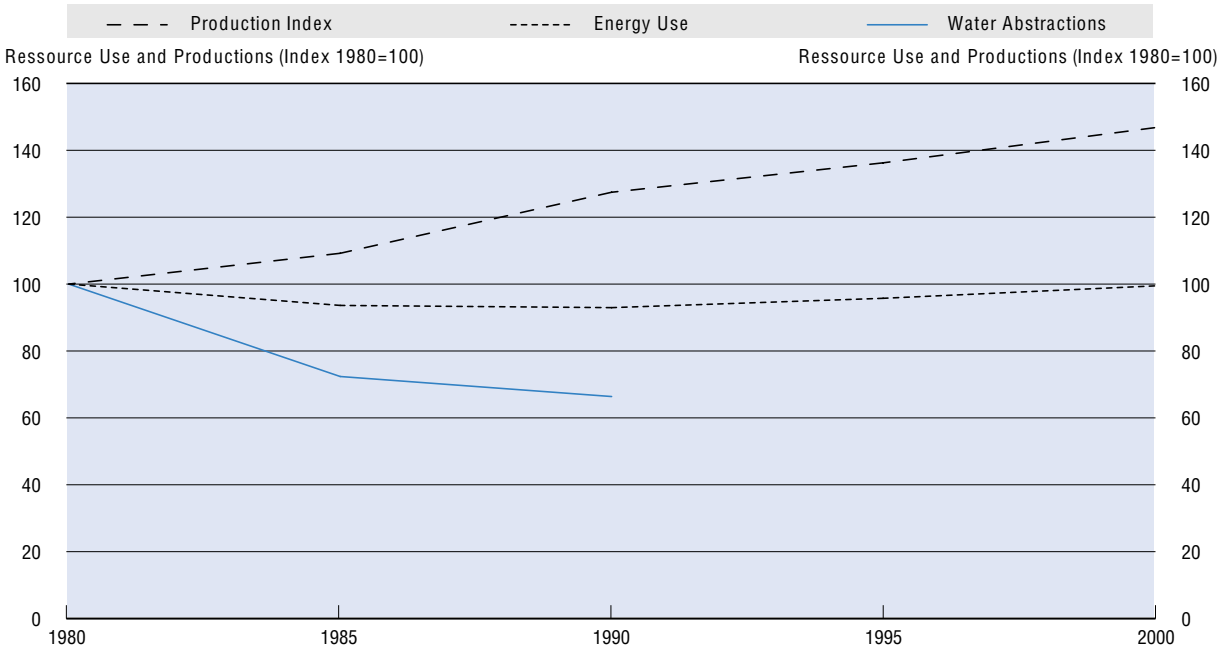
Overall, the manufacturing sector in OECD countries made considerable progress in reducing its impact on the environment in the period from 1980 to 2000. Manufacturing as a whole reduced its pollutant emissions and resource inputs despite a greater than 50% increase in production output. These gains in reducing pollution came from plant modernisation, product mix changes and pollution prevention and control measures. Gains also derived from changes in the sectoral composition of manufacturing. However, the story underlying this positive result is complex due to the great diversity of sectors in manufacturing — from raw materials processing to materials fabrication to goods assembly — and the many resources and pollutants involved. Some sectors improved more than others; some pollutant emissions decreased more than others; and some input resources were reduced more than others.

Manufacturing affects the environment primarily by: *(i)* using resources such as energy and water; *(ii)* producing polluting air emissions and harmful by-products; *(iii)* releasing toxic processing agents; and *(iv)* manufacturing products that harm (or help) the environment in their use. Unfortunately, data on these effects are sometimes insufficient or even unavailable. In OECD countries, the most complete data refer to energy use and high volume by-product air emissions. Some countries also have data for toxic releases. Among the items in this list, the production of goods that can cause environmental damage is the most highly regulated (e.g. disposal of motor oil and batteries) although controls could be strengthened. OECD and Eurostat are now improving the classification and collection of data on environmental goods and services (OECD/EUROSTAT, 1999).

Resource use

Manufacturing accounts for less and less of the total consumption of energy and water in OECD countries.[1] Water consumption in manufacturing fell 34% from 1980 to 1990 in OECD countries, and has generally remained at this level. Manufacturing energy use declined 6% from 1980 to 1985, but by 1997 had returned to its 1980 levels, while production rose 47% during this period (Figure 15.1). However, manufacturing demand for energy is not expected to grow substantially in the next decades, particularly as compared to the electricity, transport and residential sectors.

Figure 15.1. **OECD manufacturing resource use, 1980-1997**



Source: OECD (1999), *Environmental Data Compendium,* Paris.

Table 15.1. Energy use and intensity of selected US manufacturing sectors

	Energy Use 1015 Joules (PJ)	Energy Intensity (million Joules per USD of shipments)
Chemicals and Allied Products	3 453	10.9
Alkalies and Chlorine	136	65.7
Industrial Gases	104	31.4
Inorganic Pigments	42	13.1
Industrial Inorganic Chemicals nec	363	21.3
Plastics Materials and Resins	337	10.7
Synthetic Rubber	66	13.1
Cellulosic Manmade Fibers	30	16.0
Organic Fibers Noncellulosic	120	9.7
Gum and Wood Chemicals	11	13.3
Cyclic Crudes and Intermediates	164	11.8
Industrial Organic Chemicals nec	1 445	26.0
Nitrogenous Fertilisers	302	79.7
Phosphatic Fertilisers	19	4.2
Carbon Black	32	42.3
Iron and Steel	2 012	28.5
Paper and Allied Products	2 779	20.0
Pulp Mills	265	61.3
Paper Mills	1 363	39.1
Paperboard Mills	981	53.3
Textile Mill Products	327	4.1
Electronic and Other Electric Equipment	243	0.9
Transportation Equipment	378	0.9
Motor Vehicles and Car Bodies	111	0.7
Motor Vehicle Parts and Accessories	123	1.4
Total	17 424	5.3

Note: Excludes feedstock uses of energy.
Source: U.S. Department of Energy (1994), *Manufacturing Energy Consumption Survey* Washington, D.C..

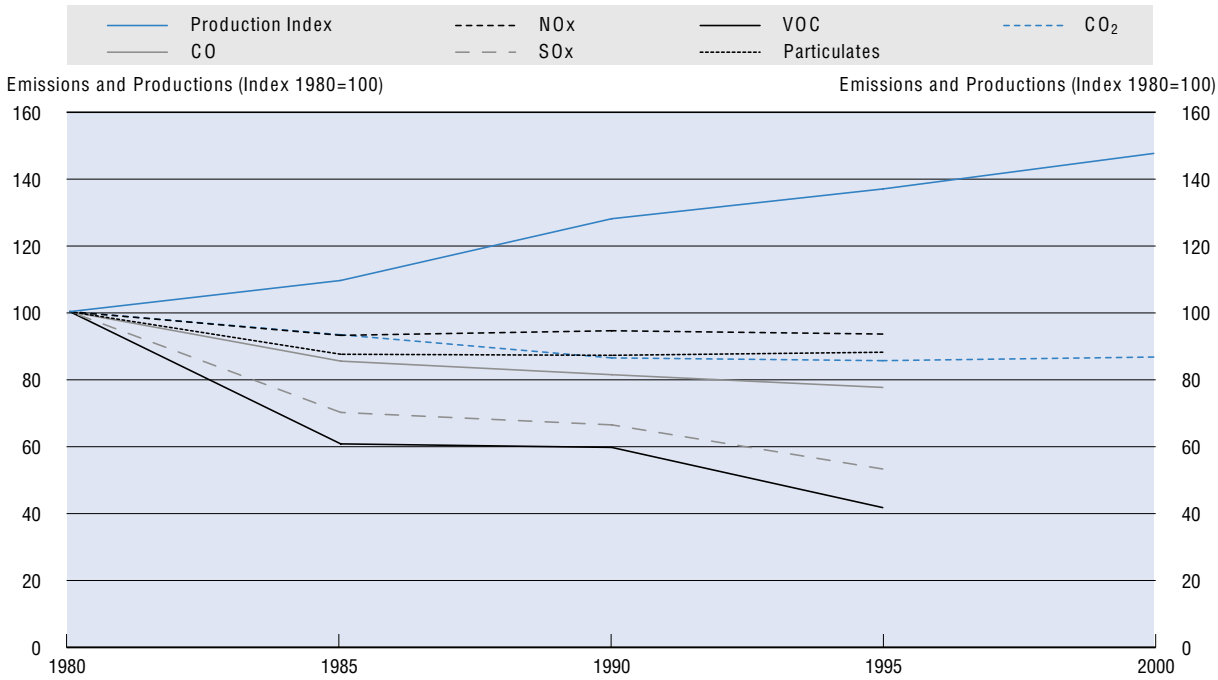
The most intensive energy-using sectors are those that chemically or physically transform matter, such as chemicals, steel, paper and cement. In OECD countries, these four sectors account for two-thirds of total energy use in manufacturing. The fabricating and assembly industries (such as automobiles, electronics and machinery) consume relatively little energy. For illustrative purposes, Table 15.1 shows the energy use and intensities of selected industrial sectors in the United States.

From 1978 to 1997, manufacturing energy use in the European Union fell by 4%, while manufacturing production rose 36%. Moreover, there were large shifts in the types of fuel used in this period. Industrial use of oil, coal and off-site-produced heat fell by 36%, 27% and 47%, respectively, while use of natural gas, electricity and renewable, and waste energy grew by 32%, 27% and 141%. In 1997, the principal energy uses in European manufacturing were petrochemical feedstocks (19%), heat and power in chemicals processing (14%), iron and steel (13%), cement, glass and ceramics (11%), pulp, paper and print (8%) and food and tobacco (8%).

Air pollution

Air pollution tends to come from large heavy industries such as chemicals, petroleum refining, iron and steel, pulp and paper, cement and glass production. Overall, manufacturing emissions of traditional air pollutants — nitrogen oxides (NO_X), carbon dioxide (CO_2), carbon monoxide (CO), volatile organic compounds (VOCs), sulphur oxides (SO_2) and particulate matter — are decreasing relative to production in OECD countries. Manufacturing emissions of greenhouse gases[2], for example, increased by about 3% between 1990-96 relative to a greater increase in output.[3] Some emissions have seen decreases in absolute levels. (Figure 15.2)

Figure 15.2. **OECD manufacturing air pollutant emissions, 1980-1997**



Note: Emissions include those from fuel combustion and production processes in manufacturing, mining and quarrying, and include solvents for VOCs. Production index includes manufacturing, mining and quarrying, and gas, electricity and water.

Source: OECD (1999), *Environmental Data Compendium,* Paris.

Despite a 36% increase in OECD manufacturing production from 1980 to 1995, polluting air emissions decreased (Figure 15.2). This varied from a 7% reduction for NO_X to a 58% reduction in particulates. The principal sectoral sources of air pollution vary with the type of pollutant (Table 15.2). Among the sectors profiled in this study, the pulp and paper industry is the most intensive emitter of SO_2, NO_2, and suspended particulates, but falls far below the cement, lime and plaster industry in manufacturing as a whole. The textiles and chemicals industries are the next most intensive SO_2 and NO_2 emitters in the selected group. The iron and steel industry is the next most intensive CO emitter, while the chemicals and electronics industries are the most intensive VOC emitters. The iron and steel industry is second to pulp and paper as an emitter of suspended solids.[4]

Toxic releases

Toxic releases from OECD manufacturing, including those to air, water, underground injection and land, have also decreased in the last 20 years. Based on evidence primarily from the United States, the major sources of toxic material releases are primary metals (32% of the total), chemicals (25%), pulp and paper (19%), plastics fabrication (5%), transportation equipment (5%) and fabricated metals (4%). The releases, however, vary by manufacturing sector (Table 15.2). Primary metals is the principal source of land disposal and off-site transfer, and the iron and steel industry is the most intensive emitter of bio-accumulative metals to land. The chemicals industry is the major source of air and water releases and underground injection. As for the water-borne pollutants, BOD and suspended solids, the pulp and paper sector is first in intensity followed by textiles. All of the selected sectors release toxic chemicals to the air and land, but for the electronics and automobiles the releases are proportionally large.

In the United States, for example, overall toxic releases declined by 45% from 1988 to 1998, while at the same time industrial production rose 38%. Most of the decline was achieved in airborne releases, which fell 58% from 1.1 million metric tonnes (t) in 1988 to 460 000 t in 1998. There were also declines in water releases (-73%), underground injection (-29%) and land disposal (-24%), but these reductions were much smaller in absolute terms. Off-site transfer of toxic materials declined as much 45%, but rose again to end the period at almost exactly its 1988 level.

Sectoral case studies

Chemicals

The chemicals sector has significantly reduced its energy use and emissions over the past two decades, but challenges still remain, particularly in the areas of climate change, ozone depletion and endocrine disruption. The sector encompasses a diverse group of establishments producing more than 70 000 chemicals and formulations, including various organic and inorganic chemicals, plastics, synthetic rubber, soaps, paints, industrial gases, fertilisers, pesticides and pharmaceuticals. These products are produced from metals, minerals, coal, oil, natural gas, vegetable oils, animal fats and other raw materials.

Worldwide, the chemicals sector produces about USD 1.7 trillion of products in 2000, a tenfold increase from 1970. World demand and production of chemicals is expected to grow by 40-60% by 2010. Production has been concentrated in the United States, Europe and Japan, but is now spreading to many non-OECD countries. OECD countries still produce about two-thirds of world output, although this share is projected to decline. Within the OECD, the pharmaceuticals segment of the industry is growing at about double the pace of industrial chemicals.

The chemicals sector has a history of emitting traditional air pollutants (except for fine particulates) and water-borne suspended solids. However, chemicals rank far below the pulp and paper industry among the selected sectors in its intensity of most of these pollutants. It ranks relatively high in its intensity of toxic chemicals and bio-accumulative metals released to air and land. Overall, the industry is a very intensive energy user, especially when its vast use of oil, natural gas and coal as feedstock materials are

Table 15.2. **Pollution intensities of selected manufacturing sectors**
(kilogrammes of emissions per USD million of production output)

	Air						Water		Toxic Chemicals			Bio-accumulative Metals		
	Sulphur Dioxide (SO_2)	Nitrogen Dioxide (NO_2)	Carbon Monoxide (CO)	Volatile Organic Compounds (VOCs)	Fine Particulates (PM10)	Total Suspended Particulates (TP)	Biological Oxygen Demand (BOD)	Suspended Solids (SS)	Air	Land	Water	Air	Land	Water
Industrial Chemicals														
- Industrial Chemicals except Fertilisers	2 179	1 779	217	354	0	517	15	201	369	410	0	7	112	0
- Fertilisers and Pesticides	42	443	2	23	0	114	4	94	110	63	0	0	0	0
- Synthetic Resins, Plastics Materials and Manmade Fibres	672	690	64	1 487	0	197	34	79	628	239	0	1	40	0
Iron and Steel	156	253	1 947	66	0	692	0	140	179	660	0	17	489	0
Pulp, Paper and Paperboard	9 625	4 655	2 224	571	0	986	2 911	3 501	467	21	17	0	30	6
Textiles														
- Spinning, Weaving and Finishing	3 394	1 799	169	58	7	239	266	498	160	71	0	15	52	2
Automobile	2	18	3	491	0	5	0	5	211	70	0	2	16	
Electronics														
- Radio, TV and Communication Equipment	0	34	0	1 016	0	1	0	5	290	238	0	0	111	0
Most Intensive Manufacturing Sector	Cement, Lime and Plaster	Cement, Lime and Plaster	Sawmills, Planing and Other Wood Mills	Distilled Spirits	Oils and Fats	Cement, Lime and Plaster	Pulp, Paper and Paper-board	Pulp, Paper and Paper-board	Ship-building and Repairing	Leather Tanning and Finishing	Pulp, Paper and Paper-board	Non-ferrous Metals	Iron and Steel	Pulp, Paper and Paper-board
	40 012	24 622	2 791	8 200	41	10 377	2 911	3 501	2 400	2 394	17	49	489	6

Note: Inter-Quartile Mean pollution intensities (an unweighted mean of the plant intensities after dropping those which are below the first quartile or above the third quartile).
Source: Hettige *et al.* (1994), *The World Bank Industrial Pollution Projection System.*

considered. The various segments of the chemicals industry vary dramatically in energy intensity. For example, nitrogenous fertilisers are 19 times more energy intensive than phosphatic fertilisers.

In the OECD countries, the chemicals sector has greatly reduced its energy consumption, air emissions and toxic releases per unit of output in the last two decades. With regard to energy, most savings were for energy use for heat and power purposes rather than energy used for feedstock. For heat and power, there have been declines in oil, coal and heat consumption and an increase in natural gas consumption, while electricity use remained steady. Energy consumption per unit of chemicals production declined by 43% between 1974 and 1998 in the United States and by 70% between 1970 and 1998 in Japan. In Europe, the chemicals industry grew by 57% from 1980 to 1997, while energy use for heat and power purposes declined by about 21%.

Energy savings in the chemicals sector have been made from increased use of combined heat and power (CHP) technology. Because of the industry's heavy use of steam, CHP is a very attractive source of heat. Savings have also come from process integration (e.g. PINCH[5]-optimised heating and refrigeration systems), energy recovery, and improved sensors and process control. Improved catalysts are resulting in increased yields, decreased unwanted by-products and energy savings from lower operating temperatures and pressures. In the longer term, biotechnology holds promise in reducing energy used for both processing and feedstock purposes in the chemicals sector.

Chemicals also reduced its emissions of traditional air pollutants in the last two decades, particularly carbon monoxide (CO) and volatile organic compounds (VOCs), the sector's two principal air pollutants. During 1980-98 in the United States, these two pollutants declined by 48% and 75% respectively. Toxic releases to air, water and land have been similarly reduced. In the United States during 1988-98, toxic releases to the atmosphere were reduced by almost two-thirds. Releases to other media, which were somewhat lower to begin with, also declined — by 78% for water releases, 29% for underground injection, 26% for land releases and 47% for off-site transfers.

Most reductions in harmful emissions are the result of new technologies. In the chemicals sector, air emissions can be point source (coming from stacks and vents), but also fugitive (from leakage of pumps, valves and tanks). Liquid wastes can come from equipment washing solutions, product washes, leaks and spills In addition, there can be solid wastes of spent catalysts, spent filters and sludges. Some of these sources were reduced through maintenance and pollution control measures, others through plant modernisation. For example, the chlorine industry is moving away from diaphragm and mercury cell processes towards the more efficient (in terms of material and energy inputs and outputs) membrane cell process. A relatively recent development, membrane cells have fewer adverse effects on the environment and produce a higher quality product at a lower cost than the other methods.

In spite of these gains, concerns about the human health and environmental effects of chemical product use remain. Efforts to further reduce toxic emissions and other negative effects from chemicals can be enhanced by strengthening the regulatory capacity and framework governing chemicals use and disposal (particularly in non-OECD countries); improving the testing, assessment and management of the safety of existing chemicals; and finding ways to better evaluate and manage the risks resulting from the release of chemicals from products, including through life-cycle assessments and more holistic approaches. There are also economic instruments to consider such as taxes or charges on certain chemicals, tradable emission permits, and refund systems to reduce these emissions. The chemicals sector could also make more efficient use of energy through developments in Best Available Technologies (BAT), including energy saving technologies, modernisation of production facilities, more use of biotechnology-based processes, and substitutions in feedstocks. However, large expenditures on new technologies and processes are hindered by long investment cycles for new plant and equipment in sectors such as chemicals.

Ensuring compliance with voluntary agreements, which are growing in number in the chemicals sector, is also needed. Voluntary instruments, including agreements, codes and labelling schemes, have played an important role in aiding chemicals companies to enhance their environmental performance. The *Responsible*

Care programme is the chemical industry's voluntary commitment to improve its health, safety and environmental performance. Initially developed in Canada in 1984, the Responsible Care programme was taken up by the International Council of Chemical Associations in 1991 and now covers 87% of global chemical production in 42 countries. The Product Stewardship component aims to prevent injury to human health and the environment through the various life-cycle stages. Although practised by the larger multinationals, the Responsible Care concept needs to be extended to small and medium-sized enterprises (SMEs) and to companies in non-OECD countries. In chemicals and other sectors, more firms are also developing environmental management programmes through the adoption of standards such as the *ISO 14000 Series* and the European Union's *Eco-Management and Auditing Scheme,* EMAS (OECD, 2001*b*).

Iron and steel

The OECD iron and steel sector continues to reduce its energy usage and emissions due to both reductions in steelmaking capacity and to technical improvements. However, additional technical changes and regulatory approaches are needed to bring major advances in steel-making energy and material reductions for the next 10-20 years. The iron and steel industry processes iron ore and ferrous scrap materials into steel sheet, bars, beams, and other products. In the OECD, the iron and steel industry shrank during the 1980s, but grew again in the 1990s to surpass its 1980 level by 2%. It now produces 52% of world output.

Reductions in pollution and energy have derived from the use of modern equipment, including dry coke quenching, blast furnace top gas power recovery, continuous casting (improved yields), wastewater treatment and new steelmaking techniques. There are two principle types of steel mills. *Integrated mills* rely mostly on ore-based processes, the most common of which involves reducing pelletized iron ore into pig iron using coke (in a blast furnace); refining the iron into steel (in a basic oxygen furnace, BOF); and casting, forming, and treating the steel into the final products. *Minimills* usually produce steel from scrap, not iron, in an electric arc furnace (EAF). The EAF method, which is also employed at some integrated mills, avoids several of the most polluting and energy-intensive processes of the integrated method, i.e. the ore preparation, cokemaking and ironmaking steps. The cost advantages of the EAF method led to an increase in its share of OECD steel production from 18% in 1970 to 35% today.

The iron and steel industry is a major source of most of the traditional air pollutants, particularly CO and suspended particulates, and of water-borne suspended solids. The most polluting steps in the steelmaking process are summarised in Table 15.3. Steelmaking ranks high in its intensity of toxic chemicals and bio-accumulative metals released to the air and land. In fact, it is the highest-ranking sector in releases of bio-accumulative metals to land. Overall, iron and steel is the most intensive energy user of the selected sectors. There are, however, segments of other industries that are more energy intensive, e.g. the nitrogenous fertiliser and the alkalies and chlorine parts of the chemicals industry.

Table 15.3. **Pollutant releases of selected steps of the steelmaking process**

Process Stage	Potential Pollutant Release
Ore Preparation (Sinter/Pellet Production)	Dust (including PM10), CO, CO_2, NO_X, VOCs, methane, dioxins, metals, radioactive isotopes, HCl/HF, solid waste
Coke Production Blast Furnace	Dust (including PM10), polycyclic aromatic hydrocarbons (PAHs), benzene, NO_X, VOCs, methane, dioxins, metals, radioactive isotopes, HCl/HF, solid waste
Basic Oxygen Furnace	Dust (including PM10), H2S, CO, CO_2, SO_2, NO_X, radioactive isotopes, cyanide, solid waste
Electric Arc Furnace	Dust (including PM10), metals (zinc), CO, dioxins, VOCs, solid waste Dust (including PM10), metals (zinc, lead, mercury), dioxins, solid waste
Wastewater Treatment	Suspended solids, metals, pH, oil, ammonia, solid waste

Source: UNEP/IISI, 1997.

The US primary metals industry, which includes iron, steel and non-ferrous metals, reduced its emissions of most of the traditional air pollutants during 1980-1998; emissions of CO, SO_2 and particulates, the industry's principle air pollutants, declined by 33%, 76% and 73% respectively while emissions of NO_X rose by 35%. Although the US industry reduced its toxic chemical releases by more than 30% during the early 1990s, by 1998 releases were back to 1990 levels, a trend that was accompanied by a production increase of 31%. Although toxic releases to the atmosphere were cut in half and releases to land decreased by 7%, these declines were offset by increases in off-site transfers. In Europe, where the primary metals industry grew by 12% from 1980 to 1997, energy use for iron and steelmaking declined by about 28%, while energy used for non-ferrous metal production fell by 15%. There were declines in the use of all fossil fuels, especially oil, while electricity use remained steady.

While the iron and steel sector has reduced its intensity of resource and energy use and greatly expanded activities for scrap and by-products recovery, pollutant releases still place significant pressures on air, soil and water. Environmental regulations in OECD countries — based on permits and emission limits — have been effective in controlling excessive pollutant outputs, but further progress is needed in enhancing plant efficiency and reducing emissions. The iron and steel sector also has not reached its full potential for recycling iron, steel scrap and by-products as well as for energy recovery, partly due to long cycles for new investment in plant and equipment. In some OECD countries, voluntary agreements are being used in the iron and steel sector in advance of and as a supplement to regulatory approaches, particularly for achieving reductions in greenhouse gas emissions. In Germany, for example, the flexibility of voluntary arrangements is credited with helping the steel sector surpass negotiated targets and facilitating implementation of the Kyoto Protocol. However, the steel sector has been exempted from carbon taxes in some countries due to competitiveness concerns, and there remains wide latitude for greater use of economic instruments in improving the environmental performance of the OECD iron and steel sector.

Pulp and paper

Across the OECD, the pulp and paper sector has had a mixed record in reducing its resource use and polluting emissions in the past 20 years. Pulp and paper is highly intensive in energy and resource inputs. Environmental effects from this industry include forest depletion, biodiversity loss, air pollution and waste releases. However, newer sustainable forestry practices can prevent deforestation. Output of pulp and paper has increased moderately in the last two decades and is projected to grow by 2.5% annually to 2010. OECD countries dominate world production of pulp and paper products, accounting for over 85% of production capacity, but Asia and Latin America are playing an increasing role in the expansion of the sector. It is expected that demand for higher quality (stronger, brighter and more versatile) as well as more environmentally-demanding paper will continue to increase.

The pulp and paper sector processes cellulose fibres, primarily from wood, into writing paper, newsprint, magazine stock, paperboard, cardboard, sanitary tissues, and various other decorative and structural papers. There are five principle process steps in paper production: *(i)* wood preparation; *(ii)* pulping; *(iii)* bleaching; *(iv)* chemical recovery; and *v)* papermaking. Wood fibre is the predominant ingredient in paper. However, trees cut specifically for paper manufacture provide only slightly more than half of the fibre used on average. The remaining fibre is secondary material obtained by recycling waste paper, spent packaging, used newsprint, etc. The waste residues of lumber operations and wood chips from sawmills provide additional material. A small but growing share of fibre is from non-tree plant sources, such as kenaf, a type of hibiscus.

Among the selected sectors, the pulp and paper industry is the most intensive emitter of the air pollutants SO_2, NO_2, CO and suspended particulates, the water pollutants BOD and suspended solids, and water-borne toxic chemicals and bio-accumulative metals. Pulp and paper is the most intensive of all industries in the water-related categories, being one of the largest process water users, and ranks high in its intensity of toxic chemical releases to the air. The industry is also a very intensive energy user, and the pulp mill segment is among the most energy intensive of all industry segments. Overall, however, the pulp and paper industry is about 30% less energy intensive than the iron and steel industry.

Innovations in technology, process and management have been introduced in the OECD pulp and paper sector due to consumer pressures as well as government policies. This has led to shifts towards less environmentally disruptive pulping and bleaching, increased use of recovered paper and fillers, and in-house water recycling. For example, in the Nordic countries, in particular, market demands have prompted many innovative solutions to diminish environmental impacts associated with forestry and the pulp and paper sector. In Europe overall, the pulp and paper industry grew by 47% from 1980 to 1997 when its energy use increased by 27%. In the United States, the pulp and paper sector reduced its toxic chemical releases gradually during 1988-1998 by a total of 14% as production increased by 23%. Releases to the atmosphere, which accounted for 85% of 1988 total emissions, were reduced by 17%; however, releases to water and land increased. The US industry also reduced its emissions of most of the traditional air pollutants. During 1980-1998, emissions of CO, the industry's principle air pollutant, declined by 48%, but emissions of NO_X, while starting at a level well below that of CO, rose by 250%.

Pulpmaking is the principle source of water pollutants in the sector. Though there are potentially less polluting pulping methods available, recent environmental improvements to the century-old Kraft process are likely to assure its dominance well into the 21st century. Power boilers are sources of emissions of particulates, SO_2 and NO_X to the air. The chemical recovery boilers emit SO and reduced sulphur compounds. One source of energy savings in the industry, prompted largely by cost-cutting considerations, has been the greater use of process wastes as a fuel for boilers and CHP units. The trend towards increasing substitution of recovered fibre to wood pulp in papermaking is expected to continue, but there is the problem of growing volume of waste paper disposed in landfills.

Government policies, including information dissemination and eco-labels, which complement consumer demands for sustainable practices in pulp and paper, should aid the industry in reducing negative environmental and resource externalities. Future policy frameworks should take into account the full life-cycle impacts from forestry to wastepaper disposal and the trade-offs in using alternative raw materials. Despite significant gains in recycling, there are economic, technical and quality limits to increasing continuously the quantities of wastepaper to be recycled. The future should yield more innovative techniques for pulping and bleaching; greater energy conservation and increased use of biofuels for reducing CO_2 emissions; and wider use of closed-cycle mills to eliminate water effluents. Incineration with energy recovery is an option to address both wastepaper generation and greenhouse gas emissions. Although the pulp and paper sector will have a significant presence in the OECD area, higher rates of growth are predicted for non-OECD countries.

Textiles

Both downsizing and new technologies have reduced the environmental impacts of the OECD textiles sector, where the major concern continues to be water pollution. The textiles sector spins natural and manmade fibres into yarns and threads, weaves and knits them into fabrics and then dyes and finishes them for further processing into apparel, home furnishings and industrial goods. The OECD textiles sector grew by a modest 5% during 1980-95, but has been shrinking in the 1990s. This has been accompanied by increases in output in non-OECD countries. While the contraction continues, the rate of decline appears to have slowed somewhat in the late 1990s, but OECD production is not projected to increase greatly in the future.

The textiles industry is only moderately energy intensive. It is four times more energy intensive (measured in energy use per value of gross output) than the automobile and electronics industries, but much less energy intensive than the processing and materials production industries such as chemicals, steel and pulp and paper. Further energy savings are being realised. For example, European textile production declined by about 12% from 1980 to 1997, when the sector's energy use declined by 23%. Large declines in the use of coal and oil were only partially offset by increase in the use of natural gas and electricity.

The textile industry is a relatively minor source of air pollutants compared with many other industries, but its wide variety of air pollutants makes sampling, analysis, treatment and prevention more complex.

Operations that represent the greatest concern are coating, finishing and dyeing operations. Textile mills usually generate NO_X and SO_2 from boilers. Other significant sources of air emissions in textile operations include resin finishing and drying operations, printing, dyeing, fabric preparation, and wastewater treatment plants. The textiles industry is also the only one of the selected sectors registering a fine particulates emission intensity. Air pollutants from production, however, are being reduced. The US textiles sector reduced its toxic chemical releases by nearly three-quarters in the last decade, nearly all of which were in the form of releases to the atmosphere.

Water pollution is the principle environmental concern of the textile sector. There are large volumes of pollution in the form of washwater from preparation and continuous dyeing, alkaline waste from preparation, and batch dye waste containing large amounts of salt, acid or alkali. The primary sources of BOD include waste chemicals or batch dumps, starch sizing agents, knitting oils, and degradable surfactants. Wet processing operations, including preparation, dyeing, and finishing, generate the majority of textile wastewater. Because of the wide variety of process steps, textile wastewater typically contains a complex mixture of chemicals.

De-sizing, the process of removing size chemicals from textiles, is a large source of wastewater pollutants and often contributes up to 50% of the BOD load. Dyeing wastewater typically contains by-products, residual dye and auxiliary chemicals. Of the 640 000 tonnes of dyes produced annually worldwide, about 10-15% is disposed of in effluent from dyeing operations. Finishing processes generate wastewater containing natural and synthetic polymers and a range of other potentially toxic substances. In response to government regulations as well as market demand, textile firms are working on the technical advances needed to further reduce harmful effluents from textiles processes.

Automobiles

Environmental concerns in the OECD automobile producing sector relate to toxic releases to air and water, which — although being reduced per unit of output — may remain significant given rapid growth in production. This section considers environmental impacts in the manufacturing of automobiles as distinct from their use (the environmental dimensions of motor vehicle products are discussed in Chapters 12 and 13). The automobile industry encompasses establishments which fabricate and assemble approximately 8 000 to 10 000 different parts into approximately 100 major motor vehicle components, including suspension systems, transmissions, and radiators, and then assemble those components into automobiles. In the OECD, the gross output of the industry grew by about 40% during 1980-95. The sector shrank in the early 1990s, but recovered with strong and accelerating growth in the late 1990s.

Compared with the other selected sectors, the automobile industry uses much less energy and produces less air and water pollution. The industry is not an intensive energy user, being about 80% less energy-intensive than manufacturing as a whole. However, efforts to reduce overall energy use in automobile manufacturing are limited. For example, the European transportation equipment industry's energy use remained steady relative to output during 1978-1997. However, large declines in the use of coal and oil were offset by increases in the use of natural gas, electricity and heat.

The automobile sector is an intensive emitter of VOCs, but not of other traditional air pollutants. It also releases toxic chemicals to the air and land through potentially hazardous chemicals that accompany the cleaning and painting processes. The manufacturing processes used to produce the thousands of discrete parts and accessories vary, depending on the end product and materials used. For example, different processes are employed for the production of metal components, in comparison to the production of plastic components. Most processes typically include casting, forging, moulding, extrusion, stamping, and welding. Table 15.4 shows the major processing steps and potential pollutants in the automobile sector.

New automobile manufacturing techniques, including enhanced recycling and treatment of harmful by products, are contributing to a decrease in toxic emissions. In the period 1988-98, the US transportation equipment industry reduced its toxic chemical releases by 55%, while production increased 14%. Most of

the reduction was in the form of releases to the atmosphere, which accounted for 87% of 1988 total emissions. More radical innovations in recycling and effluent treatment may be needed, however, to offset emissions from projected increases in production in the OECD area.

Table 15.4. **Principal polluting outputs of automobile production**

Process	Air Emissions	Process Wastes (Liquids/Waste Waters)	Other Wastes (Solid and Hazardous Wastes)
Metal Casting (Foundry)	SO_2, particulates (lead, cadmium and other), dust containing crystalline silica	wastewaters containing lead, cadmium and sludges, spent solvents	slag (reactive hazardous waste)
Metal Shaping Metal cutting and/or forming Heat treating	Solvent wastes (e.g., 1,1,1-trichloroethane, acetone, xylene, toluene, etc.)	Acid/alkaline wastes (e.g., hydrochloric, sulphuric and nitric acids), waste oils and cyanide wastes	Metal wastes(e.g., copper,, chromium and nickel) and solvent wastes (e.g., 1,1,1-trichloroethane, acetone, xylene, toluene, etc.)
Surface Preparation Solvent cleaning Pickling	Solvent wastes (e.g., acetone, xylene, toluene, etc.)	Acid/alkaline wastes	Ignitable wastes, solvent wastes, (e.g., 1,1,1-trichloroethane, acetone, xylene, toluene, etc.), still bottoms and metal wastes
Assembly			Solid wastes associated with parts packaging
Surface Finishing Electroplating Painting Finishing	Solvent wastes (e.g., 1,1,1-trichloroethane, acetone, xylene, toluene, etc.)	Acid/alkaline wastes, cyanide wastes, plating wastes, and wastewaters	Metal wastes, reactive wastes, metal paint wastes, ignitable paint wastes, solvent wastes and still bottoms
Facility cleanup	Solvent wastes (e.g., 1,1,1-trichloroethane, acetone, xylene, toluene, etc.)		Solvent wastes and still bottoms

Source: Adapted from US EPA (1997), Office of Compliance Sector, Notebook Project, *Profile of the Motor Vehicle Assembly Industry*, September.

Electronics

In the OECD area, electronics is one of the fastest-growing manufacturing sectors, and although it is not particularly energy or pollution intensive, there are concerns about toxic and solid waste releases with increasing output. The electronics sector encompasses diverse establishments engaged in producing telecommunications equipment, computers, automotive electronics, military electronics, industrial electronics, consumer electronics and semiconductors. The gross output of the radio, television and communications equipment segment almost tripled during 1980-95 and the pace of growth accelerated in the late 1990s. The gross output of the remaining parts of the sector, including computers and semiconductors, also grew rapidly, almost 16% annually in the late 1990s.

The electronics sector is not an intensive energy user, being about 80% less energy-intensive than manufacturing as a whole. Semiconductor manufacturing needs large amounts of pure water and can be fairly water-intensive. Various chemicals are released into the environment during the manufacture of electronics products, by three segments in particular: *(i)* semiconductors; *(ii)* printed wiring boards (PWBs); and *(iii)* cathode ray tubes (CRTs). Table 15.5 shows the chemical releases and transfers for these three segments; while some of these releases have been eliminated in OECD countries, they may still be found in other regions of the world. The radio, television and communication equipment segment of the electronics industry has fairly intensive releases of toxic chemicals to the air and land and bio-accumulative metals to the land.

Table 15.5. **Polluting outputs of selected electronics production**

Process	Air Emissions	Process Wastes (Liquids/Waste Waters)	Other Wastes (Solid and Hazardous Wastes)
Semiconductors Crystal Preparation Wafer Fabrication Final Layering and Cleaning Assembly	Acid fumes, VOCs and dopant gases	numerous spent solutions (deionised water, solvents, acids, caustic cleaners, resist material, etchants and developing solutions), aqueous metals and D007 (chromium)	Silicon, spent solvents and epoxy materials, and F003 (Spent non-halogenated solvents)
Printing Wire Board Board Preparation Electroless Plating Imaging Electroplating Solder Coating Assembly and Soldering	Particulates, acid fumes, VOCs, organic vapours , ammonia fumes and CFCs	numerous spent solutions (deionised water, solvents, acids, caustic cleaners, electroless copper baths, resist material, etchants, plating baths and catalyst and developing solutions), aqueous metals (nickel, silver and copper), flux residue and D008 (lead), D002 (corrosive hazardous materials)and D003 (reactive hazardous materials)	Sludge and scrap material, waste rinse water and sludges from wastewater treatment, F001-5 (halogenated solvents used in degreasing), F006 (wastewater treatment sludges from electroplating operations), F007 (spent cyanide plating bath solutions from electroplating operations) and F008 (plating bath residues from the bottom of plating baths from electroplating Operations where cyanides are used in the process), solder dross and scrap boards
Cathode Ray Tubes Preparation of panel and shadow mask Application of coating to panel interior Installation of electron shield Preparation of funnel and joining to panel mask assembly Installation of electro gun Finishing	Solvent vapours, lacquer vapours and VOCs	spent solvents, spent photoresists, deionised water, acids, oxidisers, carbon slurry, surfactants, chromate, phosphor solutions, chelating agents, caustics, alcohol, coatings, ammonia, aluminium and process cooling waters, electron shield degrease, and funnel wash, seal surface cleaning and frit application wastewaters	Glass (lead) from breakage, lacquer wastes, frit glass (lead) and frit contaminates clothing, instruments and utensils.

Source: US EPA (1995), Office of Compliance Sector Notebook Project, *Profile of the Electronics and Computer Industry*, September.

Despite rapid increases in production, the electronics sector has steadily reduced its toxic chemical releases, particularly releases to the atmosphere. In the United States, the country for which the most data are available, the electronics industry reduced its toxic chemical releases by 80% while production tripled in the 1990s. Four types of pollution prevention techniques and processes have been primarily responsible for reduction of environmental impacts in electronics manufacturing:

- *Process or equipment modifications* to reduce the amount of waste generated. For example, manufacturers can change equipment or processes to enhance water conservation by installation of counter-current rinsing systems; reduce alkaline and acid concentration in tanks by installing a pH controller; and reduce drag-out by decreasing the withdrawal rate of parts from plating tanks.

- *Raw material substitution or elimination,* which replaces existing raw materials with other materials that produce less waste, or a non-toxic waste. Examples include substituting non-cyanide solution for a sodium cyanide solution in copper plating baths and replacing hexavalent chromium with trivalent chrome plating systems.

- *Waste segregation/separation/preparation,* which avoids the mixture of different types of wastes and the mixture of hazardous wastes with non-hazardous wastes. This makes the recovery of hazardous wastes

easier by minimising the number of different hazardous constituents in a given waste stream. Also, it prevents the contamination of non-hazardous wastes. A specific example is segregation of wastewater sludge by metal contaminants.

- *Recycling,* which uses or reuses waste as an ingredient or feedstock in the production process on-site. Examples of recycling include recovering copper during the etching processes, recovering lead and tin from printed wiring boards, and installing a closed-loop recycling system to reuse freon (which is being phased-out) and reduce/reuse water consumption.

In general, much electronics equipment has relatively short service lives and some of the waste generated can be hazardous in nature (e.g. mercury, PCBs, brominated flame retardants). Given rapidly increasing production of electronics products, which is expected to grow at more rapid rates in the future, the disposition and recycling of equipment is an important environmental issue. Already, toxic landfills in OECD countries are filling with computers and other electronic devices. New approaches such as extended producer responsibility (EPR) will be needed to enhance the recyclability of electronics products. Foreign assistance to and investment in non-OECD countries, which now account for more than half of computer manufacturing and assembly, should give greater attention to reducing negative environmental impacts from processes and products, for example through capacity building and technology co-operation. To this end, the World Semiconductor Council has promoted and achieved lower toxic emissions among its members, including Taiwan and other large electronics manufacturing centres.

Environmental implications of structural change in industry

The implementation of new technologies and approaches for reducing resource use and polluting emissions are only partly responsible for progress in achieving sustainable development in the OECD

Table 15.6. Key environmental parameters of manufacturing and services

	Manufacturing	Traditional services	ICT-based services
Physical space 1. Services for the physical space	*Industrial plant* Lower quality heating, cooling, ventilation and lighting (high energy use)	*Commercial office or retail space* Higher quality heating, cooling, ventilation and lighting (lower energy use)	*Limited office and warehouse space* Higher quality heating, cooling, ventilation and lighting (lower energy use)
Production processes	*Manufacturing equipment*	*Standalone computing and communications equipment*	*Networked computing and communications equipment*
2. Production of equipment (upstream effects)	Industrial equipment	Computing and communications equipment	Computing and communications equipment; network infrastructure
3. Production of raw materials (upstream effects)	Raw materials (steel, petrochemicals, glass, solvents)	Paper; office furnishings	Paper; office furnishings
4. Energy to power production equipment	High fuel and power consumption for processes	Power consumption for equipment and retail space	Power consumption for equipment and networks
5. Raw materials collected at the site	Water	Little or none	Little or none
6. Pollutant emissions	Process-related air, water emissions and hazardous material releases	Little or none	Little or none
Disposition of obsolete production equipment	Long equipment lifetimes, some hazardous materials	Short equipment lifetimes, some hazardous materials	Short equipment lifetimes, embedded hazardous materials
Inventories	High	Medium	Low
Deliveries	Freight	Freight or customer travel	Freight or via internet

area. In the last 30 years, OECD economies have been characterised by decreasing energy and pollution intensity owing also to: *(i)* structural shifts between sectors within manufacturing; *(ii)* structural shifts from manufacturing to services; and *(iii)* structural shifts within services from traditional sectors to ICT-based sectors. Different raw materials and pollution flows are associated with these sectors of the economy and should be considered when analysing structural changes (Table 15.6). Here, a distinction is made between manufacturing (chemicals, iron and steel, etc.), traditional services (tourism, health care, retail) and newer ICT-based services (communications, finance, education). Their potential environmental effects broadly differ. Compared to manufacturing, services sectors have far fewer impacts on the environment. Compared to traditional services, ICT-based services are relatively environmentally benign.

Manufacturing

The first phase of structural change with environmental implications has occurred within OECD manufacturing. Different sectors vary widely in their environmental impacts as well as in the gains achieved in the past two decades and their growth rates. Table 15.7 shows the estimated gross output and growth rates of selected manufacturing sectors in OECD countries. The iron and steel and textile sectors, both environmentally intensive, grew little during the 1980s and 1990s. The pulp and paper sector is growing at a moderate pace. Within the chemicals sector, certain segments (e.g. pharmaceuticals) are growing at least twice as fast as the industrial chemicals segment. Automobiles and electronics, which have relatively low pollution and energy-use intensities, are large and growing at a rapid rate. As a result of structural shifts, the share of world manufacturing produced in non-OECD countries is increasing with associated environmental impacts; the implications are considered more fully in other parts of this report.

Table 15.7. **Output and growth of selected OECD manufacturing sectors**

	Gross Output, 1995 (billions of USD)	Growth 1980-95	Annual Growth 1980-95	Annual Growth 1995-99
Industrial chemicals	532	29%	1.7%	-
Other chemicals	479	69%	3.6%	-
Iron and steel	485	-1%	-0.9%	-
Paper and paper products	431	30%	1.7%	1.8%
Textiles	309	8%	0.5%	-1.3%
Motor vehicles	1 097	39%	2.2%	5.2%
Radio, TV and communications equipment	622	267%	10.2%	12.1%
Other electrical machinery	470	222%	8.9%	15.6%
Total manufacturing	10 990	27%	1.6%	3.5%

Note: Australia, Austria, Belgium, Canada, Denmark, Finland, France, western Germany, Greece, Iceland, Italy, Japan, Korea, Mexico, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, United Kingdom and United States.
Source: OECD STAN database, 1996 and OECD, Indicators of Industrial Activity, Q1, 2000.

These structural changes within manufacturing have helped reduce negative environmental impacts due to slower growth in larger, polluting sectors and faster growth in more environmentally friendly sectors. This is seen in the overall decline in OECD energy intensity since the oil shocks of the 1970s (measured in terms of energy use per GDP). Within manufacturing, it is estimated that about one-third of the decline in energy use is due to structural changes and about two-thirds to efficiency improvements. Movement away from heavy industries (steel, chemicals, cement) towards lighter manufacturing sectors (electronics and equipment assembly) has been largely responsible. A notable exception to this trend is the pulp and paper sector, which is growing faster than most heavy industries, partly because of service sector demand for paper.

Similar trends are seen with regard to changes in pollution intensity. Structural shifts within manufacturing have reduced some emissions intensities by as much as 20%, but have also raised the intensities of some releases by 4-5% (Table 15.8). Combining sectoral pollution intensity data (measured in kg per USD million of value added) with temporal structural data (value-added by each sector) highlights the effect of structural

changes on pollution intensity. When pollution intensity data, disaggregated to the ISIC 3 digit level, is held constant, the results reflect only the changes due to shifts in the relative contributions of the various manufacturing sectors to the economy.

Table 15.8. **Changes in pollution intensities in OECD manufacturing due to structural change**

	Pollution Intensity, 1980 (kg/USD 1 million of Value Added)	Pollution Intensity,1995 (kg/USD 1 million of Value Added)	% change
Air			
Sulphur Dioxide (SO2)	4 520	3 942	-12.8%
Nitrogen Dioxide (NO2)	2 289	2 058	-10.1%
Carbon Monoxide (CO)	3 814	3 449	-9.6%
Volatile Organic Compounds (VOCs)	1 678	1 555	-7.3%
Fine Particulates (PM10)	708	590	-16.6%
Total Suspended Particulates (TP)	1 108	958	-13.5%
Water			
Biological Oxygen Demand (BOD)	600	581	-3.2%
Suspended Solids (SS)	12 108	9 648	-20.3%
Toxic Chemicals			
Air	787	820	4.2%
Land	1 507	1 492	-1.0%
Water	127	134	5.8%
Bio-accumulative Metals			
Air	17	14	-15.7%
Land	431	369	-14.3%
Water	3	2	-8.2%

Note: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States.
Sources: Hettige *et al.* (1994), *The World Bank Industrial Pollution Projection System*; and OECD STAN database, 1996.

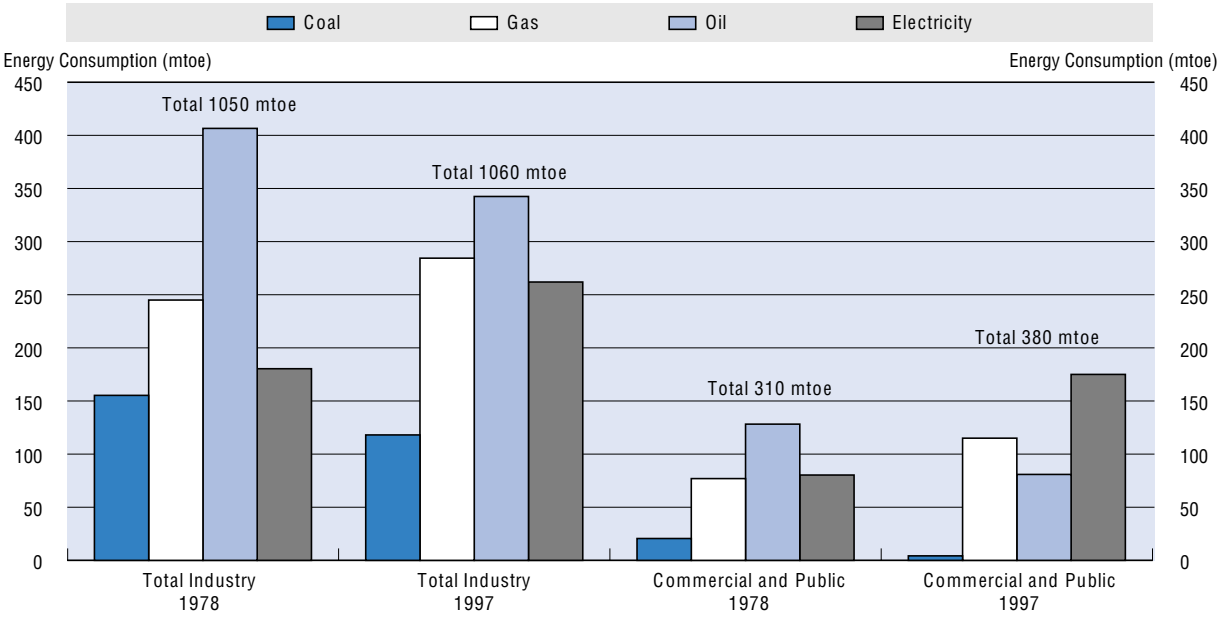
Traditional services

In the second phase of structural change, further environment-related improvements have occurred due to the shift away from manufacturing and towards more service-based economies in OECD countries. Manufacturing has slipped to less than 20% of GDP in the OECD area. Services now account for between one-half and three-quarters of the value of OECD production. Job creation in services is exceeding overall job growth in the OECD area, with about 65% of OECD civilian workers engaged in activities related to services (OECD, 2000*c*). Most of this growth has been in what are called "traditional services" as opposed to newer services based on information and communications technologies (ICT).

There is limited quantitative analysis concerning the nature and extent of the environmental consequences of this structural shift towards services. Little environmental and energy information is collected about the services sector, which is generally ill defined in many statistical series and "often credited with whatever cannot be attributed to households, manufacturing or transport" (IEA, 1997). This data gap stems partly from the service sector's diversity as well as the ambiguous and fluid boundaries of the sector. Transportation, a sector that is both a major energy consumer and a source of greenhouse gases, is sometimes placed within the services sector. Construction, which is considered a service sector, is often combined with manufacturing in industrial indicators.

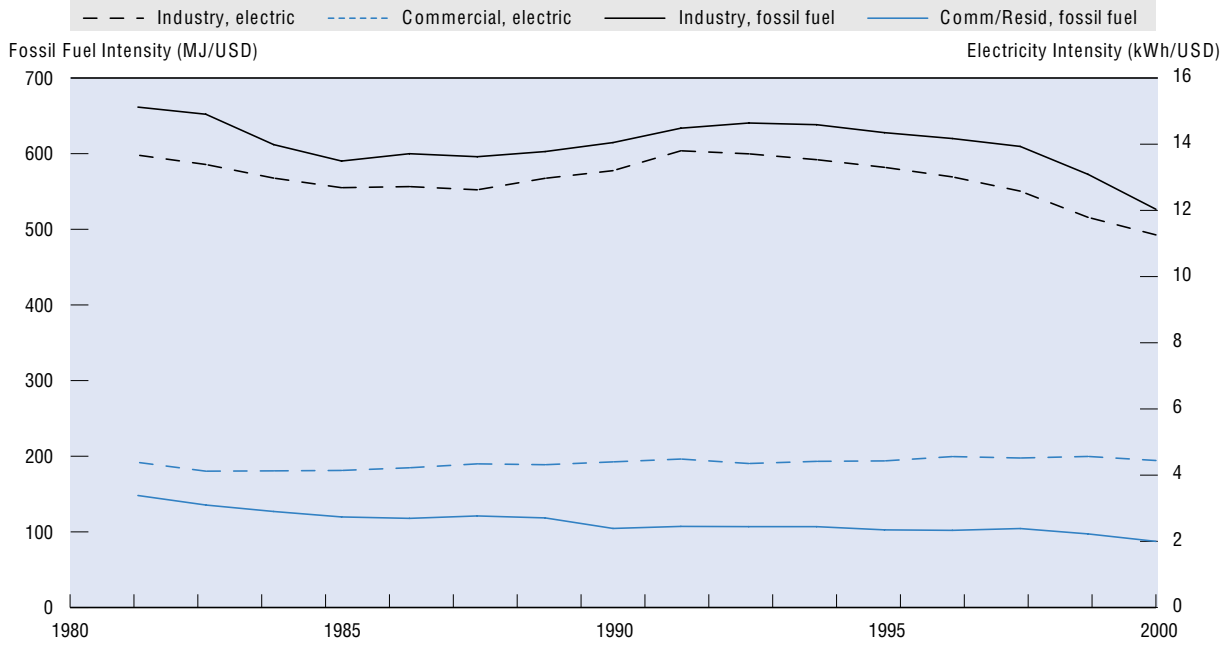
Available data shows further declines in energy intensity in OECD economies due to the shift from manufacturing to services. As shown by trends in energy use in the industrial, commercial and public sectors in OECD countries between 1978-97, services generally use much less energy than manufacturing, about one-third as much in 1997 (Figure 15.3). Since services account for between 50-75% of OECD output, it is clear that they are much less energy-intensive than manufacturing. This is corroborated by data on fossil fuel and electricity use in the United States, which shows that the commercial sector is on average about 17% as fossil fuel-intensive and 39% as electricity-intensive as manufacturing (Figure 15.4).

Figure 15.3. **Energy use in OECD industrial and commercial and public sectors, 1978-1997**



Source: IEA (2000), *Energy Balances of OECD Countries,* IEA/OECD, Paris.

Figure 15.4. **Fossil fuel and electricity intensities of US industrial and commercial sectors, 1983-1998**



Sources: US Department of Energy, *Annual Energy Review*; and US Census Bureau, *Statistical Abstract of the United States.*

Similarly, service sectors are far less polluting than manufacturing and some reductions in overall polluting emissions can be ascribed to the structural shift to services. For example, in the United States, emissions of carbon dioxide have been closely correlated to growth in economic activity. In 1998, however, CO_2 emissions were only 0.4% above 1997 levels, despite weak energy prices and a 3.9% increase in GDP (Wright, 1999). However, part of the growth in services is due to outsourcing from manufacturing enterprises, which may become more environmentally intensive after restructuring. This, and the fact that manufacturing provides intermediate inputs to services, must be considered in examining the environmental impacts of structural shifts in the economy. Also, service sectors may impact the environment in ways that are different in nature but just as severe as those associated with manufacturing; the effects of the service sector on the environment is a subject that needs further study.

ICT-based services

In a third phase of structural change, some believe that shifts within the service sector towards ICT-based services may further reduce adverse impacts on the environment in terms of energy use and pollution. In many OECD countries, investment in ICT equipment progressed at two-digit figures over the past two decades and accounted for 10-20% of non-residential investment in the business sector. The diffusion of ICT accelerated after 1995, as a new wave of information technology based on applications such as the Internet spread rapidly throughout OECD economies. Most ICT investment and use has been in service sectors (OECD, 2000b). However, it is difficult to assess accurately the net effect of this new business model on the environment. Discussions of positive and negative environmental effects generally relate to growth in electronic commerce, which has the potential to reduce demand for certain raw materials (including energy and paper) and waste (through more efficient product design and supply chain management).

First, Internet-based business practices theoretically have potential to improve energy efficiency through effects on retail distribution systems and consumer shopping patterns. For example, a Swedish study found that if Internet food shopping rises to 10% of the market, energy consumption for shopping would fall by 5-7%, with a 4% decrease in CO2 emissions and a 9% decrease in NO_X emissions (Swedish EPA, 2000). Similarly, a US study estimates that by 2010 energy consumption would fall by as much as 1.5% due to substitution of electronic for material products (Romm, 1999). However, others point out that simply selling online can waste energy, particularly if products are shipped by air. Increased fuel consumption by vehicles making home deliveries could also exceed reductions in fuel use resulting from fewer trips to the mall.

There is also the problem of increases in electricity consumption needed to power the multitude of computers, peripherals, servers and other network devices on which electronic commerce is based. It has been suggested that the 100 million nodes on the Internet consume 290 TWh per year, or 8% of total US electricity demand. This climbs to 13% when the electric power to build and operate un-networked chips and devices is included. Some authors project that the Internet will account for half of all electricity demand in the United States within the next decade (Huber and Mills, 1999). Other researchers find this claim significantly overestimates electricity use, and suggest that total Internet-related electricity use is 36 TWh per year, or one-eighth of the previous estimate (Koomey, 1999).

Growth in electronic commerce could possibly result in large reductions in paper use for newspapers, catalogues, directories, direct mail and packaging. Part of this would be due to “dematerialisation” as seen in the downloading of computer programmes and music directly from the Internet, saving in packaging and solid waste. Other savings would stem from reductions in paper use. However, despite previous predictions that the personal computer would result in the “paperless office”, US shipments of office paper actually jumped 33% between 1986 and 1997 (Cohen, 1999). Electronic commerce could increase paper use if consumers print out texts in addition to reading them on-screen. The increasing number of computers and printers in offices can lead to higher paper consumption or “rebound effects” where decreasing materials consumption per unit of production is offset by absolute increases in consumption (Kahlilainen, 2000).

Secondly, electronic commerce may allow for major gains from improved supply chain management, reduced inventories, improved forecasting and reduced mistakes and wasted production. Some studies of electronic commerce find that its environmental benefits depend on whether corporations fully integrate electronic commerce into all aspects of their supplier and consumer relationships. The integrated scenario combines retail online sales (business-to-consumer e-commerce) with electronic procurement of materials and components (business-to-business e-commerce) along with management of products at the end of their life cycle through reuse and recycling.

Growth in electronic commerce can lead to improved product design resulting in less waste, as well as some substitution away from more or less environment-intensive inputs. The Internet has made possible "mass customisation" in place of the traditional mass production model. Companies can find out exactly what product a consumer wants before it is produced, as well as how it is working and what variations or accessories may be needed after it is purchased. The surmised drop in product waste could improve the yield of raw materials (often energy and pollution-intensive) into sold products, as opposed to simply finished products (Romm, 1999). In addition, electronic commerce can allow for the design of more cost-effective take-back and recycling systems.

These electronic-based approaches also help reduce inventories. With falling information costs, some intermediary stages in the product supply chain may be bypassed, reducing the need for duplicate inventory space. Improved inventory management through electronic co-ordination of just-in-time shipment of parts can reduce building construction for inventory warehousing. While lowering land usage and the number of buildings in the retail sector, electronic commerce may also reduce warehouse space, which itself is less energy-intensive than retail or office space.

Policy implications

Environmental management in industry

Policies which promote "market pull" for environmental processes and products (OECD, 2001*b*) can reinforce the recent positive trends in manufacturing. Governments can also enhance opportunities for making eco-efficiency a winning business strategy (OECD, 2001*a*). Eco-efficiency is a management philosophy that encourages business to search for environmental improvements that yield parallel economic benefits. It focuses on business opportunities and allows companies to become more environmentally responsible as well as more profitable. The experience of numerous enterprises shows that preventing pollution and avoiding waste can pay off financially. According to the World Business Council for Sustainable Development, governments can drive the sustainability performance of the entire economy through highlighting eco-efficiency targets such as *Factor 4* and *Factor 10* in industry and other sectors (WBCSD, 2000). According to WBCSD case studies, this calls for increased use of economic instruments and voluntary agreements in environmental policy, a greater environmental dimension to innovation policy, and the elimination of perverse industrial subsidies which distort pricing and negatively affect ecosystems.

Environmental management systems are key to fostering more sustainable practices in the industrial sector. These systems aim to ensure the consistent control of company procedures and operations that can have a significant impact on the environment. International standards such as the *ISO 14000 Series* and the European Union's *Eco-Management and Auditing Scheme* (EMAS) provide model frameworks for enterprise environmental management systems and performance. They call for the development of environmental policies and principles; a review or audit of enterprise activities to identify all environmental impacts; specification of environmental objectives and targets, as well as of a plan to achieve them; audits of the system to ensure effectiveness and compliance; and periodic management reviews to ensure that the system continues to be suitable and effective for the organisation and its goals. However, the propensity for a firm to have an environmental management system in place is related to its financial resources and size. Governments should investigate how such systems can be more widely implemented among small and medium-sized enterprises (Kestemount and Ytterhus, 1997). Some governments are providing incentives

for the development of environmental management systems; for example, the Netherlands and Japan provide certain "regulatory relief" (e.g. extended compliance periods) for firms which have introduced *ISO 14001*.

Reporting, both internally to management and externally to stakeholders, is a key element of an effective management system. Through environmental reporting, firms can use accounting procedures that better integrate environmental costs and benefits with other aspects of the firm's operations, and for easier identification of environment/commercial synergies. Cross-cutting indicators can build a bridge between environmental performance and economic sustainability. The *Sustainability Reporting Guidelines* of the Global Reporting Initiative (GRI) help enterprises report on their environmental, economic and social performance based on related indicators. Corporate environmental reporting is voluntary in most OECD countries. Norway and the Netherlands are two countries having mandated comprehensive environmental reporting by industry.

Governments can also work with the *financial community* to link environment-related performance more effectively to investment worthiness at the firm level. Favourable access to financial resources based on environmental factors is becoming a more important driver of enterprise behaviour. The financial community, including commercial banks and insurers, are increasingly conscious that sound environmental management is a key component of good enterprise management as well as a means to avoid expensive environmental liabilities (e.g. accidents). Studies show a strong correlation between the eco-efficiency measures of a company and its competitiveness and financial performance. Investment companies such as Dow Jones and Innovest are developing environmental and sustainability rating systems for enterprises. The *Dow Sustainability Index* evaluates companies on their efficient use of resources and other environmental and social criteria. Governments can encourage better corporate environmental reporting and management and help raise the profile of environmental factors in financial analysis. These measures, coupled with more market-based approaches in environmental policy and innovation policy tools (e.g. research and development, technology diffusion), will be most effective in putting industry on a sustainable basis.

Environmental policy approaches

More innovative, diversified and market-based environmental policies are needed to achieve fully sustainable practices in industry. Different approaches are needed to stimulate the next wave of technology development required to address the ongoing environmental impacts of manufacturing, particularly greenhouse gas emissions and toxic releases. Such packages would combine a robust regulatory framework with the removal of distorting subsidies, more systematic use of taxes and charges, tradable permits, voluntary agreements, and eco-labels and other information-based incentives. The emphasis should be on getting markets to work for the environment and promoting "win-win" behaviour by industry.

Firm surveys show that, in the past, environmental regulations have been an important force in reducing pollution from OECD manufacturing. For example, a survey of 3 000 manufacturing firms in 10 European countries found that the most important factor affecting their environmental performance was national regulations, followed by management and customers (Kestemount and Ytterhus, 1997). Iron and steel, pulp and paper and chemicals are among the manufacturing sectors where increased resource and energy efficiency and improved production techniques are significantly reducing resource use and the pollution and waste emitted per unit of output. However, environmental performance has not been uniformly positive across all manufacturing sectors and all OECD countries. In addition, there are serious concerns about the hazardous waste and toxic pollutants emitted from manufacturing facilities which may have negative effects on human health (OECD, 2001*c*).

In manufacturing, there is more scope for the use of economic instruments — such as taxes and emissions trading — to stimulate better market functioning and trigger enterprise responses to environmental challenges. Carbon taxes are an important mechanism for reducing greenhouse gas emissions from manufacturing and meeting Kyoto Protocol targets for addressing climate change. However, in many countries

applying carbon taxes, energy-intensive industries such as chemicals and iron and steel have been exempted primarily due to competitiveness concerns. Such exemptions can disadvantage other domestic industries or activities with respect to the protected sectors and increase the overall costs of addressing environmental problems. To reach a given level of pollution abatement nationally, exempting some activities means that the tax rate or degree of regulation will have to higher in those sectors where it is applied. This asymmetrical treatment is inefficient as it places the main burden of carbon reduction on the less polluting sectors of industry. Economic instruments such as environment-related taxes should be extended to all sectors of manufacturing, and alternative means (including more international co-operation in levying taxes) should be found for offsetting price effects or adjustment costs.

In many manufacturing sectors, voluntary agreements are being used in addition to regulations to encourage early environmental compliance by industry. These agreements are typically negotiated between governments and companies with specific targets and time schedules. A failure to reach environmental goals can increase the risk of new regulations. Firms value these agreements due to their flexibility, and they can be useful in new and poorly understood policy areas. However, evidence is mixed regarding the effectiveness of voluntary agreements, which have been found to have modest environmental impacts (OECD, 1999). The transparency, goals and incentive structure of voluntary agreements generally need to be enhanced. In order to stimulate further technological changes in manufacturing and make the transition to a lower-carbon economy, voluntary agreements should be used as part of a policy mix including regulations and economic instruments.

Since achieving enhanced environmental performance in OECD industry requires new and innovative processes and products, environmental policy should be integrated with technology and innovation policy instruments (OECD, 2000*a*). In some cases, improved environmental performance can be achieved by more widespread diffusion of existing technologies such as energy-saving techniques. In other cases, entirely new processes may be needed to radically reduce energy and material inputs, such as biotechnology-based processes in chemicals and pulp and paper (Griffiths and Wald, 2000). Green product design — for items ranging from refrigerators to automobiles — can be the most innovative way to reduce waste and pollutants. Behavioural changes on the part of consumers are also needed to stimulate demand for alternative goods and services. Overall, innovation policy (including programmes for basic research, technology development and diffusion, networking and clusters) should reinforce environmental policy in encouraging a shift from end-of-pipe solutions, via process improvements, to genuine technology shifts in industry in the interest of sustainable development.

NOTES

1. Major energy and water consuming sectors tend to be chemicals, ferrous and non-ferrous metals, pulp and paper and food-processing.

2. Carbon dioxide, methane and nitrous oxide.

3. It is estimated that manufacturing is responsible for 17% of OECD greenhouse gas emissions, compared to 28% for energy industries and 23% for transport.

4. In the United States, for example, air emissions in manufacturing declined between 9% (NO_X) and 75% (particulates) in the period 1980 to 1998, while industrial production rose 65%. In 1998, manufacturing emissions accounted for 36% of total VOC emissions, 22% of SO_2 emissions, 16% of NO_X emissions, 7% of CO emissions and 4% of particulate emissions. The metals processing sector accounted for 10% of manufacturing emissions of the five gases in 1998, 66% in the form of CO. Similarly, the chemicals sector accounted for 9% of manufacturing emissions of the gases, 55% in the form of CO. Petroleum refining, pulp and paper, and cement and other minerals production were the next largest industrial sources of the five pollutants. Solvent use accounted for 14% of emissions, and nearly all of it in the form of VOCs.

5. Pinch Technology is a methodology, comprising a set of structured techniques, for the systematic application of the first and second laws of thermodynamics.

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Chapter 16.

TERRITORIAL DEVELOPMENT

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TERRITORIAL DEVELOPMENT

Introduction

The territorial organisation of economies and societies is today undergoing dramatic change. Globalisation, technological innovation, sectoral adjustment, migration, and population ageing make it increasingly difficult to predict the future of *places*. Economic change tests the ability of all regions to compete; the gap between leading and lagging regions in terms of growth, income and employment is widening, as are gaps within regions. Social change tests the cohesion of communities, as patterns of exclusion related to employment, income and changes in the structure of families can be aggravated by territorial trends such as urban sprawl, distressed areas, and rural depopulation. Environmental factors test the ability of national and local governments to manage resources in a sustainable manner and to maintain and improve the quality and safety of life, in areas of both economic growth (congestion, pollution, contamination, waste generation) and decline (abandoned urban and rural land, degradation of the built heritage, lack of investment in environmental management, etc.).

The emergence of a borderless economy does not imply that cities and regions are the same everywhere, but that their distinctive characteristics can become comparative advantages economically, socially and environmentally. Increasing decentralisation and devolution mean that territories also have more responsibility for managing their assets, and for implementing national policy objectives.

How is this context relevant for sustainable development? Unsustainable patterns can result from ignoring large differences among territories which national trends often conceal. Some specific issues which cannot be addressed by uniform national policies include the conservation of rural amenities, whose values are generally not reflected in market prices; urban challenges such as congestion, waste and water management; the growth of distressed areas; and the loss of greenfields and open space. Many territorial trends that imperil sustainable development also damage the competitiveness of cities and regions; equally, remedial and preventive measures which protect and improve the environment and quality of life in regions contribute to sustainability. As noted in previous chapters of this report, sectoral policies have territorial and land-use dimensions which need further consideration. It is important to get things right at the local and regional levels in order to achieve national and international goals.

Territorial development includes social, economic and environmental aspects of sustainable development at the sub-national level. The positive impact of territorial development policies comes in part from the fact that cross-sectoral integration takes place, often quite literally, on the ground, and is reflected in the spatial arrangements that transform the functional dimensions of different sectors (transport, energy, housing, etc.) into liveable places. Territorial development provides a framework for linking environmental, social and economic aspects of sustainability.

Progress toward sustainability will require change in the organisation of cities and regions, in the management of their natural resources — including their demand for energy — and in land-use patterns. The lessons of recent years indicate that the cities, communities and regions of developed countries can be modified and improved, but this often takes decades. Significant modifications can provoke public opposition, and often require both public and private investment, as well as changes in the behaviour of individuals and enterprises.

Governments have only recently begun to re-examine traditional spatial planning, land use, and social and economic development policies in an effort to meet these challenges. Territorial development policy emerged in the early 1990s when many Member countries introduced or expanded area-based policies and programmes, and tried to improve their capacity for cross-sectoral policy implementation. Increasingly, obstacles and problems at territorial levels are addressed through policy intervention, rather than tolerated as part of the cost of social and economic change.

A major challenge is to develop a coherent strategy that operates effectively at international, national and local levels:

- Territorial trends widely recognised as unsustainable (such as urban sprawl or the loss of rural amenities) have significant spillover effects, and cannot be addressed effectively at the local or regional level in the absence of sound national policies.

- A successful policy mix will combine national policies, local initiatives, and implementation strategies that are effective across different levels of government, and across administrative or jurisdictional boundaries at the sub-national level.

- To achieve policy coherence, the territorial impacts of national economic and sectoral policies need to be identified, and addressed in national policies.

- An area-based approach connects the environmental, social and economic aspects of development. Territorial development policy is the only policy field in which the spatial aspects of different sectors, and hence the spatial organisation of the economy, are explicit.

- Governance issues are critical to improving vertical and horizontal co-ordination, co-operation with the private and community sectors, and the capacity of sub-national authorities to meet the obligations of international treaties; they can also prevent competition between territories for jobs and investment due to differences in environmental standards.

- Top-down, technocratic strategies alone appear unable to generate a reassuring vision of the future on which an overall development strategy can be based. Territorial policies respond to the requirements for ecological sustainability and to the demand of people for places that combine economic opportunity with a higher quality of life.

This chapter considers why and how territorial policy can contribute to the goals of sustainable development, based in part on the importance of cross-sectoral integration and on the roles and responsibilities of different levels of government. It identifies some of the obstacles to better policies and highlights the lessons that can be learned from innovations in policy and practice, mainly at the local and regional levels. Finally, it addresses national measures to implement policy objectives, with special attention to spatial issues and policy implementation mechanisms.

From a remedial to a proactive approach

Many environmental policies have roots in efforts to remedy conditions at the territorial level, where many problems are concentrated. Frequently this remediation has involved addressing the legacy of economic activities from the past, when neither technological systems nor regulatory and pricing mechanisms coped adequately with the externalities of production and consumption. Much progress has been made in recent years as the lessons of past policy and market failures have been applied to better planning and to the use of economic instruments.

Regions may be classified for analytic purposes according to their population density as metropolitan, intermediate and rural. There are leading and lagging regions in all three categories. This typology is further

complicated by topographic variation, stretching from mountainous to coastal regions, and from arid regions to regions subject to severe flooding. There are 500 major regions in OECD countries, and 2 500 smaller ones. Each of the three categories of regions face different problems:

- Metropolitan areas (where 40% of the OECD's population lives) confront problems of urban sprawl, abandoned industrial sites, enclave communities and other manifestations of a spatial-social fracture, and multicultural integration of people from 100 or more nationalities.

- Intermediate areas (32% of OECD population) face problems of inadequate economic diversification, and of declining quality of life due to spread of urban problems.

- Rural areas (28% of OECD population) confront problems of depopulation and decline of traditional activities, conflicts over land use associated with tourism, loss of rural amenities, needs for improvements to quality of life, and impact of uncontrolled urbanisation.

The variety of regions and places within Member countries is a major factor in the emergence of territorial development policies. Carrying capacity refers to the limits within which any given place can handle the environmental consequences of activities. Although adjustments, technological improvements and substitutions can improve the performance of a given locality, this capacity varies across space. Precisely because conditions vary widely, not only from one region to another, but even within a single region, national policies that set uniform standards or targets may be inappropriate at best, counter-productive at worst. Macroeconomic and sectoral policies can rarely take full account of the varying density and uneven spread of positive and negative effects within a nation (e.g. employment, pollution).

Difference among and within territories should be viewed as a strength, not a liability. Sustainable places have a capacity for renewal, whether by generating firms and creating jobs; integrating people into communities and reducing disparities; improving quality of life; or maintaining and enhancing cultural and natural amenities. These aspects of economic development highlight the importance of social capital that is rooted in the culture and traditions of a particular place. Social endowments take on greater significance in territories that do not enjoy a comparative advantage based on fortuitous geographical location (e.g. at the confluence of two rivers) or endowment in natural resources (e.g. coal). A territory with a diversified social and economic base is more able to respond to external shocks than a more homogenous and specialised one.

Territories can become laboratories where new approaches and solutions can be developed and diffused, a phenomenon that has been a long-standing feature of policy innovation in many federal states and is increasingly recognised in centralised ones. Territorial development policy is relevant to all territories, not by imposing a single model for development, but by helping each to enhance its particular strengths and address its problems. Indeed, in many countries, regional and municipal authorities are further ahead than the central government in the design and implementation of strategies for sustainable development.

The need for an integrative, cross-sectoral approach

The territorial dimensions to the challenge of achieving policy coherence include:

- *Lack of co-operation and of a shared strategy across jurisdictions.* Metropolitan areas, which are often composed of more than fifty individual municipalities and can even spill over regional boundaries, are particularly complex to manage: the selection of major infrastructures, or options over environmental strategies, can provoke long-lasting conflicts which impede progress toward sustainability by delaying needed investments. In some rural regions, depopulation and low density can make projects too costly to finance without support from higher levels. Increasingly, solutions to problems that spill over jurisdictional boundaries require a sharing of authority and of resources to work.

- *Mismatch between roles and objectives at different levels of government.* The principle of subsidiarity means that decision-making is brought to the level at which the people most directly concerned can take more

responsibility. Local and regional problems however are not necessarily easier to solve at lower levels of government. Effective solutions will depend on setting framework policies and objectives at the regional and national levels, and on distributing roles and responsibilities in a way that is consistent with the resources and opportunities for initiative available at each level. But frequently, national governments transfer responsibilities for carrying out environmental or social policies, without adequate resources ("unfunded mandates"). They may even set objectives and priorities which do not meet local conditions. It is worth observing that economic instruments are sometimes easier to introduce at the central level, and regulations easier to apply at the local level.

- *Compartmentalised approach to administration and policy at each level*, and lack of assessment of the territorial impacts of macroeconomic, fiscal and sectoral policies. A compartmentalised structure can inhibit creative problem-solving. Many sectoral policies, including housing and transport, but also energy and environment, industry and trade have spatial impacts that are unintended. Certain fiscal measures or subsidies, such as tax relief on interest payments for mortgages or a low tax on energy, have been linked to patterns of low-density housing that use land inefficiently and increase car use. Road building programmes to alleviate traffic congestion only redistribute traffic further afield, often leading to increased energy use and pollution. The quality of schools or access to health services have an impact on where people choose to live, often in patterns which reinforce segregation based on income and which limit opportunity to the most vulnerable in society. Policy coherence is more difficult to achieve when these spatial impacts are ignored. Methods to improve territorial impact assessments are therefore a priority.

Examples of potential policy contradictions and unintended territorial effects of sectoral policies can be found in all countries. Support policies linked to the quantity of agricultural production have exacerbated the tendencies to intensification and accelerated the loss of valued natural environments, landscape and habitats. Large public works and infrastructures (like those for energy and transport) have major effects on decisions of where to locate and invest. They also have environmental consequences that are not fully understood or anticipated when the works are planned, and are not covered in most cost-benefit analyses. Efforts to promote tourism can compromise unique and fragile environments. Property rights can frustrate efforts to restrain new housing developments in sensitive locations. Planning policies that have produced rapid urban growth have led to the depopulation of other areas, and to unsustainable settlement patterns.

Efforts to improve policy coherence bring to light the connections between the economic, social and environmental aspects of development. There is often a correlation between the socio-economic profile of a place and its environmental problems. Issues of environmental justice arise because people living in distressed urban areas are likely to be exposed to higher levels of toxic waste and contaminated land, polluted waterways, air pollution, and noise, as well as substandard housing and crime. Many rural areas are afflicted by a combination of similar problems. Conversely, the experience of local and regional development shows that environmental improvements may lead to economic and social development, attracting new jobs and investment (Brown, Dühr and Nadin, 2001).

Widening social disparities — incompatible with sustainable development objectives — are a function of inadequate skills for today's economy, poverty, and spatial patterns that isolate people from jobs. At the very least, affected individuals may lack the financial and institutional resources to solve problems made more severe by the effects of spatial concentration. Areas of high unemployment and disadvantage are increasingly found in close proximity to areas of high growth, and are often part of the same region. These are neither isolated phenomena, nor the inevitable consequences of growth about which little can be done, but rather manifestations of dysfunctional patterns of growth and change at local and regional levels often resulting from shortcomings in national policies.

Distressed areas are those where the loss of resilience inhibits recovery, places whose decline can compromise the growth of a wider region. People living in distressed urban areas (between 7% and 20% of many major urban centres) represent many different socio-economic backgrounds. Many have average, or above-average, incomes. Racial and ethnic discrimination, however, often interfere with mobility. Those

living in a distressed urban area will have more difficulty finding employment than someone with similar qualifications living elsewhere. Yet because it is can be difficult for people to relocate from such areas, the downward spiral by which distressed areas form is often self-perpetuating. In the United States, for example, concentrated poverty, population decline, and the departure of middle-class families to suburbs make it difficult for cities to make the improvements — in jobs, housing and education — that are necessary for their recovery. Although central city poverty rates have fallen since 1993, the percentage of urban families living in poverty is twice that of suburban families, and the gap is widening for minorities.[1] Worst-case housing needs[2] rose between 1993 and 1995. A recently completed EC Urban Audit shows that European cities also bear the brunt of unemployment and poverty: the income of about 25% of urban households was less than 50% of the national average.

A sectoral approach to these problems cannot leverage local resources to rebuild communities as effectively as one that makes the links between environmental improvements, investment and job creation, and social cohesion. Short-term pressures to meet economic objectives often lead to long-term costs as localities make trade-offs between competitiveness and sustainability (OECD, 2000). Integrative, cross-sectoral approaches have much greater potential for achieving cost-effective results than those which treat environmental, economic and social issues separately.

The challenges of restoring the land and improving the built environment

The fact that human settlements and most productive activities are concentrated on a relatively small portion of the landmass gives rise to the misperception that land is abundant. Predominantly urban regions account for 4% of the total OECD area, and intermediate regions another 10%. Some Member countries with large deserts or mountainous areas (such as Korea, Switzerland, Canada, and Australia) have very little land available for residential use. Land is in fact a scarce resource, not only because there are often competing demands for its use, but also because land use is so difficult and costly to change. The costs of the neglect of land, of its misuse and of its ruin, need to be considered when looking at the risks associated with overall patterns of territorial development. More flexible spatial planning systems are needed to make the built environment easier to renovate and adapt over time.

National policies that either ignore the spatial impact of sectoral initiatives, or treat all places alike, are unable to address problems in their spatial context. Spatial planning has not always offset these deficiencies. Indeed, it may have exacerbated them by concentrating on the supply of land and on the location of different types of facilities (housing, factories, stores, etc) using a static, mono-functional model, rather than by taking the dynamic inter-relationships of different types of spatial use into account. Regulatory and planning instruments, often reinforced by fiscal measures, can perpetuate the status quo, thereby closing off certain options (OECD, 1996).

Traditional spatial planning has largely been concerned with indicating where major material investments should go, usually without regard for the impact of this development beyond the locality in question. Yet many of today's major environmental and social problems involve spillover costs, whether in the form of transport congestion, noise, air pollution, and waste disposal, or from such things as insecurity and underemployment. For example, at the rural/urban interface, the encroachment of urban development can induce an increase in the price of adjacent rural land, whereas tourism and other economic activities can affect fragile ecological zones, including seacoasts. Spatial planning is often shaped by pressures to put short-term, highly mobile economic needs and investments ahead of medium or long-term social and environmental objectives.

Short-term planning also affects the application of precautionary approaches, as shown by efforts to address risks of natural disaster. Natural catastrophes compromise sustainability, not only through loss of life and property, but also by causing pollution when industrial facilities and essential public services are destroyed. Disaster management has typically focused on relief once a catastrophic event has occurred. Often, however, the impact of a disaster reveals shortfalls in prediction techniques, planning and building standards, and risk management. Rebuilding on more sustainable lines after a disaster is often compromised

by financial and regulatory pressures to replace what was lost and to help local economies recover quickly. Taking the time required to make changes that reduce future risks — incorporating lessons learned and adopting best practices — can help create the higher level of security the public now expects from government.

Many environmental policies have been introduced to cope with problems caused by previous land-use decisions and past economic activities. Yet the lessons of past policy and market failures need to be applied to the design and implementation of new, more pro-active approaches.

Buildings and districts can last for decades, surviving long after the economic, social and technological conditions applied at the time of their construction have changed. Sometimes historic areas survive because of the amenities they offer and because they have adapted to local social and economic conditions. By contrast, much recent construction (such as social housing and office buildings from the 1950s-70s) is characterised by premature obsolescence due to a lack of quality and adaptability. These factors contribute to an early decline in values and investment in areas that often have a high level of infrastructure and other public services.

Some argue that the spatial pattern in market economies reflects consumer preferences. This point of view, however, fails to acknowledge the extent to which regulatory and fiscal measures limit what can be built and where. What people want is in fact highly contingent on what they have come to expect. As a result, property and construction firms are less likely to innovate or invest in research.

About 1% of the built environment is modified annually. The spatial structure of streets and properties, which is often stable for a generation or more, can be very costly to modify. This *inertia* means that more than 80% of what will exist in cities and regions in 2020 is already built. Rebuilding places as they are — a major challenge for sustainable places in the 21st century — involves the difficult problem of adjusting building standards, zoning rules, codes, and fiscal measures to promote innovation for both new and old buildings and areas alike.

Previously developed land is being abandoned at the same time as greenfield sites are urbanised, an example of policy conflict in many countries. As jobs and housing spread outward, large, already developed urban areas are not being maintained or renewed, and are sometimes just abandoned.

The deconcentration of urban areas means that overall, population densities are falling (Box 16.1), sometimes dramatically, while travel times and distances are increasing, with significant consequences for land use, energy consumption, noise levels, and air and water quality.[3] This phenomenon, generally referred to as "urban sprawl", significantly complicates efforts to reduce car dependency and transport-related aspects of energy consumption, air pollution, and land deterioration.

Box 16.1. **Urban deconcentration**

During the past hundred years, the surface of urban land per capita in Europe has increased tenfold. A study of 132 cities over the 1970s-90s prepared for the ECMT/OECD study on urban travel and sustainable development (1995) showed that, on average, a population increase of 10% leads to a 51% increase of occupied surface area. The US Fish and Wildlife Service reports that urban and suburban development contributed to 21% of the loss of wetlands between 1985 and 1995. In the region of Toronto (Canada), the outer edge supports 1 376 people per square kilometre, the inner core, 6 000; 36 hectares of rural land are developed for each 1 000 people newly accommodated in the region.

Source: OECD (1998), *Report on Urban Brownfields*, Paris.

The OECD study of urban "brownfields"[4] suggests that some countries do not even know the scale of this problem; when the problem is assessed, the number of sites can run into tens of thousands of hectares. There are at least a million brownfield sites in Member countries. There are, however, no international obligations on national governments to maintain registers of brownfield land, nor international standards for land remediation: information on both impediments to remediation and its benefits is insufficient. The lighter regulatory burden for greenfield development also discourages the remediation of brownfields.

Data from the United States indicates that one building is torn down for every six houses or apartment buildings constructed, equalling about 150 000 demolitions per year. An estimated 15%-20% of waste going into landfills comes from construction and demolition debris. Regulations and standards concerning the use and recycling of construction materials may reduce waste generation from demolition and increase its recycling. The scale of demolition might be curbed by planning strategies and fiscal incentives that emphasise market-based re-development on previously developed sites, including the renovation of existing buildings.

Sustainable construction and design could yield an economy of at least 5% in energy use (OECD, 1993). But the sheer size of the construction sector in terms of employment, its fragmented nature, and the low level of investment in research are obstacles to innovation. Governments can set an example by setting sustainability objectives for site selection and use of buildings, in addition to the solely commercial price criteria currently used in many OECD countries.

Although much of the illustrative material in this section relates to urban problems, rural areas also confront specific challenges associated with land use. These include: (*i*) loss of open space and farmland due to urban sprawl, population deconcentration and structural change in the agricultural sector; (*ii*) inadequate levels of water quality and waste management; (*iii*) salinity and erosion of the soil; (*iv*) shifts in population, which expose small towns and villages to decline; (*v*) the concentration of some services for health and education in major urban centres; (*vi*) car dependency; (*vii*) agricultural practices which generate environmental problems; and (*viii*) an inadequate supply of amenities to promote rural development. The "drivers" for the development of territorial approaches in rural areas vary from place to place and have changed over time.

Identifying, measuring and mapping poverty and social exclusion in rural areas is more difficult since individuals and households are widely dispersed. Poverty and social exclusion may be offset by favourable environmental conditions and strong community solidarity. Some changes affecting rural areas positively are the growth in demand for tourism and leisure on the part of urban residents; growing consumer demand for local produce; the diffusion of new communication technologies; and a cultural shift towards greater appreciation of the quality of life available many in rural areas.

Changing policy priorities

Environment Ministers are increasingly recognising this challenge.[5] Because urbanisation in developing countries will be one of the major influences in the 21st century affecting progress toward sustainability, the experiences of OECD countries may yield valuable lessons on what to do, and what not to do in the pursuit of a more balanced pattern of development.

The integrated planning and management of land resources, advocated in Chapter 10 of Agenda 21, was the theme of the eighth session of the UN Commission on Sustainable Development (April/May 2000). Acknowledging the rapid and uncontrolled growth of urban and peri-urban areas as one of the "hot spots" of land degradation, the *Decision on Integrated Planning and Management of Land Resources* adopted by the CSD calls on governments to pursue "strategic planning approaches aimed at managing urban growth and limiting urban sprawl" and to support "sustainable land use practices that promote interaction between urban and rural areas." Integrated land-use planning and management are relevant for the implementation of several international agreements.[6]

A shift from remedial to proactive approaches requires several of the changes in policy direction already identified above. These include re-using previously developed land, renovating and upgrading the existing building stock, and establishing spatial and infrastructure systems that enhance accessibility rather than increasing distance travelled. These will bring greater recognition of the benefits to social cohesion and economic development that can come from environmental improvements. In simple terms, people and places need a strategy for the future.

Key issues in territorial development: strategies for people and places

Territorial policies, which respond to the needs and strengths of particular localities, are not only complementary to macro-level measures but essential for the successful implementation of both national and international sustainable development policy goals. Moreover, local and regional activities are increasingly important in the formulation of national policies, especially where they offer opportunities for civil society to influence national priorities at the local and regional levels. While many local environmental initiatives have evolved to tackle specific problems concentrated in particular areas, it is evident that they are now also responding to the sustainability agenda.

Strategies for local sustainability

Agenda 21 from the World Summit on Environment and Development (1992) provides the framework for the development of local Agenda 21 (LA21) strategies for the implementation of sustainable development objectives. These strategies depend upon action at the local level. Chapter 28 calls upon local authorities to work with their communities to prepare LA21 plans and local strategies for sustainability.[7]

Developing these local strategies involves integrating sustainable development goals into a local authority's policies and activities. A range of successful examples are provided in Box 16.2. Agenda 21 has placed political obligations on national governments, while leaving local authorities scope to determine what is needed to move their areas toward sustainability, and to develop more integrated approaches to their main economic, environmental and social activities.

Efforts like these are encouraged by various international networking organisations and forums. In Europe, the largest initiative for local sustainability is the *European Sustainable Cities and Towns Campaign*,[8] which now has around 800 local and regional authorities as members. This initiative supports the objectives for sustainable development set out in the Treaty of the European Union and the fulfilment of international obligations.

The production of local strategies and action plans for sustainability is encouraged by most national governments (Lafferty, 1998; Lafferty and Eckerberg, 1998). National associations of local and regional authorities have published guidance and promoted the exchange of experience. Progress on LA21 has been particularly marked in some countries within federal government systems, or where regional government structures are strong. Regional governments may also co-ordinate and support local efforts, generally in partnership with regional associations of local authorities.

Areas with particular environmental or geographical features — such as valued landscapes or habitat, islands in peripheral coastal areas, mountainous regions and coastal zones — often receive special policy treatment. The success of local economies and the quality of life of residents in these typically fragile environments depend upon sensitive management. Furthermore, such regions often extend across national or regional boundaries, or mark these boundaries, posing particular problems for management.

Coastal areas, for example, face many interrelated problems, ranging from erosion, loss of biodiversity, habitat destruction and water pollution to the decline of the fishing industry and uncontrolled urban sprawl. Many problems are the result of existing policy and management systems. Typically, different administrations and agencies have overlapping jurisdictions in coastal regions, and various sectoral policies overseen by

Box 16.2. **Implementing Agenda 21 at the territorial level**

The Municipal Government of *The Hague* (the Netherlands) aims to create a sustainable city with the co-operation of all who live and work there. Residents, business associations and many others participate in work groups which develop projects on themes such as nature and landscape, waste and raw materials, energy and health. Their activities are overseen by a Managing Committee composed of the mayor and municipal councillors responsible for relevant departments of the city council. Progress toward sustainable development is assessed using an innovative "environmental thermometer", developed by the city council, which allows measurable changes in environmental conditions to be publicly displayed.[9]

Calvia, Majorca (Spain) a resort that was suffering from declining competitiveness and tourist appeal, compounded by environmental problems, has developed a long-term strategy for the sustainable management of its local area based on Local Agenda 21 principles and processes. Municipal administrative structures have been modified to build in community consultation. A range of actions identified in collaboration with citizens is now being worked into the municipality's main programmes.

The State and the Local Government Association of *South Australia* have established a "Partnership for Local Agenda 21" which supports action in municipal and rural councils. This has contributed not only to a relatively high take-up of LA21 in terms of declared political commitment, but also to the adoption of strategies for biodiversity, climate protection, water, waste and coastal areas; of "State of the Environment" reporting and of environmental management systems; and integration of LA21 principles into corporate planning.

Norway is unusual in the development of a county-level version of LA21. Innovative forms of community participation are applied at the county level, and "regional nodes" have been established to promote and co-ordinate local efforts. These activities are having an important role in rejuvenating regional democracy and in re-orienting regional policies toward a more holistic, ecosystems perspective.

In the *United Kingdom*, the Local Government Act (2000) places a statutory obligation on all local authorities in England and Wales to prepare a "community strategy" to promote the economic, social and environmental wellbeing of their area, and to contribute toward sustainable development nationally. Community strategies are expected to contain a long-term vision, focusing on outcomes, an action plan identifying short-term priorities, shared commitment by an alliance of partners to deliver the action plan; and effective arrangements for monitoring and review.

In the Australian state of *New South Wales*, local governments have statutory obligations to include ecologically sustainable development (ESD) principles in the performance of their functions, and to provide ESD and State of the Environment reports in their annual reporting cycle. All federal agencies will be required to report on the inclusion of ESD principles in policy outcomes in their Annual Reports beginning in 2000/01.

Source: European Commission, *Good Practices in Urban Management and Sustainability*, *<europa.eu.int/comm/urban/>*

them have had unintended negative consequences. The need to move toward integrated approaches that can respond to the complexity of issues *on the ground* has been recognised for some time. Integrated Coastal Zone Management (ICZM) is now well established in several OECD countries, such as Australia and the United States, and sustainable development objectives are now often built into ICZM strategies. The emerging European strategy for ICZM places particular emphasis on "sustainability" policy processes — such as the application of all available policy instruments and effective community participation — and on the role of local and regional authorities in strategy formulation and implementation.

In general, LA21 has widespread endorsement because it is seen as enabling local and regional authorities to build their capacity to manage their own organisations and areas in ways that are more economically, socially and environmentally sustainable, resulting in positive impacts. However, demonstrating precisely what these impacts are has been hampered by the lack of suitable measurement tools. Assessments

have focussed more on processes and organisational aspects than on outcomes, such as environmental improvements or socio-economic benefits, at the territorial level. This is now changing as the extensive work on developing and using local indicators for sustainability becomes increasingly embedded in routine performance measurement and other impact assessment work, and as new ways are found to monitor the effects of integrated actions. For example, the *European Common Indicators for Local Sustainability* project emphasises integrated — rather than single measure — indicators, including several relating to land use.

Local and regional policies for economic and social development

Comparable shifts are occurring in local and regional policy towards economic goals and social development. Local and regional economic development initiatives have a long history in most OECD countries. The effects of both macroeconomic and sectoral policies become real at the local level. Policies for local and regional development can help better integrate these effects and remedy unwanted or unforeseen results. In the 1990s, the sustainability agenda has had a considerable impact upon well-established local and regional activities. The main trends include:

- The "greening" of local economic development — primarily by simultaneously improving economic competitiveness and environmental performance of enterprises (so called "win-win" strategies), by introducing environmental management systems and green local purchasing policies, by fostering firms specialising in environmental technology, and by marketing cities on the basis of their environmental quality.

- Promoting job creation through environmentally friendly activities (green jobs) or by addressing unmet social needs, especially by utilising community-based sector solutions (e.g. home-based services, recycling programmes, drug prevention).

- A shift from inward investment to diverse "home-grown" solutions, and to support for small and medium sized enterprises (SMEs). The emphasis is now on "endogenous" approaches which focus on retaining and expanding existing businesses and on promoting start-ups, usually via a range of instruments such as financial and technical assistance, business incubators, export promotion initiatives, and in some areas, the targeting of specific sectors.

- Changes in the processes by which local and regional strategies are formulated and delivered, including partnership across public, private and community sectors.

In some countries, particularly in northern Europe, measures to "green" the local economy are based on the goal of de-coupling economic growth from environmental pressures. The key principles of achieving the maximum economic benefit for each unit of resources used, and of maximising the rate at which resources are re-used within production processes, underpin strategies to reduce use of resource and energy inputs, prevent waste, and reuse/recycle materials. These actions are designed to minimise the "ecological footprint" of economic activities on the territories in which they are located, to ensure that carrying capacities are not exceeded. Such strategies are attractive — commercially and environmentally — because they also promote cost savings, innovation and competitiveness for both cities and the businesses based in them.

At least two European countries (Sweden and Germany) now have legislation to promote ecocycles approaches. Solutions based on the notion of eco-industrial networking, in which several companies work together to improve both environmental protection and competitiveness in all participating enterprises, fit this model (Box 16.3). The most recent and radical solutions promote "zero emission" production zones.

An ecocycles approach, when applied to the understanding of how local economies function, can prevent the leakage of jobs, savings and investments from a locality. Businesses are encouraged to purchase from local suppliers and to recruit local labour where possible. Municipalities are encouraged to find tax-efficient methods for cross-subsidising public services. Retaining local financial services (including

Box 16.3. **An example of an eco-industrial network**

In the city of *Juvaskyla,* Finland, energy generation and heat distribution companies, paper mills, a plywood producer and a horticultural centre are partners in an eco-industrial network. District heating is provided by the Rauhalahti CHP Plant, which uses local milled peat and wood as the principal fuels. A second CHP plant and waste heat from the paper mill supplement this main source. The main users of electricity supplied by these power plants are the city and the paper mills. Ash produced at the Rauhalahto plant is used in parks and gardens, including the horticultural centre (Viherlandia) — an important tourist attraction. The results of this collaborative effort include reduced fuel consumption; reduction of 30% to 50% in sulphur dioxide and NO_X emissions (with resulting improvements in local air quality); lower production costs for the energy companies (since heat is sold, in addition to electricity) and reduced costs for consumers.

Source: European Commission, *Good Practices in Urban Management and Sustainability,* europa.eu.int/comm/urban/

banks), and establishing community credit measures (such as Local Exchange and Trading Schemes, LETS) can help build such an approach in disadvantaged neighbourhoods, whether urban or rural.

The OECD has been active in supporting such trends in the greening of enterprises through the use of *environmental management strategies.* There is now the additional opportunity to support the development of *sustainability management systems*, as firms seek to link socially-responsible employment practices (increasingly required by law through, for example, equal opportunity legislation) to good environmental management.

An important driver for more socially-oriented local economic and employment strategies has been the growing concern, on the part of most OECD governments, to find more effective ways of tackling poverty and social exclusion. Local governments and agencies have developed their own policies to promote the inclusion of marginal groups — such as young people, the frail elderly, and minority ethnic groups. In some cases, these policies are now part of overall strategies for regeneration, along with business support.

Especially promising are measures to encourage entrepreneurship and new business creation; locally managed labour market measures, to help the unemployed to overcome barriers to work (Box 16.4); and the support of "third sector" organisations that create routes to work at the same time as providing welfare services for local communities.

Box 16.4. **Labour market initiatives**

Glasgow Works, operating since 1994, is one of a range of initiatives put in place to tackle problems resulting from the decline in heavy manufacturing industry (principally ship-building) in the region. An intermediate labour market initiative — funded by the European Union, the local business community and local and regional government agencies — it provides project work for the long-term unemployed, equipping them with the skills and self-confidence to re-enter the labour market. Project-ideas worked up by the project team are contracted to small local partnerships led by voluntary organisations, companies or colleges. The project team puts together funding packages, recruits potential workers, provides guidance and carries out evaluation and monitoring. Some projects have focused on environmental issues, namely landscaping, the establishment of an environmental information centre, and the re-use of electrical goods. Projects meet local needs and deliver a high standard of service, while making good use of local expertise, and promoting a range of skills and job types.

Sources: European Commission, *Good Practices in Urban Management and Sustainability,* europa.eu.int/comm/urban/ and Lloyd, P. and P. Ramsden (2000).

In sum, there is now a move towards building more "self-reliant" local economies. Fostering social and environmental responsibility, encouraging local diversity (so as to limit the vulnerability of specific sectors or firms to outside shocks), and enabling localities to meet needs with their own resources (thereby retaining investment and wealth) are all important elements of this effort. Local assets, which might otherwise be degraded, are valued and preserved, producing income and employment.

Territorial policies for rural development

In most OECD countries, policy for rural areas in the latter half of the 20th century has combined support for an increasingly mechanised agriculture (principally through subsidies) and protection of the countryside (for example, through the designation of nature conservation areas). Many countries are now encouraging the development of area-based initiatives to tackle social and economic problems in rural communities rather than use agricultural subsidies for these purposes.

Early initiatives arose primarily to fill gaps in service provision (OECD, 1997*b*). They were usually "bottom-up" initiatives, fostering self-help approaches based on patterns of mutual assistance typical of rural communities. Some national governments have gone on to establish financial support programmes targeted at rural communities affected by structural changes (for example, in coal-mining areas). Support has also been directed to remote localities dependent upon primary sectors (such as fisheries) and to pockets of deprivation in less peripheral areas. These funding programmes increasingly incorporate sustainability objectives and require recipient communities to adopt comprehensive local programmes. Many local partnerships are taking advantage of these public-sector funding opportunities (Moseley, 2000).

New approaches in the 1990s stress the strengths of the rural economy, taking advantage of some of the changes affecting rural communities to build strategies for achieving "territorial competitiveness". *Strengths* often relate to rural amenities (the natural and cultural heritage of the local area), such as wilderness, cultivated landscapes, historical monuments, and even cultural traditions — all of which have a strong territorial connotation, and are important for sustainability at both the local and national levels. Devising such strategies requires an accurate assessment of the character and extent of these attributes, as well as methods for valuing them. Reconciling economic development with amenity conservation is the major policy challenge identified in the OECD's work on amenities. Examples of successful policies in this field include those for "low impact" tourism, the provision of a "green" recreation resource for adjacent urban areas, and marketing local food and forestry products.

Some OECD countries are now making changes to national rural policies in light of their experience with integrated actions at local and regional levels. Separate sectoral approaches are being replaced by more integrated strategies in key fields such as transport, housing, education, health, tourism and forestry. The countries most likely to make significant progress with these changes are those that have put in place over-arching policies for sustainable development, incorporating clear goals and promoting co-ordination between different organisations.

Territorial policies for urban areas

Urban policy initiatives in OECD countries highlight two recent developments. First, the physical extension of buil-up areas has become a key sustainability issue. Second, multipurpose approaches, partnerships, and community involvement (OECD, 1998*b*) are emerging to tackle economic, social and environmental challenges simultaneously.

Although urban sprawl is a widespread problem, its causes — and potential solutions — vary from country to country. It is linked to the lack of effective controls over the development of land. In such cases, putting in place and implementing appropriate regulatory instruments is an important part of the response. Major infrastructure developments (especially relating to transport) often exacerbate the spread of urbanisation. Even where appropriate policies and strict controls are in place, market pressures necessitate measures to manage the demand for development outside urban centres, and to encourage the re-use of vacant land

and property (brownfield sites) in urban locations. Some countries are now using fiscal and dedicated funding instruments complementary to land-use planning measures to accomplish this (Box 16.5).

Box 16.5. **Urban redevelopment initiatives**

In the *United Kingdom*, the government has adopted a national target of providing 60% of all additional housing on previously developed land, or through conversion of existing buildings, by 2008. Fiscal instruments to support these targets are being considered. These include greenfield tax, land-value tax, the introduction of the full rate Value Added Tax on the sale of all new housing developed on greenfield sites, and tax breaks for investment in new development, repair and conversions of brownfield sites.

The *United States' Brownfields Initiative* has generated over USD 1 billion investment in redevelopment and cleanup projects from hundreds of small grants (USD 200 000) made to local communities. As well as making best use of brownfield land, the objectives of the initiative cover environmental protection, economic regeneration and community revitalisation. Showcase communities have been designated to demonstrate the successful conversion of brownfields and community empowerment to revitalise urban areas.

Source: OECD (1998), *Report on Urban Brownfields*, Paris.

OECD work on brownfield development (OECD, 1998c) identified several obstacles to re-use: inflexible planning regimes, fiscal structures, inadequate local public services and contradictory locational aspirations of many households and businesses. The re-use of these sites can benefii both the environment and the quality of life of residents by reducing the need to travel, reducing pressure on greenfield sites, and enabling local economic diversification and mixed uses. Achieving urban sustainable development through the re-use of urban land requires:

- Well-developed regional and city-level strategies that address urban growth and the re-use of brownfield sites, including inventories of sites.

- Flexible and innovative processes that encourage public and private-sector involvement in investment, with appropriate funding mechanisms to leverage private investment.

- Effective communication of the benefits of urban containment and brownfield development through public participation and the sharing of experiences.

- Assertive action and strong leadership at all levels of government and the provision of accurate information.

- Coherent legislative and policy frameworks that require evaluation of outcomes using indicators.

National level area-based regeneration strategies primarily addressed to disadvantaged urban neighbourhoods continue to be important in many Member countries (OECD, 1998*a*). These seek to integrate distressed areas (often burdened by severe environmental problems) into the larger metropolitan region, thus contributing positively to a better management of urban growth. Examples include the Netherlands' *Major Cities Programme*, the French *Contrats de Villes* and a range of area-based initiatives in the United Kingdom. Such initiatives focus the efforts of public agencies, private investors and local communities through the development of partnership-based, integrated strategies that bring together a range of complementary actions. Increasingly, Member countries are pursuing more "joined-up" policies for urban sustainable development, which have explicit economic, social and environmental goals.

The growing demand for housing in OECD Countries provides an opportunity to implement some strategies for sustainability. Estimates of the future demand for housing show that social change, principally

related to an increase in the number of households and a decrease in their size, is likely to be at least as important as increases in income. In England, the number of households will increase by 19% (3.8 million additional households) between 1996 and 2021; 78% of the increase in the number of households between 1991 and 2011 will result from single-person households. If current land use patterns and spatial planning systems prevail, most of the demand will be met through the loss of open space. Several Member countries are setting targets to increase the share of new housing on previously developed sites, often involving renovation of existing buildings (Box 16.5). In addition, they try to design much of this new housing stock to be suitable for different social groups and conditions, including the elderly and home workers.

Approaches to urban regeneration promoted by the European Union are founded on good practice at the local level and strongly influenced by the concepts of sustainability and ecosystems. These approaches stress the need for strategic and integrated action to achieve four interdependent aims: *(i)* strengthening economic prosperity and employment; *(ii)* promoting equality, social inclusion and regeneration; *(iii)* protecting and improving the urban environment; and *(iv)* contributing to good urban governance and local empowerment. In the European Commission's view (European Commission, 1997), tackling these complex and interrelated challenges requires:

- Integrated approaches within strategic frameworks, making full and complementary use of all available instruments, and the design of measures that solve more than one problem at a time.

- Policy interventions which solve problems locally, rather than pass them on to other places or future generations.

- Policy solutions which lead to changes in individual patterns of consumption and behaviour on the part of all key actors, especially enterprises and citizens.

Building territorial development strategies for sustainability: a common approach?

There is a growing body of good practice which demonstrates the feasibility and benefits of locally based solutions, many of which are transferable. The search is on for multipurpose measures which solve several problems simultaneously (an example is the insulation of social housing, which creates jobs, reduces energy consumption, and improves the quality of life of residents). Multipurpose strategies are however difficult to "mainstream" when powerful sectoral policies remain in place, sometimes exacerbating the uneven development of regions.

The success of policies and approaches at the sub-national level depends on the establishment of appropriate framework conditions that include national policy initiatives and strong measures to assure policy coherence.

Modes of intervention: systems and policies for the sustainable management of territories

To achieve more sustainable outcomes at the territorial level, national (and, where relevant, federal or regional) governments can use the following types of policies, measures and institutional arrangements: *(i)* establishing a *strategic approach* to territorial management at the regional, national — and where appropriate — trans-national level; *(ii) translating sustainable development principles* into policies and measures; and *(iii)* establishing an *appropriate tool kit* of policy instruments and implementation mechanisms. These are dependent upon effective forms of governance — including institutional arrangements — that foster sectoral integration, sharing of competencies, partnership and participation, and the exchange of experience.

A strategic approach to territorial management

The sustainable development agenda is a complex one, which demands action by many different stakeholders at the national and territorial levels, all of whom need to be involved in establishing shared

goals and targets and in action to ensure that they are met. A few countries — such as the Netherlands, Denmark and Ireland — have established national spatial plans specifically to guide territorial development toward sustainability goals, along with legally-binding mechanisms to ensure that local decisions are in line with national objectives (European Commission, 1997 and 1998). Elsewhere, national planning systems are being adjusted in response to sustainable development objectives established in separate over-arching strategies. In all cases, the kinds of processes now common in Local Agenda 21 work are increasingly influencing the formulation of strategies and implementation mechanisms (Box 16.6).

Box 16.6. **Vertical and horizontal integration**

In *Finland,* the 2000 Land Use and Building Act makes sustainable community development and construction a legal requirement for the nation. The first paragraph of the Act states that "plans for land use shall be made in a manner contributing to sustainable development of natural resources and the environment."

In *Japan,* the fifth National Development Plan (1998) establishes balanced and sustainable development as a fundamental goal for the country, and applies this principle to territorial development policies. The document is not binding but is intended to build a common strategy for planning and sectoral policies (National Land Agency of Japan 1998).

In the *United Kingdom,* a national strategy for sustainable development ("A Better Quality of Life") calls for regional sustainable-development frameworks (RSDFs) in each English region to identify links and conflicts among existing regional activities and initiatives and "set a common and high level vision for sustainable development at the regional level".

Source: OECD (2001), *Towards a New Role for Spatial Planning*, Paris, forthcoming.

Many countries have started by identifying a set of sustainability principles and exploring how these can be applied in a practical way to territorial development (Blowers, 1997). In doing this, they face the task of incorporating these principles into goals, policies and actions at all territorial levels. The national and regional frameworks that result must allow for specific local solutions to be devised.

Territorial development policy should pay particular attention to the following principles (European Sustainable Cities Project 1997 [10]):

- *The precautionary principle*, particularly applicable in conditions of uncertainty and high risk.

- *The polluter pays principle*, to ensure that the costs of environmental damage are borne by those who cause it.

- *Demand management* measures, rather than simply meeting demands.

- *Environmental efficiency,* to reduce use of natural resources, protect critical natural capital and ensure that carrying capacities are not exceeded.

- *Welfare efficiency* to obtain the most human benefit from economic activity.

- *Equity* in the distribution of costs and benefits of development.

- *Local self-sufficiency*, preventing the transfer of the costs of growth and environmental quality to other places.

- *Re-use and recycling* through the closure of resource loops and the active management of resource flows.

- *Diversity* in the built and natural environment, avoiding mono-cultures and promoting mixed use.

Considerable progress has been made in many countries and regions in translating these universal principles into territorial development strategies, policies and actions (Table 16.1). These principles are also used as criteria in the monitoring and evaluation of territorial policy and outcomes (OECD, 1997*a*). However, there is still widespread debate about the applicability of particular policies and measures — such as increasing urban densities, compact cities, growth restraints, transport node development, and methods of traffic restraint — in different national, regional and local circumstances.

Certain implementation tools are relevant in addressing more than one theme or objective (such as measures to promote the mixed use of built and open space). Many contribute to reducing the total environmental impact (or "footprint") of various land uses, and use measures which involve actions across various sectors (for example, transport and waste management). Some implementation tools represent additions or adjustments to spatial or land-use planning systems; others are fiscal, market-based or awareness-raising actions intended to change the attitudes and behaviour of citizens and enterprises.

A tool kit of policy instruments and mechanisms

Systems for regional planning and local development regulation are important tools for managing territorial development. Sustainability is most likely to be advanced where these systems:

- *Provide for the effective participation of all stakeholders in setting goals* through development of a strategic vision.

- *Promote an integrative* rather than a sectoral *approach.*

- *Actively shape territorial development patterns* through flexible spatial planning systems.

- *Harness and co-ordinate public, private and community resources*, so that property and infrastructure investment and expenditure can contribute to more-sustainable outcomes.

- *Promote area-based approaches* to direct public and private resources more effectively and address many interrelated issues (such as environmental quality, employment, safety, housing, investment and entrepreneurship); *identify* the critical relationships among agents likely to shape the future economic, social, political and environmental qualities of territory. Just as in the spiral of decline, environmental problems lead to high social and economic costs, in a virtuous cycle of redevelopment, environmental improvements may lead to social and economic gains.

- *Allow for incremental steps*, combined with regular use of indicators and intensive public consultation and participation.

Economic instruments are increasingly important as direct public-sector expenditure for territorial development gives way to private investment. The framework for their application is set out in Chapter 5. Recent years have seen greater use of taxes, charges and tax breaks to promote more-sustainable land uses and the design of energy-efficient buildings. Other measures include deposit-refund systems (to promote recycling rather than landfill of waste) and environmental compensation (to ensure that the environmental costs of new development are offset by investment in new ecological resources). Financial incentives may form part of public-private partnership arrangements where there is a sharing of risk (Box 16.7).

Tools for measurement, monitoring and review are gaining significance as governments wrestle with the complex and multifaceted challenges of sustainable development. They are an important means of raising awareness and changing behaviour. One such tool is the *environmental management system* (EMS), which allows organisations to set standards and measure performance, thereby providing incentives to achieve goals. EMS enables an organisation to collect the information necessary to measure and improve its

Table16.1. **Examples of applying sustainability in spatial planning and territorial development policy**

Policy themes and objectives	Examples of implementation tools
Managing urban growth and the prevention of urban sprawl to minimise transformation of rural land to urban uses	National and regional land-use zoning Urban growth boundaries Green-belt policies Specifying environmental limits and carrying capacity
Creating more balance in the urban structure so as to get a better distribution of urban services, infrastructure and opportunities	Regional incentives Betterment and impact taxes Agreements with developers on contributions to social and physical infrastructure
Reshaping the spatial structure of existing urban areas so as to increase urban densities	Mixed-use developments Conversion of redundant buildings and recycling of urban land Retrofitting suburbs and conversion of "edge cities" Prohibition of "out of town" services Re-urbanisation in areas of unauthorised development
Re-using vacant and derelict urban land and property and regeneration of urban brownfields	Greenfield development taxes Targets for brownfield land for development Subsidies for reclamation of brownfield sites
Protecting environmental resources and mitigating the impact of new development on the built and natural heritage	National regional and local designations of areas of environmental and landscape value with strict development controls Compensation mechanisms to ensure that the stock of ecological/environmental capital is maintained Ecological reconstruction through greenways and other habitat creation to increase biodiversity Local biodiversity action plans
Reducing the need to travel while maintaining access to services and opportunities	Concentrating new development around public transport corridors and nodes Use of information and communications technology Rural diversification and conversion of agricultural buildings to other employment uses
Reducing and mitigating the impact of traffic	Traffic management schemes to limit access to certain areas Pedestrian-friendly zones Demand management through accessibility planning, road pricing or congestion charging Car-free housing developments
Reducing over-exploitation of land through agricultural intensification and agro-environmental problems	Limiting car parking in urban centres and new development Designation of environmentally sensitive areas including water courses and aquifers Countryside management schemes Bringing certain agricultural practices within land use planning control Promotion of low impact agriculture food production and local markets
Improving durability, adaptability, and ecological and energy efficiency in the built environment	Strengthening regulations requiring energy conservation in co-ordination with fiscal incentives Promotion of renewable energy sources and combined heat-and-power schemes Life-cycle costing of construction; flexible design and reuse; minimising demolition waste Ensuring that new development promotes cycling and walking Promoting neighbourhood identity and historical continuity
Coastal zone protection	Presumption against physical development in the coastal zone, and reclamation of degraded areas. Special designations and management plans Revoking development consents in valued coastal environments Integrated coastal management schemes
Revitalising town centres and creating more mixed use development	Promoting diversity of land uses within town and neighbourhood centres, making more efficient use of land. Targeted siting of public buildings and facilities Relaxation of rigid zoning and promotion of mixed developments
Protection of water resources and water networks	Integrated catchment management plans Designating nitrate prohibition areas Creation and management of open water networks Integrating pollution control with land-use planning Designing for a permeable land surface

Note: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States.

Sources: Hettige *et al. (1994), The World Bank Industrial Pollution Projection System;* and OECD STAN database, 1996.

Box 16.7. **Financial incentives for sustainable development**

In the *United States*, the "Liveable Communities Initiative" proposes a new financial tool to help communities, local and state governments to preserve and enhance open space and prevent urban sprawl by acquiring the title or permanent easements of land. A tax credit bond allows communities to pay zero interest for the 15-year life of the bond, and to pay the principal at the end of 15 years. Bondholders receive tax credits from the federal government, equal to the amount of interest they would have received from the communities. The initiative enables communities to purchase and protect land of special environmental quality, and to restore brownfield sites and wetlands.

In *New Zealand*, the sustainable management fund (SMF) provides financial support for practical initiatives that help to achieve sustainable management of natural resources. Projects must demonstrate that they are of practical benefit and arise from consultation with stakeholders. The emphasis is on capacity-building through the transfer of information and technologies from technical experts to local communities and authorities in order to support their evaluation and decision-making processes. (Nadin, Shaw and Cooper, 1999).

Source: OECD (1998), Report on Urban Brownfields, www.oecd.org/tds/frames1.htm, Paris

environmental performance, and to integrate environmental management systems with traditional management tools (e.g. accounting, quality management, etc.). *Impact assessment and appraisal tools* allow systematic consideration of sustainability criteria in assessing the impact of development, and can be used to adjust policy and improve development proposals. Many countries have now incorporated *environmental assessment* procedures for major territorial development projects into planning law. Some have also introduced *environmental appraisal* (or *strategic environmental assessment*) of territorial plans and policies during the formulation process.

Institutional arrangements for territorial development can either foster or inhibit effective policy and action. New institutions, instruments and procedures may be needed, particularly in relation to cross-border issues. The involvement and empowerment of citizens is a central principle of sustainable development (see Chapter 4). But territorial development policies and decisions are normally the focus of intense disagreements, because of the unequal distribution of the costs and benefits they create. Disagreements among neighbouring jurisdictions and levels of government are also common. Municipalities and regions need to co-operate on territorial development so as to reduce damaging competition and build complementary strategies (OECD, 2001*a*). Good governance for territorial development will involve:

- Applying the principle of subsidiarity, so that responsibilities are located at the most appropriate level of jurisdiction, and matching resources and responsibilities to avoid unfunded mandates.

- Fostering co-operation among sectors and institutions, and creating new institutions and procedures (if needed), especially where environmental, social and economic interdependencies cross administrative boundaries.

- Building institutional capacity to cope with cross-sectoral and mutifaceted issues.

- Establishing and maintaining procedures for citizen involvement and consultation in territorial strategy development, to promote shared goals and influence changes in behaviour.

- Promoting policies and actions that encourage private-sector interests to work toward sustainable development and foster public-private partnership.

- Promoting effective networking among regions, municipalities and communities and other stakeholders so as to exchange experience and devise complementary policies.

Changes introduced now and in the years to come, if properly guided and monitored, can have a cumulative, positive effect. Programmes and investments for sustainability — whether they involve better waste management, disaster preparedness, improvements in planning for housing, transport, education or public safety, to name a few — require investments and implementation spanning years. Public awareness and participation are critical to securing popular support for strategies that extend beyond an electoral or economic cycle. A number of practical criteria to guide implementation of sustainable development policies at the territorial level are shown in Box 16.8.

Box 16.8. Implementation for sustainable territorial development

A. Promote and implement national territorial development policies which fully integrate sustainable development as an objective:

- Prepare a national policy framework for territorial development that includes the objective of enhancing sustainability.
- Establish environmental and social objectives at national level to be attained at regional and local levels.
- Identify those aspects of national policies for sustainability better implemented at the national level, and those which should be implemented by local and regional authorities.
- Identify regional and local obstacles to the implementation of national sustainable development policies, and best practices for overcoming them.
- Identify and adjust national policies that have the unintended consequence of promoting unsustainable patterns of urban and rural development.
- Strengthen education in sustainability for professionals with responsibility for different aspects of territorial development by requiring study or internship as part of a certification process or as part of continuing professional education.
- Adapt and revise spatial-planning and land-use policies to promote more sustainable construction of buildings, the re-use of vacant land, and demand management of resources and transport.
- Re-examine subsidies and tax measures that encourage construction on greenfield land and that discourage the renovation of existing properties.
- Governments can set an example by adopting a sustainability strategy for government buildings, including social and environmental factors in decisions on building location, and incorporating design principles that promote an eco-cycle approach to building operation.

B. Promote regional and local initiatives for sustainable development based on strategic assessments, visions and local action plans, cross-sectoral integration, and governance mechanisms to co-ordinate efforts horizontally:

- Give legal recognition to the objectives of sustainable development in local legislation.
- Assess local and regional trends to determine thresholds of critical change.
- Make strategic vision exercises a requirement of local and regional projects for sustainable development and key infrastructure projects and, if need be, develop new institutions with a focus on strategic direction and co-ordination.
- Introduce environmental accounting at the sub-national level.
- Assess strengths and weaknesses of territories for endogenous development, especially for employment opportunities using renewable resources.
- Address market failures such as the under-provision of rural amenities and under-investment in urban regeneration.
- Promote the use of environmental management systems at the local level by public authorities and firms, especially by those with a major impact on waste and water systems, and on land use and transport.

Box 16.8. **Implementation for sustainable territorial development** *(cont.)*

C. Improve governance for sustainable territorial development:

- Match resources and responsibilities at each level of government; to this end, local and regional authorities should be able to set fees and impose taxes that correspond to their priorities and conditions.
- Empower local and regional levels of government to devise solutions, strengthen community capacity-building, planning systems, and information systems.
- Enable local and regional governments to set priorities and targets.
- Develop and implement metropolitan plans or contracts across municipal borders to integrate distressed areas, to improve sustainable transport (especially in car-dependent suburban areas), and to reinforce public services and infrastructure in areas of high environmental or social risk. Avoid relaxation of environmental standards in the competition for investment.

Conclusions

Territorial development combines top-down and bottom-up approaches. Many of the problems related to sustainable development must be identified and analysed at local and regional levels, since this is the level most conducive to setting priorities and designing effective, publicly supported solutions. Many practical steps are being taken based on this approach, but progress is uneven because only a minority of all cities and regions in Member countries are taking the initiative. Progress will continue as successful approaches are evaluated and best practice developed. International organisations can play an important role in assessing successful approaches and providing feedback. Stronger national framework policies, together with more robust economic instruments and measures to improve policy co-ordination between different levels of government, will increase incentives to act in the interest of sustainable development. At the very least, governments should eliminate practices and policies that only make territorial problems more difficult to solve in the future.

Territorial policies are not the simple addition of spatial planning, urban, rural and regional policies. They are a comprehensive set of objectives, established in a framework set primarily by central government but with the involvement of regional and local authorities and of all other stakeholders who share responsibility for implementation. Among the objectives of territorial development policies, the reduction of disparities, the promotion of conditions favourable to endogenous development, and a better balance between urban and rural areas play an important role in many countries. The integration of the economic, social and environmental dimensions of sustainable development is vital at the local and regional levels if national and global objectives are to be reached.

NOTES

1. Low-income, low-skilled people in the United States often have to travel considerable distances for employment, and spend as much as a third of their income on transportation (U.S. Department of Housing and Urban Development, 1998).

2. Low-income renters who pay more than 50% of income on rent, or live in substandard quality housing.

3. One quarter of all greenhouse gases are related to urban transport.

4. Previously abandoned lands which may or may not be contaminated.

5. The communiqué of G-8 Environment Ministers, on 7 April 2000, states: "Urban sustainable development will represent a major policy challenge for this century. Combating unsustainable trends in urban development including environmental pollution, urban sprawl and green-field development through integrated policy approaches will contribute to a higher quality of life of citizens."

6. Including the Conventions on biodiversity, desertification and climate change and the Habitat Agenda.

7. Chapter 28.1 notes: "Because so many of the problems and solutions being addressed by Agenda 21 have their roots in local activities, the participation and co-operation of local authorities will be a determining factor in fulfilling its objectives. As the level of governance closest to the people, they play a vital role in educating, mobilising and responding to the public to promote sustainable development."

8. See www.sustainable-cities.org

9. This and most of the other European examples cited in this section of the chapter are described in more detail on the database Good Practice in Urban Management and Sustainability at europa.eu.int/comm/urban.

10. The principles for sustainable development for territorial development and spatial planning have been further elaborated in the European Union SPECTRA project (see www.uwe.ac.uk/spectra).

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Annex 1

GLOSSARY AND ACRONYMS

GLOSSARY

Abiotic
Non-living; devoid of life.

Bequest value
A non-use value, usually measured by willingness-to-pay, attached to an environmental or cultural asset that people want to transmit to their children or to future generations.

Bioaccumulation
The accumulation of a substance (typically a persistent chemical or heavy metal) in the tissue of a plant or animal, generally through the uptake of water or food, at a rate faster than the plant or animal can excrete it, resulting in a steady increase in contamination over the organism's lifetime.

Biodiversity
Shorthand for biological diversity: the variability among living organisms. It includes diversity within species, between species and of ecosystems.

Biomagnification
The accumulation of a substance by an animal that preys on other animals that have themselves accumulated the substance. This process can deliver remarkably high concentrations of persistent chemicals or heavy metals to top predators even if the levels in the surrounding physical environment are quite low. Chemical burdens, built up over a lifetime, can also be passed to young via the egg (in the case of birds) or through the placenta and breast milk (in mammals).

Biomass
The total weight of a designated group of organisms in a particular area.

Biocatalyst
A substance, such as an enzyme, that initiates or modifies the rate of a biological process and is generally consumed in that process (in contrast with a chemical catalyst, which accelerates a chemical reaction without being consumed).

Biotope
A small area with uniform biological conditions (climate, soil, altitude, etc.).

Cap-and-trade system
A regulatory or management system that sets a target level for emissions or natural resource use, and, after distributing shares in that quota, lets trading in those permits determine their price.

Carrying capacity
The maximum population (of humans and other species) that a particular environment can sustain without irreversible environmental damage.

Catchment area
The area from which rainwater drains into a river, lake or other body of water.

Chlorofluoro-carbon
A chemical compound made up of carbon, fluorine, and chlorine. CFCs have been used as propellants in spray cans, coolants in refrigerators and air conditioners, and in foam, plastics, and cleaning solvents. They are very stable in the troposphere, but are broken down by strong ultraviolet light in the stratosphere and release chlorine atoms that then deplete the ozone layer.

Contingent valuation
A formal survey technique that requires respondents to specify their preferences for different goods or services and how much they would pay to obtain them.

Cost-benefit analysis
The appraisal of an investment or a policy change that considers all associated costs and benefits, expressed in monetary terms, accruing to it.

Cross-subsidy
A monetary transfer to one group of customers (or line of business) financed at the expense of another — e.g. the use of surplus revenue from an urban bus route to support the operation of a rural one.

Decarbonisation
When applied to an economy, refers to the phasing out of its dependence on (carbon-containing) fossil fuels.

Desertification
The transformation of arid and semi-arid land into desert, generally due to overgrazing, deforestation, poor irrigation and tilling practices, climate change, or a combination of these factors.

Dioxins
A general term that describes a large group of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD. Dioxins are generally formed as unintentional by-products of industrial processes involving chlorine (such as waste incineration, chemical and pesticide manufacturing and pulp and paper bleaching), but also during the combustion of biomass, such in wood stoves.

Distortionary subsidy
A subsidy that creates an unintended distortion in the allocative efficiency of the local or global economy (separate from the distortionary effects related to the financing of the subsidy).

Eco-label
Information (typically provided on a label attached to a product) informing a potential consumer of a product's characteristics, or of the production or processing method(s) used in its production.

Economy in transition
A country that is moving from a centrally planned economy to a market-oriented economy.

Ecosystem
A dynamic complex of plant, animal and micro-organism communities and their non-living environment, interacting as a functional unit.

Ecosystem service
A service provided by group of organisms (including humans in some cases) that is directly or indirectly beneficial to humans. Examples include the conversion of carbon dioxide to oxygen by photosynthesising plants, and the detoxification of harmful chemicals by aquatic and soil-based microbes.

End-of-pipe technology
A technology designed to control pollution from another technology, generally installed at the point of emission.

Environment
The ecosystem in which an organisms or a species lives, including both the physical environment and the other organisms with which it comes in contact.

Environmental tax
A tax that is of major relevance for the environment, regardless of its specific purpose or name.

Eutrophication
The process by which a body of water accumulates nutrients, particularly nitrates and phosphates. This process can be accelerated by nutrient-rich runoff or seepage from agricultural land or from sewage outfalls, leading to rapid and excessive growth of algae and aquatic plants and undesirable changes in water quality.

Existence value
The value to an individual of knowing that a particular environmental or cultural asset exists. It is independent of any use that the person may make of the asset.

Externality
A non-market effect on the utility of an individual, or on the costs of a firm, from variables that are under the control of some other agent.

Extended producer responsibility
An obligation placed on one or more producers of a product to take back the product for recycling or safe disposal.

Footprint (ecological)
A measure of the hectares of biologically productive area required to support a human population of given size.

Genetic diversity
The variation in the genetic composition of individuals within or among species; the heritable genetic variation within and among populations.

Genuine saving
A measure of sustainable development that corrects the traditional measure of gross savings for the monetary value of the degradation of natural capital, and of the accumulation of human capital

Geothermal energy
Literally, the heat of the earth. Where this heat occurs close to the earth's surface, and is able to maintain a temperature in the surrounding rock or water at or above 150 degrees C, it may be tapped to drive steam turbines.

Governance
The way that a corporation or government organises and carries out its economic, political and administrative authority.

Grandfathering
Granting an existing firm a legal exemption from a new or changed policy. In the case of tradable permits, it refers to the common practice of allocating permits to existing polluters or users of natural resources at no direct cost to them.

Greenhouse effect
The rise in temperature that the Earth experiences because certain gases in the atmosphere (water vapour, carbon dioxide, nitrous oxide, and methane, for example) trap energy from the sun. Because

of their warming effect, these gases are referred to as greenhouse gases. Without them, more heat would escape back into space and the Earth's average temperature would be about 33ºC colder. Similarly, their rapid accumulation in the atmosphere can lead to rising temperatures.

Greenhouse gas
A gas such as carbon dioxide or methane that reflects infrared radiation emitted by the earth, thereby helping to retain heat in the atmosphere.

Habitat
The place or type of site where an organism or population occurs naturally.

Heavy metal
A high-atomic-weight metal such as arsenic, cadmium, chromium, cobalt, lead, mercury, uranium or zinc. Heavy metals can be toxic to plants or animals in relatively low concentrations and tend to accumulate in living tissue.

Human capital
The knowledge, skills, competence and attributes embodied in individuals that facilitate the attainment of personal well-being.

Hydrofluorocarbon
A compound consisting of hydrogen, fluorine and carbon. HFCs do not deplete stratospheric ozone, but they have global warming potentials anywhere from 90 to 12 000 that of carbon dioxide.

Indicator
A summary measure that provides information on the state of, or change in, a system.

Invasive species
An introduced species that invades natural habitats.

Man-made capital
The manufactured means of production, such as machinery, equipment and structures, but also non-production related infrastructure, non-tangible assets, and the financial assets that provide command over current and future output streams. Also referred to as "human-made" or "manufactured" capital.

Market failure
A situation wherein market prices do not reflect the social opportunity cost of production or consumption. External effects or externalities are evidence of a market failure.

Market price support
An indicator of the annual monetary value of gross transfers from consumers and taxpayers (where export subsidies are given) to producers (if the difference is positive) or from producers to consumers (if negative) arising from policy measures that create a gap between domestic market prices and the border price of the good or service in question.

Maximum sustainable yield
The maximum amount of a renewable resource that can be harvested over an indefinite period without causing its stock to be depleted.

National accounts
The framework for recording the economic transactions of a country in monetary terms.

Natural capital

The renewable and non-renewable resources that enter the production process and satisfy consumption needs, as well as environmental assets that have amenity and productive use, and natural features, such as the ozone layer that are essential for supporting life.

Newly Independent States

Republics of the former Soviet Union that have since the early 1990s become sovereign states.

Non-market value

The value of an asset not reflected in market prices. Generally it includes non-use values and those indirect use values (such as certain ecosystem services) and option or quasi-option values for which there is no market.

Non-renewable resource

A resource with a more or less finite initial endowment that can be depleted over time.

Non-use value

The value to humans derived purely from the fact that an environmental or cultural asset exists, even if they never intend to use it or see it in person. It is can be further sub-divided into existence value and bequest value.

Off-grid electricity

Electricity produced by small generating units that are not connected to high-voltage transmission lines.

Option value

The benefits accruing to individuals not from the actual use of an environmental asset, but from the option to use it in the future.

Persistent organic pollutant

A complex organic chemical which resists decomposition in the environment and can migrate over great distances, which bioaccumulates and biomagnifies, and which is suspected of being toxic to humans or other organisms exposed to even low concentrations if such exposure occurs over a long period of time. Examples include certain pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, and toxaphene), industrial chemicals (PCBs and hexachlorobenzene, which is also a pesticide), and unwanted by-products of combustion and industrial processes (dioxins and furans).

Polluter Pays Principle

The principle that polluter should bear the expenses of carrying out pollution prevention and control measures decided by public authorities, to ensure that the environment is in an acceptable state (i.e. costs of these measures should be reflected in the cost of goods and services which cause pollution).

Ozone

A chemically unstable and highly reactive gas (each molecule of which consists of three atoms of oxygen in contrast with the usual two) found mainly at ground level in cities and in the stratosphere. At ground level, ozone can be a lung irritant. In the stratospheric ozone layer, the gas plays an important role in protecting the Earth's surface from high levels of biologically damaging ultraviolet (UV) radiation, which is known to be a significant risk factor for skin cancers, eye cataracts, and the suppression of mammalian immune systems.

Ozone layer

The region of the stratosphere (lying approximately 15-40 km above the Earth's surface) that contains the bulk of the world's atmospheric ozone.

Photovoltaic (solar) cell
Generally speaking, a device incorporating a semiconductor that generates electricity when exposed to (sun)light. The technology may be further subdivided into crystalline, multi-crystalline, thin-film and concentrator variants.

Precaution
Action taken in the face of unresolved uncertainty, especially if the costs of inaction are potentially both high and irreversible.

Pressure-state-response
A framework for the presentation of environmental information in terms of indicators of the pressures that human activities exert on the environment, of the state of the environment, and of society's responses.

Producer Support Estimate
An indicator of the annual monetary value of gross transfers from consumers and taxpayers to producers (measured at the producer's property), arising from policy measures, regardless of their nature, objectives or impacts on production or income. The percentage PSE is the ratio of the PSE to the value of total gross farm receipts, measured by the value of total production (at farm gate prices), plus budgetary support.

Public good
A special kind of externality in consumption where the availability of a good to one individual does not reduce its availability to others (non-rivalry) and the supplier of the good cannot exclude anybody from consuming it (non-excludability).

Regulatory capture
The capacity of narrow interest groups to shape regulations to suit their own goals.

Regulatory impact analysis
The ex-ante analysis of the effects of a proposed regulation, or the ex-post assessment of an existing one.

Renewable resource
A resource that is capable of being replenished through natural processes (e.g., the hydrological cycle) or its own reproduction, generally within a time-span that does not exceed a few decades. Technically, metal-bearing ores are not renewable, but metals themselves can be recycled indefinitely.

Reserve
In geology, a reserve refers to an estimated quantity of a natural material (mineral, mineraloid, rock, gas or liquid) in the ground that has been explored to the extent that the probability of producing the material from it economically (at current market prices and with available technology) is reasonably assured. Reserves are sub-sets of, and not synonymous with, *resources*.

Resource
Generally, a tangible asset. In geology, resources refer to accumulations of natural materials that are known or expected to exist and for which there is a reasonable assurance that a given quantity of the material can be recovered economically at current or expected future market prices using currently available technologies or technologies that can reasonably be expected to become available in the foreseeable future.

Resource rent
The financial surplus, after deducting production costs, associated with the extraction or harvest of a natural resource.

Social capital
The networks and shared norms, values and understanding that facilitate co-operation within and between groups.

Stakeholder
Somebody who has a "stake" or interest in a public policy, programme or, in some uses of the term, a corporation's activities.

Stratosphere
The layer of the earth's atmosphere just above the troposphere, extending from 10 km to about 50 km above the earth.

Subsidiarity
The notion that decision-making should occur at the level at which the people most directly concerned can take responsibility.

Sustainable development
A development path along which the maximisation of human well-being for today's generations does not lead to declines in future well-being.

Technology foresight
A process for establishing common views on future technology development strategies. Typically it seeks views from a large number of communities, including civic groups, as well as academic, government and industrial research bodies.

Threshold
When used in reference to a species, an ecosystem, or another natural system, it refers to the level beyond which further deterioration is likely to precipitate a sudden adverse, and possibly irreversible, change.

Troposphere
The region of the atmosphere closest to the Earth, extending from the surface up to about 10 km in altitude (its exact height varies with latitude). Almost all weather takes place in the troposphere.

Use value
A value obtained through the use of an environmental or cultural asset.

Volatile organic compound
A carbon-containing compound, such as gasoline or acetone, that vaporises at a relatively low temperature, generally below 40°C. VOCs can contaminate water, and in the atmosphere can react with other gases in the presence of sunlight to form ozone or other photochemical oxidants.

Willingness-to-pay
The amount an individual is willing to pay to acquire some good or service. This amount can be elicited from the individual's stated or revealed preferences.

ACRONYMS, ABBREVIATIONS AND SYMBOLS

..	data not available
—	irrelevant
%	per cent
APEC	Asia-Pacific Economic Co-operation
BIT	bilateral investment treaty
bn	billion(s)
CBD	Convention on Biological Diversity
Ceq	carbon equivalent
CFCs	chloroflourocarbons
c.i.f.	cost, insurance and freight
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	carbon dioxide
COP	Conference of the Parties
CSR	corporate social responsibility
CTE	Committee on Trade and Environment (of the WTO)
DAC	Development Assistance Committee (of the OECD)
EBRD	European Bank for Reconstruction and Development
EEZ	exclusive economic zone
EGS	environmental goods and services
EIA	environmental impact assessment
EMS	environmental management system
EPR	extended producer responsibility
EU	European Union
euro	the single currency of the countries participating in the European Economic and Monetary Union
EUROSTAT	Statistical Office of the European Communities
FAO	Food and Agriculture Organisation
FDI	foreign direct investment
f.o.b.	freight on board
FTAA	Free Trade Area of the Americas
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GHG	greenhouse gas
GEF	Global Environment Facility
GMO	genetically engineered or modified plant, animal, micro-organism or virus
GSP	Generalized System of Preferences
GW	gigawatt (= one million kilowatts)
ha	hectare
HDI	Human Development Index
HIV	human immunodeficiency virus
IEA	International Energy Agency
IFC	International Finance Corporation (of the World Bank Group)

ILO	International Labour Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization on Standardization
ITTO	International Tropical Timber Organization
kg	kilogramme
km	kilometre
kW, kWh	kilowatt, kilowatt-hour
LDC	least-developed country
M&As	mergers and acquisitions
MEA	multilateral environmental agreement
MFN	most-favoured nation
MNE	multinational enterprise
NAFTA	North American Free Trade Agreement
NEA	Nuclear Energy Agency (a semi-autonomous body within the OECD)
NGO	non-governmental organisation
NIS	Newly Independent States
NOx	any one of several oxides of nitrogen
NTBs	non-tariff barriers
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petroleum Exporting Countries
POPs	persistent organic pollutants
PPMs	process and production methods
PPP	purchasing power parity (or Polluter Pays Principle)
PSE	producer support estimate
R&D	research and development
SME	small- or medium-sized enterprise
SOx	any one of several oxides of sulphur
STE	state trading enterprise
t	metric tonne(s)
TPES	total primary energy supply
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Commission on Sustainable Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme
UNECE	United Nations Economic Commission for Europe
UNFCC	United Nations Framework Convention on Climate Change
URAA	Uruguay Round Agreement on Agriculture
USD	United States dollar
VA	voluntary agreement
VAT	value-added tax
VOC	volatile organic compound;
WBCSD	World Business Council for Sustainable Development
WHO	World Health Organization
WRI	World Resources Institute
WTO	World Trade Organisation
WWF	World Wildlife Fund; World-Wide Fund for Nature

For an explanation of technical terms, see the Glossary

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