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Sustainable Development in OECD Countries
Getting the Policies Right

Chapter 5

Reducing Water Pollution and Improving Natural Resource Management

Adequate clean water is a precondition to human and ecosystem life. Eighteen country reviews looked at policies affecting the management of water resources and the control of water pollutant emissions. The chapter reports the conclusions from the country reviews as regards developments in water use, in the quality of water bodies with a focus on the capacity of policy instruments to encourage sustainable use and to reduce pollution in an efficient fashion. It also provides data and analysis on sustainability issues in fisheries management.

1. Introduction

This annex brings together the main lessons learnt from studies on reducing water pollution and improving natural resource management that have been or will be published in the *OECD Economic Surveys*. Twelve country studies dealt with policies to reduce water pollution, focusing on the cost-efficiency of the instruments used.[1] Nine surveys looked at whether measures were in place to ensure sustainable use of natural resources, especially freshwater stocks though fish and petroleum reserves have also been considered for some countries.[2] Issues relating to oil and gas resources are not covered in this annex since they were addressed in only two country surveys (Netherlands and Norway). The adequacy of different fish-harvesting policies in terms of sustainability was discussed in four country surveys and the main findings are summarised below. In the area of water, the broad conclusion from the reviews is that, notwithstanding the improvements over the past decades, threats to the quality and availability of the resource persist in some countries, mainly because not enough use is made of market mechanisms. To support this finding, the chapter first briefly presents the problem before commenting on the extent to which the performance has moved countries closer to their adopted objectives. It then discusses the policies behind the outcomes and the corresponding recommendations that have been made in country surveys. The examples reported in the annex are mainly limited to the reviewed countries.

2. Objectives and performance

Most surveyed countries now pursue an objective of good water quality for almost all streams although the corresponding targets have been formalised only recently in many European countries. In the United States, quality objectives were set for all streams following the enactment of the Clean Water Act in 1972. Virtually all streams were assigned to the two top categories – "swimmable" and "fishable" – out of the four available ones (the two other ones being "boatable" and no use). EU countries promulgated the objective of bringing all surface water bodies to good ecological quality by 2015 in the water framework directive, which was adopted in 2000. Switzerland also has very stringent standards of water quality for both surface and underground water bodies. Canada and New Zealand still have no nation-wide water quality standards for rivers and streams, primarily because hydrologic conditions vary considerably within these countries. In New Zealand, all regional councils have

Table 5.1. **Water pollution: main indicators**

	Biochemical oxygen demand		Nitrates		Total phosphates		Nitrogen balance on agricultural land	
	Average concentrations at mouth of selected rivers						National	
	Mg O_2/litre		Mg N/litre		Mg P/litre		Kg N/ha	
	Average 1980-85	Average last 3 years	Average 1980-85	Average last 3 years	Average 1980-85	Average last 3 years	1985-87	1995-97
Australia	. .	. .	. .	. .	. .	. .	7	7
Austria	2.2	2.2	1.2	1.3	0.2	0.1	35	27
Belgium	6.6	. .	3.8	. .	0.7	. .	189	181
Canada	. .	. .	0.1	0.1	0.1	0.0	6	13
Czech Republic	8.5	4.6	5.1	3.5	. .	0.3	99	54
Denmark	3.9	2.0	3.5	2.6	0.3	0.1	154	118
Finland	. .	. .	0.2	0.3	0.0	0.0	78	64
France	5.2	3.2	2.8	3.1	0.4	0.4	59	53
Germany	3.6	2.4	3.5	3.3	0.5	0.2	88	61
Greece	. .	. .	1.3	1.5	0.4	0.4	58	38
Hungary	4.4	2.9	2.2	1.6	0.4	0.3	47	–15
Iceland	. .	. .	. .	. .	. .	. .		
Ireland	1.7	1.8	2.2	2.9	0.1	0.1	62	79
Italy	. .	. .	2.0	2.1	0.3	0.2	44	31
Japan	2.3	1.4	. .	. .	. .	. .	145	135
Korea	. .	2.8	. .	2.6	. .	0.1	173	253
Luxembourg	3.8	2.7	4.1	4.1	0.6	0.4		
Mexico	3.7	15.9	1.9	0.6	. .	0.1	28	20
Netherlands	2.8	3.1	4.4	3.3	0.5	0.2	314	262
New Zealand	. .	. .	. .	. .	. .	. .	5	6
Norway	. .	. .	0.3	0.3	0.0	0.0	72	73
Poland	5.0	4.3	1.8	1.9	0.3	0.3	48	29
Portugal	2.6	2.1	3.6	4.4	0.1	0.2	62	66
Slovak Republic	5.1	3.3	2.0	2.2	0.1	0.2		
Spain	4.7	3.6	1.7	3.1	0.6	0.2	40	41
Sweden	. .	. .	0.4	0.5	0.0	0.1	47	34
Switzerland	. .	. .	1.5	1.5	0.1	0.1	80	61
Turkey	2.1	2.7	1.3	1.0	0.3	0.2	17	12
United Kingdom	3.4	2.9	4.6	5.2	0.8	0.9	107	86
United States	1.8	1.6	1.1	. .	0.2	0.1	25	31

Source: OECD Environmental Database.

set water quality objectives. In contrast, in Canada quality standards for streams remain largely limited to regions neighbouring the Great Lakes.

The quality of surface water bodies has generally improved in the OECD area over the last two decades (Table 5.1). Pollution by organic matter and phosphates, which primarily originates from towns and industries, has

Table 5.2. **International water supply use comparison**

	Total freshwater abstractions				
	Amounts		Relative to renewable resources	Per unit of GDP	
	Billion m^3	Annual percentage change 1990-1999[1]	Per cent	Litres per $GDP	Annual percentage change 1990-1999[1]
Australia	24.1	. .	6.8	58.2	. .
Austria	3.6	–0.7	4.2	18.9	–2.6
Belgium	7.4	. .	45.1	31.8	. .
Canada	47.3	1.2	1.7	72.4	–1.5
Czech Republic	2.0	–6.5	12.4	15.5	–6.3
Denmark	0.8	–6.2	12.3	5.9	–8.3
Finland	2.3	–0.1	2.1	20.0	–1.6
France	30.3	–3.0	15.9	23.9	–4.2
Germany	40.6	–2.3	22.3	22.2	–3.6
Greece	8.7	. .	12.1	59.4	. .
Hungary	5.7	–1.3	4.7	54.6	–2.7
Iceland	0.2	–1.0	0.1	21.9	–4.3
Ireland	1.2	. .	2.6	20.1	. .
Italy	56.2	0.0	32.1	45.0	–1.4
Japan	89.1	0.0	21.2	30.0	–1.8
Korea	24.8	2.7	34.3	42.8	–4.0
Luxembourg	0.1	0.2	3.7	3.5	–4.7
Mexico	78.4	. .	16.2	102.7	. .
Netherlands	4.4	–10.7	4.9	12.8	–12.7
New Zealand.	2.0	. .	0.6	34.8	. .
Norway	2.6	. .	0.7	26.0	. .
Poland	11.3	–2.6	17.9	31.4	–6.0
Portugal	11.1	3.7	15.2	74.6	1.4
Slovak Republic	1.1	–6.6	1.4	22.5	–10.0
Spain	40.9	1.7	36.8	62.1	–0.2
Sweden	2.7	–2.1	1.5	14.2	–2.8
Switzerland	2.6	–0.5	4.8	13.2	–1.2
Turkey	38.9	3.2	16.6	100.1	–1.7
United Kingdom[2]	11.2	–0.8	17.4	8.6	–3.0
United States	492.3	1.0	19.9	67.1	–1.4

1. 1989-99 for Luxembourg; 1992-99 for Iceland; 1990-98 for Belgium, Denmark, Hungary and Switzerland; 1991-98 for Germany and Portugal; 1989-98 for Italy; 1990-97 for Australia, Austria, France, Greece, Japan and Korea; 1991-97 for Spain and Turkey; 1991-95 for Canada; 1990-94 for Ireland and Norway; 1991-96 for Netherlands; 1990-93 for New Zealand; 1990-95 for Sweden and the United States.
2. England and Wales only.

Source: OECD Environmental Database.

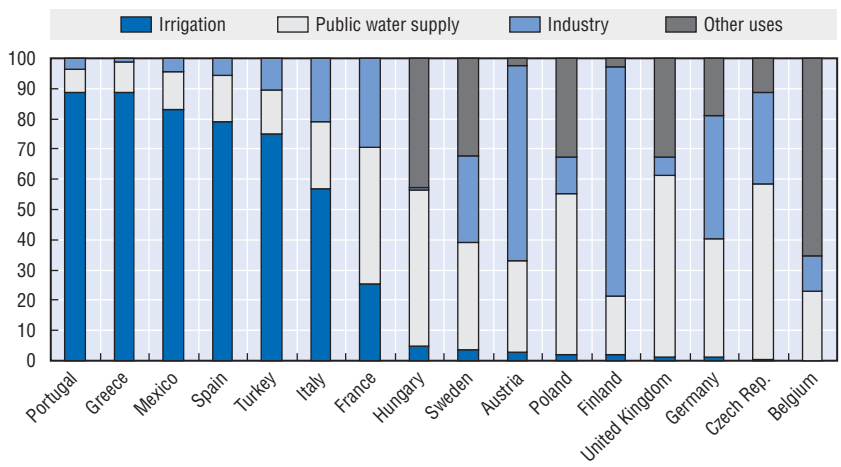
greatly diminished in all examined OECD countries bar Mexico, where four fifths of all sewage is discharged into rivers untreated. Surveys observed that this improvement has been brought about primarily by large investments in facilities for sewage collection and treatment. Some localised problems remain downstream of the few large cities that still release large quantities of

untreated sewage (Brussels, Milan, Porto). In addition, nitrogen surpluses from on-farm activities have declined in two-thirds of countries, sometimes substantially.[3] However, there were some cases when concentrations in rivers rose even though nitrogen balances declined. Such results may occur because excess nitrogen can accumulate in agricultural soils over several decades before being released to water bodies.

Some de-coupling between economic activity and water abstraction occurred during the 1990s as the quantity used per unit of GDP fell in almost all countries (Table 5.2). Efficiency improvements in water-intensive industries (such as pulp and paper, chemicals and food processing), reduced leakage in public water supply and enhanced application devices in irrigation are the main factors behind this development (OECD, 2003a). However, surveys indicated that irrigation, which accounts for most of water consumption in water-scarce countries (Figure 5.1), still threatens the sustainability of groundwater resources in all reviewed countries:

- Australia, where 30 per cent of groundwater management units are over-using resources and another 32 per cent close to full use;
- Mexico, especially in the North Central region where abstractions from underground resources, nine-tenths of which go to irrigation, exceed recharge by 62 per cent;
- the Netherlands, where excessive pumping from aquifers can result in irreversible damage from saltwater intrusion due to the low-lying nature of much of the country;

Figure 5.1. **Water abstraction by final use**[1]



1. Excluding temporary withdrawals for power plant cooling.

- Portugal, where the amount of water abstracted for agriculture rose by 72 per cent in the 1990-98 period and irrigation is shifting from regions that are best endowed with water to those that are facing water shortages;
- Spain, where saltwater intrusion is a problem in the south and the south-east of the country; and,
- the United States, where about 10 per cent of the country's water supply represents depletion of stored water.

3. Policies

3.1. Policies to reduce water pollution

Regulatory approaches, which form the main plank of OECD countries' policies to counter water pollution from industry and human settlements, have lowered pollution loads but do not appear to have done so at the lowest cost. The principal recommendations made to improve outcomes are presented in Table 5.3. Industrial plant discharges have been subject to emission limits that are often set on a case-by-case basis (Table 5.4). Central or regional governments typically mandate municipal authorities to expand sewage collection and treatment. Country reviews showed that these policy instruments have been effective in cutting pollutant discharges from towns and industries, except where enforcement is deficient (Mexico). The costs of these policies are difficult to assess, especially for businesses, because part of their expenditure to comply with wastewater permits is inextricably linked with general investment and operational spending. However, even on conservative assumptions, the associated costs appear to be sizeable in many OECD countries (Figure 5.2). Country surveys pointed out that costs are likely to have been higher than necessary because regulatory approaches do not generally equalize marginal abatement costs across sources within river basins. For instance, in the United States, the marginal costs of reducing organic pollution discharges from poultry processing have been estimated to vary across plants by a factor of 30 (Harrington, 2003).

Five reviewed countries have introduced *charges on effluents from industrial plants*. Such instruments have demonstrated their capacity to encourage cuts in pollution loads in an economically efficient way, as was found in the survey of the Netherlands. However, country reviews also noted that some implementation arrangements can blur the price signal conveyed to polluters and thus reduce the efficiency of the tax:

- in Denmark, major polluters get a tax rebate of between 70 and 97 per cent;
- in France, the tax is based on average pollution intensities for different products in a given industry unless firms specifically opt for the emission-based system, with the result that above average emitters have no incentive to reduce their discharges;

Table 5.3. **Policy recommendations in country surveys**

	Canada	Denmark	France	Ireland	Italy	Mexico	Netherlands	New Zealand	Portugal	Sweden	Switzerland	United States
Improve the availability of nation-wide information on water quality	X							X				
Better quantify the benefits of reducing pollution loads		X	X		X					X	X	X
Strengthen water basin authorities and develop integrated plans					X	X	X					
to reduce water pollution					X	X						
For industrial plant discharges,												
Strengthen the enforcement of existing controls and charges						X			X			
Introduce, or modify, emission taxes to generate a clear link												
between discharges and the amount of tax paid			X							X		
Allow trading in discharge permits within river basins								X	X			
For municipal sewage discharges												
Close gaps in wastewater treatment infrastructure					X	X			X			
Price the use of wastewater services in line with full costs	X			X	X	X		X	X			
For point discharges from large livestock rearing units,												
Enforce existing regulations and charges more strictly			X	X								
For diffuse on-farm emissions												
Reinforce controls on manure spreading and fertiliser use				X				X				X
Enforce existing legislation more effectively			X	X					X			
Make agricultural support payments conditional on good practice										X		
or scale them down											X	
Make greater use of economic instruments, notably by	X	X	X	X	X							
Taxing nitrogen surpluses, or		X	X	X	X				X	X	X	
Increasing the rates of existing charges, or							X					
Introducing (or expanding) tradeable discharge permits	X							X	X			X

Table 5.4. **Main policy instruments used to reduce water pollution**

	Canada	Denmark	France	Ireland	Italy	Mexico	Netherlands	New Zealand	Portugal	Sweden	Switzerland	United States
Industrial plant discharges												
Command-and-control regulation		X	X	X	X	–	X	X		X	X	X
Charges		X	X			–	X		–			
Permit trading												X
Municipal sewage discharges												
International and higher levels of government subsidies												
for sewage collection and treatment				X	X	X			X			
Long-run marginal cost pricing of wastewater services		X	X				X				X	
Charging of effluents from wastewater treatment plants		X	X			–					X	
Diffuse on-farm emissions												
Subsidies		X	X	X	X		X			X	X	X
Environmental conditionality of some support payments							X				X	X
Voluntary approaches for on-farm emissions	X	X	X	X	X		X	X	X	X	X	X
Regulation of nutrient management	X	X	–	X	X		X	X	–	X	X	X
Taxation of nutrient surplus		X					X					
Taxation of pesticides		X	X							X		

1. The symbol "–" denotes that instruments of the type concerned are on the books but that enforcement is limited.

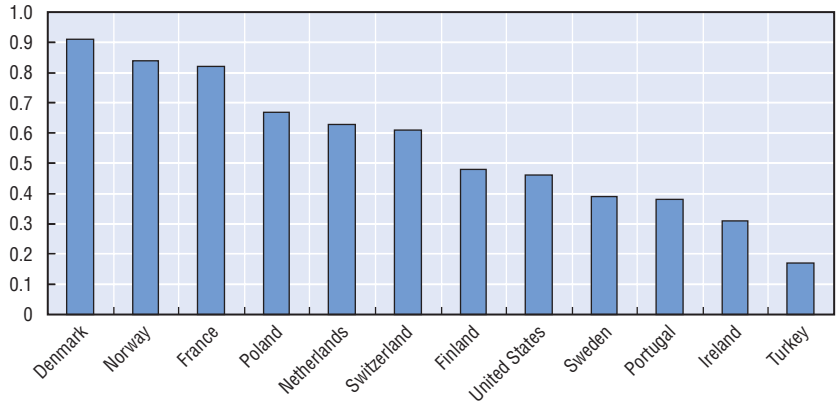
- in Mexico, the collection of effluent taxes on industrial plants is seriously incomplete; and,
- in Portugal, the 1994 decree-law creating water pollution taxes has never been enforced.

The surveys recommended making these taxes more effective by strengthening collection (Mexico, Portugal) or by reinforcing the link between discharges and tax payments (France).

The degree to which the polluter-pays principle is applied to *household effluents* varies considerably across OECD countries and, in many of them, there is scope for improving the efficiency of water pricing schemes by better reflecting wastewater treatment costs. Only a minority of surveyed countries price the use of wastewater services in line with long-run marginal costs so as to recover the full costs of the system (Table 5.4) and, in two of them (Italy, Netherlands), the costs do not include the environmental externalities of effluents from wastewater treatment plants. In many countries, sewage

Figure 5.2. **Expenditure on wastewater**

Public and private investment and operations expenditure on wastewater treatment as a share of GDP in 2000 or latest available year



Source: OECD (2003c).

treatment costs are recovered only partly or through flat-rate charges or levies that vary with property values which, in either case, give no incentive to reduce water use. In one case (Ireland), there is no cost recovery at all as water supply and sewage collection are financed through general tax revenues. Not only does under-pricing encourage inefficiently high water use, but it also puts a strain on public finances which must then bear the burden of wastewater expenditure. Surveys thus recommended moving towards volumetric water charges through combined bills that include a component based on sewage treatment costs (Canada, Ireland, Italy, Mexico, New Zealand, Portugal).

In the reviewed countries, water quality legislation controls *farming* less tightly than other activities. In a majority of cases the policy mixes include regulations but are primarily based on subsidies and voluntary approaches, which have not been effective in cutting discharges (Box 5.1). Indeed, voluntary codes of good practice have not proved able to remedy a problem that does not stem from a lack of information but from the absence of internalisation of pollution costs. Surveys noted that subsidy-based programmes (whether they make existing direct support payments conditional on environmental factors or are additional, specific financial assistance) did not deliver large cuts in pollution loads because they failed to target the most polluting farms.

Inversely, on the basis of their performance where they have been used, taxes and tradeable caps have proved capable of reducing farm effluents efficiently. The experience of nitrogen surplus taxation in the Netherlands shows that farmers respond to price signals. The survey of the United States reported that tradeable caps on farm nutrient surpluses are practicable and

Box 5.1. **OECD countries' policies to tackle nitrate pollution from agriculture***

Farming can pollute water bodies with nitrates by discharging slurry from livestock units directly into streams and spreading excessive quantities of nitrogen inputs on land, in the form of inorganic fertiliser or manure. In countries with extensive livestock rearing, nitrate pollution can also occur if animals are frequently allowed to cross streams or to graze near banks.

Little information is available about the economic costs inflicted by nitrate pollution and existing estimates vary considerably. The survey of France reported a value, derived from expenditure data on drinking water purification, of EUR 0.75 per kilogram of nitrogen in nitrate runoff, which implied a total cost equivalent to 0.1 per cent of GDP. This may be a lower bound given that it neglects all effects on water bodies other than the extra cost of water supply treatment. However, few cost-benefit studies exist of the benefits of lowering nitrate concentrations in drinking water itself. At the other extreme, a study conducted in the Netherlands, using survey responses of willingness to pay for quality improvements, valued the costs of nitrate runoff at EUR 11 per kilogram of nitrogen, suggesting a national damage of 1.4 per cent of GDP (Howarth *et al.*, 2001). Even if geographical dissimilarities (such as the particular vulnerability of the areas where the surveys were undertaken) can explain part of the difference between the two values, such a divergence strongly suggests that estimates are not entirely robust yet and that further research is warranted in this area.

Direct discharges from large livestock rearing units can be monitored relatively easily and, in most surveyed countries, they are subject to the same regulations and charges as industrial facilities and municipal sewage treatment plants. Nevertheless, the reviews of France and Ireland noted that these instruments were incompletely enforced for livestock units and recommended to implement them as stringently as for industrial plants and wastewater treatment installations.

The spreading of manure and inorganic nitrogen fertiliser on fields is more difficult to keep in check. Not only is it more difficult to monitor, but its impact on water pollution depends on the amount of nitrogen absorbed by plants, the nature of the soil and the schedule of nitrogen application. Because of the inevitable complexity of introducing any regulation or charge, many countries preferred to address these sources of nitrate pollution by publishing codes of good practice for farmers to adopt on a voluntary basis (Canada, Italy, New Zealand) or in exchange of specific subsidies (France, Ireland, Sweden) or of higher agricultural support payments (Switzerland, United States). Those approaches have been found to have small impact on nitrogen pollution, even when they involved large subsidies. For instance, in

Box 5.1. **OECD countries' policies to tackle nitrate pollution from agriculture*** *(cont.)*

France where government payments for reducing nitrate runoffs have totalled EUR 190 million annually since 1994 for little demonstrable result. Because of the EU nitrates directive, some reviewed countries gave an obligatory nature to part of the codes of good practice in specific areas (Italy, Sweden) or nationwide (Denmark, Netherlands). In the Netherlands, farmers are required to keep nitrogen accounts and are allowed to trade in manure for reducing any surpluses, which are taxed. The Dutch programme has been effective in cuttingpollution loads but costs have been high: the authorities spend EUR 24 million a year on implementing the scheme and farmers pay more than EUR 300 million yearly to test the chemical content of excess manure, weight it and transport it. Costs have also been large in Denmark at EUR 77 million annually where a mix of subsidies, regulations and assessed nitrogen surplus has been used to bring about a sharp reduction in nitrate runoffs from agriculture. In the United States, diffuse nitrate discharges are not systematically controlled nation-wide. But regional schemes have been introduced, notably in North Carolina and Connecticut, to cap on-farm nutrient surpluses (including not only nitrogen but also phosphorus) while allowing trade in permits amongst farmers, industries and municipal wastewater treatment plants. The survey of the United States observed that these trading regimes have reduced pollution loads at low cost.

* This box focuses on those policy measures that were discussed in the country surveys. A more detailed analysis of the issues at stake can be found in OECD (2001) and an in-depth case study of the water pollution impact of pig farming is available in OECD (2003b).

that trading may have cut the costs of meeting pre-existing voluntary targets by half in a scheme operating in North Carolina. Seven country reviews suggested taxing nitrogen surpluses (Denmark, France, Ireland, Italy, Sweden and Switzerland) and four recommended introducing, or generalising, catchment-level trading schemes that would cover on-farm nutrient surpluses and discharges from industries and municipalities (Canada, New Zealand, Portugal, United States).

The lack of quantitative information about the benefits of reducing pollution is a serious obstacle to the formulation of efficient water quality objectives. Indeed, monetary estimates of the advantages are needed if abatement targets are to balance costs and benefits. Whereas some information is available for costs (Figure 5.2 and OECD, 2003c), benefit valuation is still largely absent or highly uncertain. For instance (see also Box 5.1), in the United States, the Environmental Protection Agency considers that the Clean Water Act has provided benefits in line with costs but other authors have found benefit-cost ratios of 1:6

(Freeman, 2003) or even 1:20 for those Clean Water Act regulations that have been subject to regulatory impact assessment between 1981 and 1996 (Hahn, 2000). Six country surveys emphasised the lack of information about benefits as a serious problem and recommended further efforts to better quantify them (Denmark, France, Italy, Sweden, Switzerland, United States).

3.2. Policies to manage water resources

In reviewed countries, the two main families of instruments used to manage water resources are *property rights* and *taxation*, which often take the legal form of use permits and charges respectively (Table 5.5). The structure of incentives for end-users to save water was also examined in country surveys. Recommendations were made in these areas to enhance the capacity of water policies to contain water extraction within sustainable limits in an economically efficient manner (Table 5.6). This issue is of particular importance to EU member countries, which are compelled by the EU water framework directive to ensure that groundwater abstractions and natural recharge are balanced by 2016.

Country surveys observed that *property rights* have demonstrated their capacity to limit water use in an efficient fashion where they have been used but that their potential remains largely unexploited. Australia has been reforming its water policies since 1994 with the objective to obtain a fully market-based system before 2005 for apportioning the amount of water available after allowing for environmental needs. At the time when the review was conducted, in late 2002, the process was well advanced and had already

Table 5.5. **Water management policies: a summary**

	Australia	Mexico	Netherlands	Portugal	Spain	United States
Policies in place to manage water include:						
Abstraction charges for						
Industrial users	X	X	X			–
Municipal utilities		–	X		X	–
Irrigators	X		–		–	–
Phasing out subsidies to irrigators	X					
Trading in water rights	R	X				R
Consumption-based billing in urban areas	X	X	X	X	X	–
So as to recover the full cost of supplying water	X		X			
Pumping treated water to replenish depleted aquifers			X			

Notes: X indicates that the corresponding measure is implemented widely across the country;
– indicates that the instrument exists but is used to a limited extent only;
R denotes a regional measure.

Table 5.6. **Water management: policy recommendations in country surveys**

	Australia	Mexico	Netherlands	Portugal	Spain	United States
Give greater responsibility to river basin authorities		X	X			
Establish sustainable water allocations	X	X			X	
End subsidies to irrigation		X		X		X
Charge farmers and other users for the full, long-term cost of water abstraction		X	X			X
Remove barriers to trading in water rights	X			X	X	X
Charge households in line with the full costs of supplying water		X		X		X
Improve the collection of water charges		X			X	

demonstrated that trading in water rights was successful in allocating limited water supplies to its most productive uses in those regions that did not restrict transfers. In other reviewed countries, the efficiency of trading in property rights was found to be reduced by various factors. Water trading is common practice in Mexico amongst irrigators but its capacity to enhance resource allocation is seriously limited by the restriction that trade with other users, such as industrial plants, requires approval by the national water commission. In the US arid west, property rights exist for the abstraction of surface water and can be traded although this possibility is subject to complicated rules and, in some states, made difficult by poor documentation. As to groundwater, landholders have ownership over underground water in most US states but legal principles only partially account for the linkages between neighbouring properties, which in effect creates an incentive to pump the water before the neighbour does so. In Spain, the fact that abstraction rights are unclear for almost half of the irrigated acreage has created an obstacle to the implementation of effective water management policies. In consequence, surveys recommended clarifying water rights and removing any restrictions so as to facilitate water trading and to maximise its efficiency (Australia, Mexico, Spain, United States). In addition to impediments to trade, several reviews mentioned that current property rights entitlements were above the maximum environmentally and economically sustainable level of abstraction and suggested that entitlements should be reduced accordingly (Australia, Mexico, Spain).

Even though *abstraction fees* have shown that they can reduce water withdrawals, they have generally not led to a reversal of depletion trends, primarily on account of the widespread failure to charge irrigation at sufficiently high rates. In the Netherlands, the EUR 0.16 per cubic metre

extraction fee levied on households and industrial users has delivered a decrease in water abstraction by both categories of users (OECD, 2003d). However, the survey mentioned that Dutch aquifers continue to be threatened by saltwater intrusion due to excessive pumping by irrigators because only 2 per cent of them are liable to the water abstraction charge. Similarly, Mexico's extraction charge has not halted groundwater depletion in spite of a high rate of MXN 13.39 per cubic metre (USD 1.34) in dry areas because the tax exempted farmers[4] and did not recover costs incurred by municipal utilities. In most regions of the United States that have water abstraction charges, farmers are exempted or benefit from preferential rates. Surveys recommended that exemptions should be withdrawn and that all users should be charged at rates that reflected the scarcity of the resource (Mexico, Netherlands, United States).

Country surveys also identified other factors that contribute to households and irrigators making excessive use of water.

- The scarcity value of water resources is rarely reflected in the prices faced by end-users connected to municipal water supply systems, the Netherlands being the only exception amongst reviewed countries.
- Beyond the missing scarcity value, many publicly-funded water supply systems do not price their own investment and running costs in full. Such below-cost pricing is prevalent for publicly-funded irrigation systems in all the surveyed countries bar Australia.[5] Reviews noted that households' drinking water bills do not reflect actual supply costs in many municipalities of Mexico, Portugal, Spain and the United States.
- The EU common agricultural policy provides specific subsidies for irrigated areas in supplement to the regular support payments (Portugal) even though the EU water framework directive calls for full cost recovery by 2010.
- The EU cohesion policy is providing subsidies to large-scale irrigation projects (Portugal, Spain).
- Irrigators benefit from special, below-cost prices of electricity for pumping in *e.g.* Mexico.

In consequence, surveys included recommendations for moving towards the full recovery of costs (Mexico, Netherlands, United States).

3.3. Integrated water policies

A number of countries are using integrated water policies that aim at managing water resources and pollutant discharges in a common, consistent framework at the river basin level (Australia, France, Italy, Netherlands). Because they allow taking proper account of the linkage between water use and water pollution, such policies can be expected to bring more efficient results than in the absence of co-ordination. For instance, well-designed integrated water policies

Box 5.2. **Sustainability issues in fisheries management***

The sustainability of marine, wild fish resources is a cause for concern as 18 per cent of the world's commercial species are fished beyond their maximum sustainable yield and 9 per cent are depleted (OECD, 2003e). In the exclusive economic zones of the reviewed countries, fish stocks are also declining in Norway, Portugal, Spain and the United States. In Norway, rising catches (see table below) have resulted in cod and haddock facing a risk of stock collapse. In Portugal and Spain, earlier over-fishing is reflected in catches that are 41 per cent and 12 per cent below their 1990 levels, respectively. In the United States, the number of species below their maximum sustainable yield rose from 56 to 71 between 1990 and 1999 (NMFS, 2000) and the proportion of over-fished stocks increased from 28 per cent in 1997 to 36 per cent in 2002 (NMFS, 2003). Iceland is a notable exception in this list of declining stocks since its fish resources are recovering, though at a slow pace as the most valuable species, cod, is forecast to be still 60 per cent below the maximum sustainable yield in 2005.

Table 5.7. **Main indicators: fisheries**

	Fish catch (tonnes)	Fishing fleet			Transfers to the fishing industry	Aquaculture
	Per cent change	Per cent change			Per cent of landed value	Per cent change
		Tonnage	Employment	Number of vessels		
	1990-2000	1985-2001			1999	1990-1997
Australia	1	78.1	11.6	–81.4	. .	319
Belgium	–28	1.6	–33.8	–31.2	. .	273
Canada	–39		–17.2	–31.6	42.1	1 301
Denmark	4	–29.9	–22	–46.1	7.4	80
Finland	15	140.4	–27		136.8	52
France	–4	4.2		–39.2	7.2	18
Germany	–37	–86	82	58.6	31.0	–2
Greece	–25	–38.7	41.7	238.1	47.3	3 261
Iceland	32	62.7	–5.1	8.5	4.4	3 418
Ireland	27			–65.7	51.3	328
Italy	–19	–12.3		–2.6	17.8	105
Japan	–48	–42.1	–35.6	–12.6	23.7	15
Korea	–26	15.6	–30.6	4.3	12.8	–18
Mexico	–3		29.5	102.5	. .	379
Netherlands	22	20	12.8	–0.9	. .	–35
New Zealand	63		–45.7	–18.3	. .	624
Norway	69	–3.8	–22.5	–42.6	14.3	1 310
Poland	–51		–47.5	. .	. .	78
Portugal	–41	–39.3		–32.7	8.8	18
Spain	–12	–18.7		–2.6	13.8	17
Sweden	35				23.9	57
Turkey	33	21.4	159.2		. .	2 827
United Kingdom	–2	–19.7	6.5		8	659
United States	–15		–76.9		30.8	32

Source: Food and Agricultural Organization (FAO), OECD and World Bank.

Box 5.2. **Sustainability issues in fisheries management*** *(cont.)*

Country surveys mentioned subsidies and a reluctance to enforce adequate cap on total catches as the main reasons behind the over-exploitation of fish stocks. Progress on both counts has been slow.

- Subsidies to the fishing industry remain high in many OECD countries (see table below on fisheries management). Iceland, however, provided an example of support transfers that have been brought to very low levels while the fishing industry remained profitable. In EU countries, supranational subsidies for the construction of fishing vessels are scheduled to be phased out from 2005. The survey of Portugal recommended scaling back fishing subsidies.
- Total allowable catches (TAC) are in place in all reviewed countries (see table below on recommendations concerning fisheries management) but they are set at levels that are too high to protect fish stocks except for Iceland. Although Icelandic TACs are sufficiently low to secure the viability of the species, they are still too high to restore stocks to a level that maximises long-term returns. The surveys of Iceland, Norway and Portugal suggested that TACs should be tightened.

Table 5.8. **Fisheries management policies: a summary**

	Iceland	Norway	Portugal	Spain	United States
Effort-based restrictions			X	X	X
Buy-back subsidies to reduce capacity					X
Total allowable catch	X	X	X	X	X
Individual quotas		X			
Free trade in individual quotas	X				R
Fishing fee	X				

Notes: : X = denotes a policy instrument in place nation-wide; R = indicates that the instrument is used in certain regions.

Table 5.9. **Fisheries management: recommendations in country surveys**

	Iceland	Norway	Portugal
Remove fishing subsidies			X
Lower total allowable catch limits	X	X	X
Allow free trade in quotas		X	X
Remove remaining restrictions on trade	X		

Box 5.2. **Sustainability issues in fisheries management*** *(cont.)*

Caps on total catches can be enforced by various technical or administrative restrictions to reduce the fishing effort (Portugal, Spain, United States) or by the allocation of individual quotas to owners of fishing boats (Iceland, Norway and some fisheries in the United States). Surveys observed that effort-based measures usually resulted in unnecessary costs. For instance, restricting the number of fishing days creates an incentive to over-invest in fishing vessels so as to maximise the quantity of fish that can be caught in a limited period. In contrast, individual quotas have proved able to deliver cuts in fish capture at low economic cost in Iceland where they can be traded relatively freely. In Norway and in most of the United States, the exchange of fishing quotas is subject to various restrictions that aim to preserve the geographical pattern of employment in fishing communities. Such limitations come at a substantial cost since they prevent market forces from reallocating resources in a way that minimises the cost of meeting a given TAC. The survey of Norway recommended allowing free trade in fishing rights and the review of Iceland suggested that the remaining restrictions on trade should be abolished.

* This box focuses on policies that were examined in the OECD economic surveys of Iceland, Norway, Portugal and Spain in the context of the Organisation's work on sustainable development. Some US policies are also mentioned here because the country's exclusive economic zone has the largest domestic marine wild fishery catch in the OECD area. Fisheries management is discussed in detail in OECD (2003e).

lead the authorities to compare the costs of cleaning water downstream before it is supplied with those of discouraging pollution upstream. Integrated policies also facilitate cost recovery. Supervising water supply operators provides the river basin authority with a wealth of information on the costs of upstream pollution, which they can use to estimate the rates at which pollutant releases should be charged. Moreover, integrated management makes it easier to add pollution-based charges to water bills. For those reasons, several country surveys recommended reinforcing integrated water management schemes (Italy, Netherlands) or introducing such arrangements (Mexico).

An important development in this area is the EU water framework directive which calls for the generalisation of integrated water management and full cost recovery in all EU member countries. Under this directive, management plans must be ready for all EU river basins by 2010. The directive also calls on EU countries to ensure that charges for water supply, sewage collection and treatment recover the associated costs in full. But countries that have a history of not pricing water can be exempt from this obligation if they demonstrate that they will achieve the environmental objectives set by the directive through other means.

Notes

1. The EDR Committee has released country surveys of policies to reduce water pollution for Canada, Denmark, France, Ireland, Italy, Mexico, the Netherlands, New Zealand, Portugal, Sweden, Switzerland and the United States.
2. Reviews of natural resources management policies have been conducted by the EDR Committee for Australia, Finland, Iceland, Mexico, the Netherlands, Norway, Portugal, Spain and the United States. The question of water supply was covered in all surveys except for Finland, Iceland and Norway because they are abundantly endowed with water and there are no concerns over excessive exploitation. The review of Iceland focused on the husbanding of fish stocks, an issue that was also addressed in the Norwegian survey though it dealt in more detail with the management of oil and gas resources. The survey of Finland looked at the question of whether forest resources are managed in a sustainable fashion.
3. The main sources of nitrogen inputs in agricultural soil are livestock manure and fertiliser. Other sources include deposition of air pollutants and sewage sludge spread on farm land.
4. Farmers have become liable to the tax since 2003 but at a rate of only MXN 0.1 per cubic metre.
5. Below-cost pricing can take different forms in different countries. In Mexico, Portugal and Spain, only a fraction of the investment costs are recovered from users. In the United States, farmers pay back the investment expenditure to the Bureau of Reclamations in full but over a 50-year period and with a zero interest rate.

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Chapter 6

Reducing and Improving Management of Waste

Reducing waste generation and increasing recycling rates have been considered as central objectives of many sustainable development strategies. This chapter provides data on performance towards these goals and on the associated costs, notably for recycling programmes. It examines which waste disposal options enable to prevent negative effects on the environment at least cost and then presents recommendations drawn from peer reviews on ways to increase the efficiency of strategies to reduce waste-related environmental degradation.

1. Introduction

This chapter provides a synthesis of a series of nine country studies on municipal waste management that have been included in the OECD economic surveys under the heading of sustainable development.[1] The main issues addressed were how to reduce the environmental cost of waste generation and treatment without imposing a high economic cost on society. The reviews did not cover industrial and toxic waste. The discussion below is based on the country reviews but also makes use of information with wider country coverage contained in the accompanying tables.

2. Performance

Since 1990, municipal waste generation has continued to grow in all OECD countries, but it has risen slower than private consumption in about half of them (Table 6.1). Korea, and, to a lesser extent, Poland and Ireland have been notably successful in decoupling waste generation from consumption growth, while Spain, Denmark, Italy and Sweden have recorded significant increases in waste generation per unit of private consumption. Relative to the level of consumption, waste generation around the close of the 1990s was relatively low in Japan and the United States, and relatively high in Turkey and Hungary.

The continued expansion of municipal waste generation was accompanied by a notable shift in treatment practices in many countries, recycling and composting replacing landfilling and incineration. Indeed, recycling and composting have become the dominant means to treat such waste in six European countries (Austria, Belgium, Denmark, Germany, Netherlands and Sweden) and recycling rates have become very high for some materials (Table 6.2). In many of the other countries, although the share of municipal waste going to landfills has fallen over this period, this traditional mode remains the most common means to dispose of waste. Incineration is the most important treatment stream in Denmark, Luxembourg and Japan.

3. Policies

The country reviews generally concluded that neither the mix of waste treatment methods nor policies within individual disposal streams were efficient in reducing the environmental cost of waste at a low cost. The reviews accordingly recommended corrective policy actions, recognising at the same time that countries might want to pursue particular waste policies

Table 6.1. **Performance indicators: municipal waste**

	Waste generation					Initial treatment for waste disposal						Waste disposal costs
	Period	Relative to population	Relative to population	Relative to consumption	Relative to consumption	Year	Total	Recycling	Composting	Incineration	Landfill	
		Kg per capita latest available year	Annual growth, per cent	Kg per USD 1 000, 1995 prices and PPPs	Annual growth, per cent		1 000 tonnes	Per cent				Per cent of GDP
Australia		. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	0.10[3]
Austria	1990-1999	563	3.4	46.1	1.4	1999	3 096	37	17	16	31	1.47
Belgium	1990-2000	545	2.9	46.3	1.2	1999	5 473	40	16	27	17	0.83
Canada[1]	1992-1998	328	0.7	25.1	–1.0	1998	9 926	30	11	. .	. .	0.19[3]
Czech Republic	1996-2000	334	1.9	54.2	0.7	2000	3 434	. .	. .	. .	. .	. .
Denmark	1995-2000	664	3.3	61.4	2.2	2000	3 546	22	16	52	10	1.08
Finland	1994-1999	465	2.4	49.0	–1.4	1999	2 400	32	0[2]	8	60	0.11
France	1989-1999	524	1.2	46.4	0.2	1999	30 744	10	8	33	48	0.57
Germany	1993-1998	538	0.1	45.1	–0.9	1998	44 094	34	7	21	37	0.85[4]
Greece	1990-2001	428	3.4	44.8	1.6	1997	3 900	8	0	0	91	0.38[3]
Hungary	1990-2000	445	–1.6	86.2	–2.2	2000	4 084	0	0	9	91	. .
Iceland	1990-2000	704	0.8	52.4	–1.4	2000	192	9	2	9	81	0.26[3]
Ireland	1990-1998	555	0.6	53.0	–3.1	2000	2 302	8	1	0	91	0.10
Italy	1990-2000	507	3.7	39.9	2.1	1997	27 425	7	9	6	78	. .
Japan	1990-1999	406	–0.1	34.6	–1.4	1999	51 446	13	0	78	9	0.07[3]
Korea	1990-2000	361	–6.6	50.3	–10.5	2000	16 950	41	0[2]	12	47	0.49
Luxembourg	1992-1999	642	1.8	38.7	0.8	1999	227	0	15	59	26	. .
Mexico	1991-2000	316	2.5	63.5	1.3	2000	30 733	2	0	0	98	0.06[3]
Netherlands	1990-2000	609	2.0	53.3	–0.1	2000	9 691	23	24	41	13	0.58
New Zealand[1]	1990-1999	378	1.5	37.7	0.0	1999	1 450	0	0	0	100	. .

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Table 6.1. **Performance indicators: municipal waste** *(cont.)*

	Waste generation					Initial treatment for waste disposal						Waste disposal costs
	Period	Relative to population	Relative to population	Relative to consumption	Relative to consumption	Year	Total	Recycling	Composting	Incineration	Landfill	
		Kg per capita latest available year	Annual growth, per cent	Kg per USD 1 000, 1995 prices and PPPs	Annual growth, per cent		1 000 tonnes	Per cent				Per cent of GDP
Norway	1992-2000	613	2.1	50.8	–0.9	2000	2 755	22	9	15	55	0.26[3]
Poland	1990-2000	316	0.8	64.0	–3.8	2000	12 226	0	2	0	98	0.27
Portugal	1990-2000	443	4.0	51.3	1.2	2000	4 531	6	6	21	67	0.24
Slovakia	1993-2000	316	0.7	58.2	–2.9	2000	1 706	3	6	15	76	. .
Spain[1]	1990-2000	518	4.8	51.9	2.6	1999	18 377	5	18	6	72	0.25
Sweden	1990-1998	452	2.4	47.5	2.1	1998	4 000	25	8	35	33	0.37[3]
Switzerland	1990-2000	652	0.7	41.8	0.2	2000	4 681	32	14	48	6	0.30[3]
Turkey	1989-1998	385	0.9	101.4	–2.0	1998	24 945	0	1	0	99	. .
United Kingdom	1990-1999	567	2.0	44.8	–0.2	1999	33 200	9	2	8	81	0.40
United States	1990-1999	764	0.3	35.7	–1.9	1999	208 520	22	6	15	57	0.25
OECD average		523	0.5	41.9	–1.2		566 052	17	6	20	57	
EU average		530	1.6	45.9	0.5		193 005	17	9	18	55	

1. Data exclude non-household waste.
2. Included in recycling.
3. For this country no information about business sector costs is available. An estimate based on the average for countries without private specialised enterprises has been added. This estimated correction amounts to 0.03 per cent of GDP.
4. For Germany, no figure for the costs incurred by private specialised waste companies was available. An estimated figure of 0.19 per cent of GDP has been added, based on the cost of the Duales System and estimates of the quantity of non-sales packaging that is recycled.

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Table 6.2. **Recycling rates for different categories of raw material**

	Glass packaging	Plastic	Aluminium packaging	Steel Packaging	Paper	Municipal waste
	2000	2000	1999	2001	2000	Recent year
Australia	40	11	67		47	n.a.
Austria	84	19	50	77	66	34
Belgium	87	16	70	88	52	40
Canada		3	63	80	46	30
Denmark	65	7	0	54	48	22
Finland	89	14	95	25	67	32
France	55	8	19	55	50	10
Germany	83	29	72	78	70	34
Greece	27	2	36		35	8
Ireland	35	6	16	66	10	8
Italy	40	11	42	44	37	7
Japan	78	3	73	85	59	13
Korea	67				60	41
Mexico	13				7	2
Netherlands	78	15	70	77	45	23
New Zealand	42				65	n.a.
Norway	85	15	82	56	68	22
Poland						0
Portugal	40	3	20	28	40	6
Slovak Republic						2
Spain	31	14	19	46	48	5
Sweden	86	9	90	71	63	25
Switzerland	91	7	90	70	63	32
Turkey	31				40	n.a.
United Kingdom	34	7	36	37	41	9
United States	23		54	58	42	22

Source: Paper: OECD; Glass: OECD; Steel; Association of European Producers of Steel for Packaging; Plastics: Association of Plastic Manufacturers in Europe; Aluminium: European Aluminium Association.

to attain other objectives. The recommendations are summarised in Table 6.3 and are discussed below.

3.1. *Targets of waste management policy*

The shifts in waste treatment since 1990 have taken place against the background quantitative targets established by governments. At the level of the European Union, this process resulted in the adoption of the 1999 Landfill Directive that specified upper limits on the percentage of biodegradable and inert municipal waste that could be sent to a landfill, and some EU member countries have established more demanding targets in this area. Earlier, the 1994 EU Packaging and Packaging Waste Directive set a minimum total

Table 6.3. **Recommendations on waste management in country surveys: a summary**

	Austria	Belgium	Denmark	Germany	Ireland	Korea	Spain	Sweden	Switzerland
Bring costs in line with benefits in different waste streams		X	X					X	
Base landfill taxes on the externality cost	X		X		X	X			
Better management of landfills							X		
Place a cap on recycling costs	X	X		X		X	X	X	X
Avoid ambitious recycling targets					X				
Lower costs of waste management									
Through increased competition		X		X					X
Through benchmarking		X							
Through trading across municipalities								X	
No discrimination against one-way beverage containers				X					
Establish appropriate waste disposal charges						X		X	X

recycling rate, and recovery and recycling rates for all packaging materials, to be attained in 2001 (Table 6.4). Outside the EU, quantitative targets have been set in Japan and Korea and nearly all US states have indicative recycling targets. In contrast to other countries with high recycling rates, Switzerland does not generally set specific quantitative targets for recycling.

Looking forward, a planned new EU packaging directive will give additional impetus to recycling in member countries. It increases the minimum recycling rate for packaging material in general, to be attained in 2008, to well beyond past recycling targets and how they have been implemented at the national level. It also specifies recycling objectives for five specific materials: glass, paper, plastics, steel and aluminium that are more ambitious than current practice.

3.2. Instruments to discourage landfilling and incineration

To attain the objective of reducing the amount of waste going to landfills and incineration, countries have used a mixture of regulations and taxes. Most member countries have established regulations that ensure the environmental damage from landfills is reduced by capturing landfill gas and by cleaning water that seeps from decomposing waste, and this has raised the private cost of such disposal. The cost of incineration has also increased with tighter regulations on the technology used for burning waste and monitoring emissions. Other types

Table 6.4. **Recycling targets in Europe**

	All packaging		Any material	Specific materials (recycling rates)					
	Recovery rate	Recycling rate	Minimum recycling rate	Glass	Paper	Plastics	Steel	Aluminium	Composite
European Union									
EC Directive: objectives for 2001	50-65	25-45	15						
EU Environment Ministers and European Parliament: objectives for 2008	60	55-80		60	60	22.5		50	
National implementation									
Portugal	50	25	15						
UK	56	50	18						
Spain	50-65	25-45	15						
France	50-65	25-45	15						
Finland	61	42	15	48	53	45	25		
Belgium	80	50	15						
Denmark			15	65	55	15	15		
Austria	50	25	15	93	90	40	95		40
Netherlands	65	65	15	85	35	80			
Sweden			15	70	40 to 65	30	70	70	
Germany	65	45		75	70	60	70	60	60
Ireland	50-65	25-45	15	45	31	10	5	25	
Italy	50-65	25-45	15						
Luxembourg	55	45	15						
Greece	55	45	15						

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of regulations used to discourage traditional modes of disposal include the introduction of a total ban on the landfilling of biodegradable waste in several countries in Europe (Austria, Belgium,[2] Denmark, Finland, France, Netherlands, Sweden[3] and Switzerland) (Table 6.5). In these countries, such waste has to be treated before final disposal. Moreover, in Denmark and Sweden (as from 2005), the landfilling of combustible waste is prohibited.

In an effort to divert waste from landfill, some countries have introduced landfill taxes. The taxes vary significantly across countries and may increase the private cost of landfills from just under 20 per cent (in France) to close to, or more than, doubling such costs (Belgium, Denmark and the Netherlands). In the latter cases the tax exceeds the standard estimated externality costs associated with such disposal (Box 6.1) by a large margin.[4] Two EU countries, the United Kingdom (not reviewed by the EDRC) and Ireland, initially based landfill taxes on estimated externalities but subsequently raised the tax substantially in order to divert waste from such form of disposal. In the United Kingdom, this policy did not achieve the objectives called for by the EU directive, prompting the government to introduce a tradeable quota system for landfill waste as from 2004. This instrument should ensure that the target is met at the lowest cost.

The private cost of incineration has also risen with the introduction of taxes on incineration. Such taxes are, however, confined to three countries in the OECD: Belgium,[5] Denmark and Norway, and may raise the private cost of

Table 6.5. **Waste disposal policy instruments**

	Ban on landfilling of biodegradable municipal waste	Tradeable permits for landfill tonnage	Landfill tax	Incineration tax	Beverage container deposits
			Euro per tonne	Euro per tonne	Euro cent per container
Austria	Yes	No	44	0	40
Belgium (Flanders)	Yes	No	52	13	12 to 24
Canada	No	No	0	0	None
Denmark	Yes	No	50	38	27 to 98
Finland	Yes	No	15	0	11 to 45
France	Yes	No	9	0	None
Germany	No	No	0	0	25
Ireland	No	No	19	0	None
Korea	Yes	No	0	0	None
Netherlands	Yes	No	65	0	16 to 72
Norway	No	No	0	18	16 to 40
Sweden	No	No	31	0	7 to 56
Switzerland	Yes	No	0	0	16 to 40
United Kingdom	No	Yes	19	0	None
United States (10 states)	No	No	0	0	4

Box 6.1. **The externality costs of landfills and incineration**

Both landfilling and incineration can have damaging side effects for the environment. The main negative externalities connected with landfills comes from gas emissions (notably methane), the seepage of contaminants from decomposing waste into the water system and reduced amenity value of the areas surrounding landfill sites. Similarly, incineration is associated with the emission of toxic gases (principally dioxin) and loss of amenity value. As noted in the country reviews, these traditional modes of waste disposal have at times resulted in large costs on society in terms of contaminated sites (Austria and Spain) and health problems (Spain).

However, a number of studies* have found that, as the result of increased regulation over the past decade, a significant proportion of externalities connected with landfills and incineration have been internalised. The lining of landfills has arrested seepage of contaminated water into the ground, and the capture of the emitted gas has stopped such harmful side effects. Similarly, dioxin emissions from incineration have been significantly reduced by burning techniques and filters. As a result the costs of the remaining externalities from modern landfill and incineration facilities are now reckoned to be quite small even if estimates are still marked by some uncertainty. Studies from the UK and Norway put the cost of these externalities for landfills at between EUR 7 and 20 per tonne, respectively (Davis and Doble, 2004; Martinsen and Vassnes, 2004). As to lost amenity values, a large study of house prices in the United Kingdom found that this externality of a landfill site was equivalent to slightly less than EUR 3 per tonne of waste per year. As the private costs of landfilling appear to be of the order of EUR 50 per tonne, the overall social cost of landfill is between EUR 60 and 80 per tonne of waste. This appears to be well below the social cost of incineration where a Norwegian study put externalities at EUR 40 per tonne of waste, while private costs are around EUR 80 per tonne net of electricity and heat that is sold (Martinsen and Vassnes, 2004).

Despite the moderate externality costs linked to modern landfill and incineration facilities, there is often significant local opposition to the establishment of new sites for such waste treatment purposes. For example, the review of Ireland noted the difficulties for the authorities to find sites for planned facilities and the review of Korea reported the public opposition to new waste treatment sites. This could reflect that the lower externality cost has not yet been recognised by the public at large. It could also mirror that the amenity costs are higher than estimated by the economic effects of these sites due to the importance of non-economic factors.

* ECON (2001), COWI (2000).

incineration by 15 to 50 per cent. Unlike the tax on landfills, the taxes on incineration are probably lower than the cost of the associated externality.

In view of the discrepancy between landfill taxes and the externality costs, the country reviews of Austria, Denmark, Ireland and Korea recommended to bring taxes in line with the environmental damage caused by landfills. More generally, the surveys of Belgium and Sweden argued that costs should be aligned with benefits in all waste treatment streams. It was also recommended to relax the restrictions on waste disposal by landfilling in Spain, where it was suggested that compostable waste should be permitted if landfills had methane recovery, and in Sweden, where the prohibition of combustible waste was called into question. Spain was also encouraged to bring non-conforming landfills into line with minimum standards or close such sites.

3.3. Instruments to encourage recycling

A wide range of different policies have been introduced to reach recycling targets in addition to policies diverting waste from landfills and incineration. The principal approach in most countries has been to establish a system of extended producer responsibility and mandate packaging producers to recycle their products directly or indirectly. Alternatively, countries have sought to impose taxes on packaging material in order to attain recycling targets. For beverage containers in particular, many countries have also sought to stimulate recycling and reuse with mandatory deposit systems.

3.3.1. Mandated recycling and recycling organisations

In countries that have adopted relatively low recycling targets (*e.g.* Ireland, Portugal and Spain), the basic system is that business users of packaging (retailers, manufacturers and producers) are given the responsibility to recycle their own waste.[6] However, this liability can be transferred to a collective organisation that subsequently takes responsibility for ensuring that packaging waste is recycled in exchange for a cost-based fee that differs according to the packaging material (a "green-dot" system). In other countries, the obligation of businesses is extended to include taking back household packaging, but once again the obligation can be transferred to a central organisation in exchange for a fee. In turn this requires obligatory sorting of refuse by households. Costs are particularly high in countries (such as Germany and Austria) where the central recycling organisation collects sorted waste. They tend to be relatively low when municipalities are responsible for collecting household packaging waste, with recycling organisation reimbursing them for the cost incurred.

The unit cost of recycling is very high relative to that for alternative means of waste disposal in some countries (Table 6.6). Thus, the average recycling fee per tonne of materials in Austria, Germany and Japan is several

Table 6.6. **Recycling of packaging material: fees and operational characteristics**

	Fees by material					All materials	Characteristics of recycling operations			
	Glass	Plastic	Aluminium	Steel	Cardboard	Weighted average	Recycling company collects	Commercial and industrial packaging covered	Household packaging covered	Kerbside collection
	Euro per tonne					Euro per tonne				
Producer recycling fee										
Austria	87	1 097	494	399	203	238	Yes	Yes	Yes	Yes
Belgium	19	348	171	58	38	50	No	No	Yes	Yes
Finland	10	20	20	20	3	4	No	Yes	Yes	No
France	2	116	32	14	74	56	No	No	Yes	Yes
Germany	81	1 504	975	387	191	254	Yes	No	Yes	Yes
Luxembourg	17	286	143	41	31	44	No	No	Yes	Yes
Portugal	1	40	37	17	10	11	No	Yes	Yes	No
Spain	7	118	54	31	15	16	No	No	Yes	No
Sweden	86	166	166	166	61	73	No	No	Yes	No
Japan	47	592			331	298				
Ireland	6	58	57	63	14	25	No	No	No	No
Memorandum items:										
Traded recycling allowance										
United Kingdom	17	8	18	14	9	10		Yes	No	No
Packaging tax										
Denmark	250	1 000	4 440	1 230	130	515				

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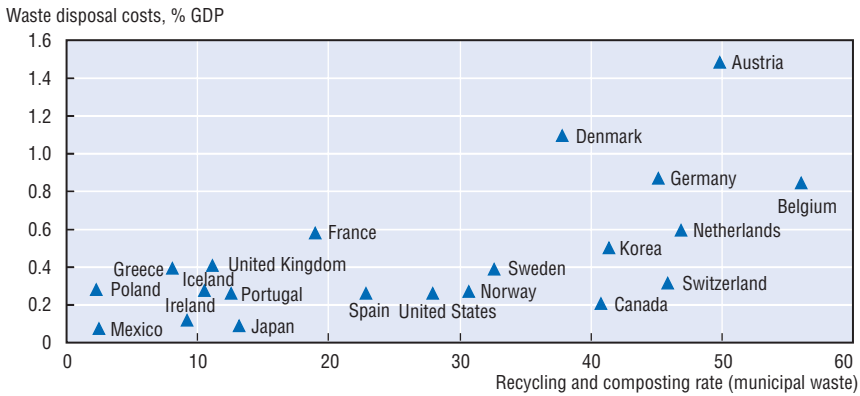
times higher than the estimated social costs of landfilling of EUR 60-80 per tonne of waste or incineration of EUR 120 per tonne of waste. The cost differential is even more striking for some specific materials. For example, recycling fees for plastic and aluminium in Germany are more than ten and eight times, respectively, the cost associated with alternative disposal methods. The unit cost of recycling is even higher in countries where households are mandated to sort their refuse. For example, one Swedish study estimated the cost to households of the time spent for separation and transport at EUR 180 per tonne (Radetzki, 1999).

The high unit costs of recycling could be related to inefficient organisation of such activities, but is also likely to reflect intrinsic high marginal costs of recycling. As noted in the review of Germany, the monopoly granted to one organisation to administer the recycling system is unlikely to result in efficient outcomes. Greater competition in waste management, along the lines in Ireland, where packaging producers can shop around for the lowest-cost recycling option, could help to bring costs down. Also, the country survey of Belgium drew attention to the vast differences in unit costs of waste treatment and recycling across different municipalities within the country and the benefits that could be obtained by attaining country-wide the cost levels in the most efficient local authorities. However, the positive correlation between recycling activity and unit costs of recycling suggest that recycling activity is subject to high marginal costs. The Belgian experience also suggests that raising the recycling rate by 50 per cent will double recycling costs. In Germany, one estimate put the average marginal cost of recycling for the principal waste streams at over EUR 2 000 per tonne (Staudt and Schroll, 1999), which is more than ten times higher than the social costs of landfill and incineration.

The combination of relatively high unit costs of recycling and high recycling activity has meant high outlays in macroeconomic terms: the countries with the highest recycling rates have spent more than half a percentage more of GDP on waste management than other countries (Figure 6.1). With recycling targets becoming more ambitious in many countries that currently have low recycling rates, the cost of waste management is likely to increase appreciably in the coming years.

Against the background of the high costs, the country reviews noted that it would seem to be difficult to justify high recycling rates on economic grounds. An economic rationale advanced for recycling at a higher cost than in alternative waste treatment options after pricing the associated externalities is that recycled material provides a substitute for the extra production of the raw material and so reduces the adverse environmental impact of the production of this material. However, the primary externalities generated by the production of raw materials relate to the emission of

Figure 6.1. **Waste disposal costs and recycling rates**



greenhouse gases, small particles and other polluting gases. All of these emissions are, or will be, regulated or subject to taxes and emission permits (see Annexes 3 and 4), implying that the externality is already incorporated into prices to some extent. To the extent that externality costs are not fully covered, the increasing of charges or tightening of quantitative limits on emissions represents the first best solution to reducing pollution from the production of the raw materials used in packaging. Indeed, a policy that internalise pollution costs will favour recycling, as the price of recycled material should increase relative raises the price of recycled materials. However, studies from the EC and the UK suggest that internalising GHG costs would only have a small impact on the economics of recycling in general (AEA Technology, 2001 and Davis *et al.*, 2004).

In the light of the high costs and low environmental benefits, the EDRC recommended in all the nine country reviews on waste recommended that recycling costs should be capped or that recycling should be scaled back. Ireland was warned against adopting ambitious recycling targets, while for the other countries (Austria, Belgium, Denmark, Germany, Korea, Spain, Sweden and Switzerland) it was recommended to put a ceiling on recycling costs, typically at the level of the costs (including taxes and fees to account for negative externalities) of incineration or landfill. However, in some reviews (including those for Austria and Belgium) it was recognised that countries could pursue ambitious recycling objectives in their own right. A few countries were also encouraged to take measures to lower unit costs of recycling through increased competition in waste treatment (Germany), the benchmarking of recycling costs in municipalities on the least costly one (Belgium) and greater trade in recycling services across municipalities (Sweden).

3.3.2. Taxes on packaging material

A few countries have introduced taxes on packaging materials in order to encourage the recycling of such waste, using the proceeds to finance the recycling of such products. However, Finland and Sweden abolished these taxes when packaging levies were introduced. Instead of establishing a green-dot system to stimulate recycling, Denmark has continued with its packaging tax, with particularly high rates on plastics and aluminium. The calculations that lay behind the establishment of this Danish tax were not based on a monetisation of environmental externalities and this would appear to have led to an over-estimate of the environmental damages. For example, an EC study[7] put the externalities of aluminium at about EUR 1 000 per tonne (mainly due to particulate and heavy metal emissions), equivalent to around EUR 0.01 per aluminium can. However, the Danish tax is set at EUR 0.06 per can. Other countries have put a tax on specific packaging materials to discourage their use rather than increasing recycling. For example, Ireland introduced a Plastic Shopping Bag Levy to reduce litter that resulted in a 95 per cent reduction in the use of such sacks.

3.3.3. Mandatory deposit systems for beverage containers

A number of governments have introduced mandatory deposit systems for beverage containers both as a way to increase recycling and to increase reuse. Deposit rates vary considerably between countries (Table 6.3), as well as between the types of beverage containers. The incentives for users to bring back such containers is particularly high in Denmark and the Netherlands, while the container deposit is low in the ten US states that have a mandatory system. In several countries (including Denmark, Finland, Germany, the Netherlands and part of Canada), various restrictions have been placed on the use of one-way containers to encourage reuse.

Mandatory deposit systems have proved to be an expensive form to encourage recycling. The systems are expensive to administer, costing at least 2 cents per container across the United States and Europe. For aluminium cans (the most valuable form of used containers), such costs are higher than the scrap value of the cans when delivered in bulk to a recycling centre. For countries such as Denmark and Germany that already have high recycling rates for aluminium, the schemes represent a high administrative cost for very little recycling gains. Indeed in the ten US states that have mandatory deposits, the extra net cost of administering the programmes relative to states where there was voluntary recycling was estimated at almost USD 900 per tonne. In Germany, the government introduced mandatory deposits on beverage containers in 2003, but the scheme has proved difficult to operate, as retailers are reluctant to assume the administrative costs and have stopped

selling carbonated drinks in cans and one-way bottles (un-carbonated drinks sold in cans are not subject to the deposit regulation).[8]

The prime objective of mandatory deposit schemes in some countries is to reduce litter rather than to encourage recycling and reuse. Thus, in the Netherlands, the advance deposit system was expected to reduce the number of littered drink containers by 20 per cent, equivalent to 2 per cent of overall litter, at a cost of about 3 euro cents per can. Apart from the high cost of such systems, their effectiveness in reducing litter is uncertain. For example, in the Netherlands no estimates were made of the cost of alternative clean-up strategies when the deposit scheme was initiated.

3.4. Instruments to discourage municipal waste generation

With the aim of reducing the generation of municipal waste, the practice of weight or volume charging has gained ground in recent years. In the countries reviewed for this exercise, it was used in parts of Belgium, Denmark and Switzerland, while it will introduced in Ireland in 2005. In the United States, quantity – related waste charges were paid by about 10 per cent of the population in 1998. In Korea, the simultaneous introduction of volume-related charging and free collection for selected recyclable materials led to a doubling of recycling, with landfilling being halved. The review of Sweden recommended that consideration should be given to introducing quantity-based pricing of waste, and the Korean authorities were encouraged to increase cost-recovery in waste. However, concerns that high charges were resulting in illegal disposal of waste, especially backyard burning, led to a recommendation in the review of Switzerland to reduce volume-based waste charges.

Notes

1. The countries covered were Austria, Belgium, Denmark, Germany, Ireland, Korea, Spain, Sweden and Switzerland.
2. Refers to the region of Flanders.
3. As from 2005.
4. The high tax in Austria was officially estimated to be close to the externality costs, but the latter was based on exceptionally high assumed costs of greenhouse gas emissions from landfills and on risks of contamination caused by, for example, leaky liners.
5. In the region of Flanders.
6. One country not surveyed with low targets (United Kingdom) has a markedly different system in which there is a market in recycling certificates, with each business responsible for delivering an appropriate quantity of certificates rather than actual ensuring its waste is recycled.
7. RDC PIRA (2003).

8. The scheme forces consumers to return the containers to the same shop where they were bought and to provide a receipt as proof of purchase. By October 2003, 80 per cent of deposits were unclaimed, amounting to unclaimed balance of EUR 450 million.

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Chapter 7

Policy Integration for Sustainable Development Areas

Sustainable development requires that policy decisions aimed at a specific goal take proper account of their effects in the environmental, economic and social dimensions. All country reviews of sustainable development have briefly reviewed the arrangements in place to promote policy integration. The chapter reports on the main findings and recommendations from the reviews which examined the extent to which sustainable development plans and institutions facilitate policy integration. It includes specific analysis on the role of various instruments such as cost-benefit analysis, cost-effectiveness analysis, systematic evaluation of legislation and environmental impact assessment.

1. Introduction

The integration of economic, environmental and social policies is necessary to ensure that policy settings aimed at reaching a goal in one domain of sustainable development take into account the effects on other domains. The country surveys briefly reviewed policy integration for all 30 member countries, focusing on the integration of economic and environmental concerns. The reviews looked at three types of methods to integrate cross-domain concerns in overall policy settings: cost-benefit analysis, other integration tools and sustainable development strategies. Within the environmental and economic domains of sustainable development it is, arguably, the absence of markets for many environmental services that creates the need for specific actions to integrate policies. Cost-benefit analysis represents one method of trying to mimic market conditions in the absence of markets. In principle, this evaluation tool is well suited to assessing the trade-offs between economic, environmental and social outcomes of policies in a systematic manner and so the extent of its use was reviewed in all countries. The prevalence of more procedural instruments was also documented. Finally, the reviews looked at the characteristics of countries' sustainable development strategies and related institutional arrangements.

On the basis of the information published in the OECD Economic Surveys, it appears that there is considerable scope for further improvement in the process of policy integration in governments. In particular, despite its limitations, cost-benefit analysis has offered a valuable framework for policymaking in the countries where it is used extensively. However, in most countries the use of such techniques continues to be the exception rather than the rule. While there are many factors that can lead to the adoption of policies that have unfavourable benefit-cost ratios, the more general publication of independently reviewed cost-benefit analyses would represent a significant improvement in the transparency of policymaking. Other instruments, such as environmental impact assessments, can offer a means to improve integration in decision making, but the impact of these approaches is often diminished by limited scope and failure to assess systematically the trade offs between the pillars of sustainable development. Sustainable development strategies have been issued in many countries with a view to integrating economic, social, and environmental concerns, but in many cases only establish a lengthy list of general objectives without any prioritisation or assessment of trade-offs.

Accompanying institutional arrangements can facilitate co-ordination across different ministries and levels of government, but their effectiveness seems to depend on the support of the centre of government.

2. Cost-benefit analysis

2.1. *Cross-country utilisation*

Few countries systematically require formal cost-benefit analysis for policies and projects (Table 7.1), though there has been increasing use of this technique. Cost-benefit analysis must be undertaken as part of a broader regulatory impact assessment in Canada, New Zealand, the United Kingdom, and the United States. In addition, the treaty governing the European Union requires that costs and benefits of policies be taken into account *ex ante*, Despite these requirements in various countries, cost-benefit analysis is not always used even though it is mandatory. Indeed, this often appears to be the case when new regulations are issued in Canada. In other countries, the adoption of policies in the absence of a cost-benefit analysis or when formal analysis shows that costs exceed benefits can require a minister to affirm that the benefits warrant the costs (United Kingdom) or lead to considerable debate (United States). The requirement by the European Union that EU-financed projects be accompanied by cost-benefit analyses has led to the spread of such techniques in Hungary, the Czech Republic and the Slovak Republic. Cost-benefit analysis cannot always quantify all the benefits flowing from a policy in an objective way and the conclusions of formal cost-benefit analyses are sometimes rejected because they are judged to ignore some benefits or attach low values to them. For example, end-of-life treatment of electrical and electronic waste in the EU was adopted despite costs being estimated to outweigh benefits by a ratio of five to one. A number of countries were found to use cost-benefit analysis on an *ad hoc* basis (Austria, Belgium, Spain, Korea) while a few countries mainly restrict the use of such analysis to transport and infrastructure policies and projects (Netherlands, Japan). In the case of Netherlands, parliamentarians are asking for greater use of such analysis. In Japan environmental costs and benefits are often omitted from formal cost-benefit analyses out of concern that net costs could provoke claims for compensation.

2.2. *Problems with its utilisation*

The country reviews detected three problems with the use of cost-benefit analysis as an integration tool.[1] Firstly, the analytical difficulties faced in quantifying some forms of environmental damage. Secondly, the often resource-intensive nature of quantifying damages. This was seen as a drawback in Australia and the United Kingdom. One means of speeding the process, though at the expense of a possible reduction in accuracy, is to

Table 7.1. **The use of cost-benefit and environmental impact analyses in OECD countries**

	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea	Luxembourg	Mexico	Netherlands	New Zealand	Norway	Portugal	Slovak Republic	Spain	Sweden	Switzerland	United Kingdom	United States
Environmental impact assessment of public projects (EIA)	X	XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	X	XX	X	XX	XX	X	XX	XX	XX	X	XX	X	XX	XX	XX	XX
Strategic environmental assessment of policies (SEA)	X	X	X	X		XX	X	X	X					X		X	X		XX		X		X		X	XX		
Monetary valuation of environmental effects in EIA or SEA	X		X					X							X					X								X
Cost-benefit analysis of environmental policies (CBA)	X	X		X		X								X					X	XX	X			X	X		XX	XX
Statutory independent review of CBAs						X																						X

Note: XX = quasi-systematic; X = frequent.

employ information on benefits from other studies that have been undertaken in more depth. The European Commission has used this approach extensively, through the air pollution and life-valuation estimates generated by its ExternE project. Thirdly, cost-benefit analyses are often undertaken by, or on behalf of, the sponsoring ministry or agency with little external review. In general, the auditing of proposals independently from the sponsoring ministry through either centralised auditing or review by an independent body can help raise the credibility of cost-benefit analysis. Examples where independent review might have been beneficial were found in Austria, Denmark, Spain and the United States.

3. Alternative integration tools

3.1. Cost-effectiveness analysis

A somewhat more common approach to the evaluation of policies is to examine the cost effectiveness of various policy options, as in Belgium and Norway. In these cases, the original policy target is often set on the basis of human or eco-system health and conservation objectives. The objective may also be set with reference to financial affordability, as is sometimes the case in Norway. While cost-effectiveness analysis in these cases should prevent highest cost policy options being chosen in meeting an already determined target, they do not ensure that the chosen policy targets reflect social preferences accurately. The priority given to the achievement of environmental goals is also sometimes incorporated into the constitution. For example, in Greece, the government has "a duty to protect the natural and cultural environment". As no trade-off is mentioned in the law, costs are not required to be taken systematically into account in specifying targets.

3.2. Systematic assessments of legislation

An additional method of attempting to integrate policies has been to require that all legislation include an assessment of economic and environmental impacts of proposed policies at an early stage of the legislative process. This route has been adopted by Denmark, France, Italy and Switzerland in order that the legislator or cabinet be well informed before decisions are taken. In practise, this process appears to have fallen short of expectations. A common experience has been that the assessments tend to focus on the cost to the government budget, rather than providing a fully integrated analysis. In any case, when such analyses are undertaken it is important that they use a common framework and a set of stable economic assumptions. The reviews suggested that this was not the case in Italy. In Denmark the requirement that the Finance Bill evaluate the environmental consequences of economic policy was eventually dropped.

3.3. *Environmental impact analysis*

In contrast to the limited use of cost-benefit analysis, the use of environmental impact analysis (EIA) has become a very common decision-aiding tool at the project level. However, within EIAs there is often only a limited attempt, or indeed no attempt at all, to quantify environmental or other impacts. The reviews noted this was a feature of such procedures in Finland, Germany, Greece, Iceland, Ireland, Italy, Korea, Luxembourg, Portugal, Slovak Republic, Spain and Sweden. As a result, projects that are costlier than the likely benefits can and do emerge from this type of decision making.

4. National sustainable development policy frameworks

4.1. *Different approaches to sustainable development policy frameworks*

In the follow-up to the 1992 World Summit on Sustainable Development in Rio, many countries have adopted, or have prepared, overarching sustainable development strategies that are designed to integrate economic, social, and environmental concerns. This has been the case in Austria, Belgium, Finland, Germany, Iceland, Ireland, Luxembourg, New Zealand, Norway, Portugal, Slovak Republic, Sweden, Switzerland and the United Kingdom, while in Mexico and Turkey, sustainable development issues are now incorporated into national development plans. Some governments have limited their frameworks to facilitating the integration of environmental concerns into decision making (Czech Republic, Hungary, Italy, Japan, Korea, the Netherlands and the United States), partly because it was felt that legislators at the national level were already taking into account the social pillar of sustainable development and also because some had faced difficulty in identifying tractable goals for the social pillar of sustainable development. Another approach to incorporating sustainable development concerns into policy making is to enshrine them in the constitution (Greece, Switzerland). France is currently in the process of consultation about whether sustainable development concerns should be incorporated into the constitution.

4.2. *Improving sustainable development plans*

A general weakness of many national sustainable development strategies is that they often establish a lengthy list of desirable and general objectives without either a prioritisation of policies based on an analysis of the trade-offs between economic, social and environmental concerns, or an identification of appropriate policy instruments to address these objectives cost-efficiently. On the other hand, there have been attempts to develop indicators of progress towards goals in a number of countries. The reviews noted that Australia and Korea had mechanisms in place to ensure that such indicators feed back into the policy process. In other cases, an official standing committee or a national council

monitors progress towards goals (Austria, Japan and Luxembourg). In Canada, a commissioner for the environment and sustainable development monitors sustainable development plans and presents annual reports to parliament.

A number of countries have found that an improvement of their analytical and data bases was necessary to provide accurate indicators of movement towards sustainable development and thus strengthen policy making. For example, Canada has established an information base to assess past policies and highlight areas where change is needed. In France, the Ministry of the Environment strengthened its own economic analysis of environmental measures by establishing an economic department within the ministry. This should complement the traditional *ex post* analyses of policies carried out by the General Planning Commission (attached to the Prime Minister's office).

4.3. Institutional arrangements for policy integration

Institutional arrangements to ensure that policy integration takes place across the pillars of sustainable development are diverse. In a few countries, the early links between sustainable development and environmental issues have led to ministries of environment being assigned primary responsibility for sustainable development policy (Hungary, Spain, and the United Kingdom). In these cases, institutional backing is given to these arrangements by either the cabinet (Hungary and the United Kingdom) or sectoral conferences (Spain). Overall, it appears that policy integration is better ensured with the involvement of the centre of government, though the mechanism for achieving this varies across countries. In some, the office of the president or prime minister takes a leading role in efforts to integrate sustainable development policy (Germany and Korea; Sweden is considering taking this route). In others, governments rely on inter-ministerial co-ordination that varies in its degree of formalism. Thus, Norway and Sweden have long-standing traditions of the "collegiate approach" to government. A similar approach is used in the Netherlands, though in certain key areas legislation mandates consultation among certain ministries. In Hungary, Italy, and the Slovak Republic, standing commissions or councils serve as the fora for bringing together the various parties. In Finland a National Council, chaired by the Prime Minster, sets the agenda, through the preparation of "guidance" documents rather than through formal legislative powers. Finally, an alternative approach is to rely on *ad hoc* committees that are established when a cross-cutting issue arises (Czech Republic, Germany, Greece, Luxembourg). Some rely on different mechanisms simultaneously (Canada and Ireland).

Policy co-ordination across levels of government, particularly in federal states, is another important dimension. In Australia, Belgium, Canada, the Czech Republic, Germany, Italy, Spain, and Switzerland, addressing environmental (or less frequently other sustainable development) issues has been complicated by

the allocation of responsibility across levels of government. In these cases, decisions of bodies that bring together representatives of the different levels of government (Switzerland, Netherlands), new legislation (Australia) or constitutional changes (Spain) may be required to determine which level of government is best suited to responding to particular policy issues. In some cases forging sufficient sub-national government agreement is a prerequisite for adopting the most cost-effective policy instruments. In both Korea and Mexico, the weak presence of the central authorities coupled with the orientation of local governments towards economic development has lowered the attention given to environmental concerns.

Note

1. An additional problem was noted in the case of the United States: policies governed by the Clean Air Act may not be set on the basis of formal cost-benefit analysis.

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ANNEX A

Sustainable Development Indicators

This annex presents the sustainable development indicators that have been assembled for the seven areas covered in the country reviews: reducing emissions of greenhouse gas, reducing air pollution, reducing water pollution, improving natural resource management, reducing and improving the management of municipal waste, improving living conditions in developing countries and ensuring sustainable retirement income.

Table A.1. **Reducing emissions of greenhouse gases: main indicators**

	Total GHG emission intensity	CO_2 emission intensity, electricity	CO_2 emission intensity, transport	GHG emission intensity, other sources	Total GHG emission intensity	CO_2 emission intensity, electricity	CO_2 emission intensity, transport	GHG emission intensity, other sources
	2000, g CO_2 equivalent per 1995 US$ using PPPs				Percentage change 1990-2000			
Australia	1 061	360	159	542	–1.82	–0.46	–1.52	–2.70
Austria	403	66	96	241	–2.05	–3.20	–0.02	–2.42
Belgium	600	105	97	398	–1.47	–1.27	–0.19	–1.81
Canada	888	156	183	549	–0.94	0.24	–0.85	–1.28
Czech Republic	1 082	468	100	514	–2.77	2.54	6.33	–6.58
Denmark	501	171	88	242	–2.38	–2.73	–0.84	–2.64
Finland	597	178	99	321	–2.56	–0.17	–1.83	–3.84
France	402	30	102	271	–2.00	–2.60	–0.02	–2.57
Germany	519	168	91	260	–3.92	–3.57	–1.05	–4.95
Greece	819	275	122	422	–0.16	0.07	–0.02	–0.34
Hungary	747	192	79	476	–2.60	–1.30	–0.24	–3.40
Iceland	398	0	84	314	–1.82	. .	–2.47	. .
Ireland	643	152	98	392	–4.63	–2.97	0.23	–6.03
Italy	432	108	89	235	–1.06	–0.43	0.01	–1.70
Japan	441	132	81	229	–0.34	0.13	0.89	–0.99
Luxembourg	314	6	249	59	–12.47	–27.09	0.62	–23.13
Netherlands	553	138	80	335	–2.49	–0.95	–1.09	–3.34
New Zealand	1 078	82	179	817	–2.21	2.87	0.80	–3.12
Norway	454	3	97	354	–2.91	–1.57	–2.86	–2.93
Poland	1 109	458	74	576	–5.19	–6.48	–1.39	–4.46
Portugal	516	129	111	276	–0.06	0.85	3.47	–1.51
Slovakia	846	249	70	526	–5.21	0.98	1.98	–7.60
Spain	536	130	127	278	0.35	1.21	0.97	–0.28
Sweden	340	35	110	195	–1.91	–1.52	–0.77	–2.56
Switzerland	267	2	78	187	–0.94	–3.82	–0.40	–1.11
United Kingdom	512	137	106	268	–3.58	–4.30	–1.41	–3.94
United States	779	273	192	315	–1.86	–0.73	–1.30	–3.04
Total of above OECD countries	639	201	137	307	–1.81	–0.79	–0.58	–2.76
Non-Annex 1 countries								
	CO_2 emissions				CO_2 emissions			
Korea	679	232	134	. .	0.33	4.49	1.08	. .
Mexico	456	150	124	. .	–1.22	2.86	–1.88	. .
Turkey	488	178	84	. .	0.47	4.52	–1.26	. .

Source: Greenhouse gas emissions: national submissions to the UNFCCC and national publications. Carbon dioxide emissions for electricity and transport: IEA (2001). GDP: OECD, SNA database.

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Table A.2. **GHG emissions and sectoral indicators**

	Total GHG emissions		CO_2 emissions per Kwh electricity	Manufacturing CO_2 emissions per unit of output	Residential CO_2 emissions per unit of private consumption	Road transpor CO_2 emissions per vehicle–kilometre	Electricity use per unit of GDP	Industrial output per unit of GDP
	Level million tonnes CO_2 equivalent 2000	Annual average percentage change						
		1990-2000	1990-2000	1990-2000[1]	1990-2000[2]	1990-1999	1990-2000	1990-2000[1]
Australia	502	1.7	0.1	–0.7	–1.1	–0.8	–0.6	–1.6
Austria	80	0.3	–2.2	–1.7	–2.4	–1.8	0.1	0.3
Belgium	152	0.7	–1.6	–0.2	–1.1	–0.8	–0.2	–0.5
Canada	726	1.8	1.0	–2.6	–2.0	–0.4	–0.5	1.0
Czech Republic	147	–2.7	–0.2	–7.7	–15.4	4.1	2.8	0.2
Denmark	69	–0.1	–3.4	–1.7	–4.0	–0.2	0.7	–0.6
Finland	74	–0.4	–0.9	–7.2	–7.0	–1.4	0.7	3.2
France	550	–0.2	–2.8	–2.4	–1.7	–0.5	0.6	0.3
Germany	991	–2.1	–1.3	–1.1	–4.0	0.7	–2.1	–1.8
Greece	130	2.2	–2.0	–0.4	2.6	–4.4	2.1	–1.7
Hungary	84	–1.8	–1.3	–12.7	5.4	–3.3	0.2	5.3
Iceland	3	0.7	4.9	. .	–7.7	0.3	2.6	. .
Ireland	67	2.2	–1.3	. .	–6.2	4.8	–1.8	. .
Italy	547	0.5	–1.2	–2.0	–1.4	–1.1	0.8	–0.2
Japan	1 386	1.1	–0.5	–0.8	0.1	0.3	1.0	–0.2
Luxembourg	6	–7.8	–24.5	–13.0	–2.3	3.8	–3.4	–2.2
Netherlands	218	0.4	–2.8	–1.8	–2.9	–0.1	1.8	–0.6
New Zealand	77	0.5	3.7	. .	–3.2	–2.1	–0.8	. .
Norway	55	0.6	0.5	0.8	–8.8	0.5	–1.9	–2.7
Poland	386	–1.7	0.5	–5.8	–6.7	–6.4	6.9	4.4
Portugal	85	2.7	–0.9	0.7	–1.0	–0.4	1.8	–0.6
Slovakia	49	–4.0	1.0	–4.7	–7.4	2.3	0.2	2.4
Spain	386	3.0	–0.2	–0.6	0.4	–0.3	1.2	–0.1

Table A.2. **GHG emissions and sectoral indicators** *(cont.)*

	Total GHG emissions		CO_2 emissions per Kwh electricity	Manufacturing CO_2 emissions per unit of output	Residential CO_2 emissions per unit of private consumption	Road transpor CO_2 emissions per vehicle–kilometre	Electricity use per unit of GDP	Industrial output per unit of GDP
	Level million tonnes CO_2 equivalent 2000	Annual average percentage change						
		1990-2000	1990-2000	1990-2000[1]	1990-2000[2]	1990-1999	1990-2000	1990-2000[1]
Sweden	69	–0.2	–2.3	–4.7	–4.1	–1.4	–0.5	2.5
Switzerland	53	–0.1	1.8	. .	–1.7	–0.3	1.1	. .
United Kingdom	649	–1.3	–4.1	–2.1	–1.9	–0.5	–0.7	–1.6
United States	7 001	1.3	–0.4	–4.0	–1.9	–0.2	–0.4	0.4
Total of above OECD countries	14 543	0.6	–0.7	–2.2	–1.8	–0.3	–0.2	0.0
OECD excluding US	7 542	–0.1	–1.0	–1.5	–1.7	–0.4	0.0	–0.3
EU countries	4 073	–0.3	–2.1	–1.8	–2.4	–0.4	–0.2	–0.7
	Total CO_2 emissions							
Other OECD countries								
Korea	444	6.5	–0.7	–2.3	–7.9	–4.3	5.2	2.0
Mexico	369	2.2	1.0	–6.9	–2.7	1.5	1.7	0.9
Turkey	206	4.1	0.2	1.2	–2.6	–5.0	4.3	0.4

1. 1991-2000 for Germany and Hungary; 1992-2000 for Poland; 1993-2000 for Slovakia; 1990-1999 for Portugal; no data for Iceland, Ireland, New Zealand and Switzerland.
2. 1991-1998 for Czech Republic; 1993-2000 for Slovakia.

Source: Greenhouse gas emissions, national submissions to UNFCCC, national sources and UNFCCC; carbon dioxide data, IEA; industrial production, private consumption, OECD.

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Table A.3. **Reducing air pollution: main indicators**

	Change in emissions per cent of GDP (1995, PPP), 1990-2001[1]			Level of emissions, 2001[1]			Change in sulphur dioxide emissions, per unit of electricity output, 1990-1999[2]	Change in nitrogen dioxide emissions, per vehicle-km, 1990-1999[3]
	Sulphur dioxide	Nitrogen oxides	VOC	Sulphur dioxide	Nitrogen oxides	VOC		
	Per cent, average annual change			Grams per unit of GDP, (1995 US$ PPP)			Per cent annual change	
Australia	–3.4	–1.9	–2.9	4.0	5.7	4.2	–4.7	–5.2
Austria	–9.3	–2.9	–5.8	0.2	0.9	1.1	–11.0	–4.4
Belgium	–8.3	–0.5	–2.0	0.6	1.5	1.1	–7.3	1.5
Canada	–5.8	–2.8	–3.2	3.2	2.7	3.5	–6.8	–6.1
Czech Republic	–17.0	–5.6	–5.7	1.9	3.0	1.8	–17.0	–0.6
Denmark	–18.3	–4.9	–4.8	0.2	1.5	0.9	–17.0	–5.0
Finland	–11.0	–4.4	–4.2	0.7	1.8	1.3	–13.2	–5.1
France	–8.3	–4.0	–4.9	0.4	1.0	1.5	–5.6	–5.2
Germany	–18.0	–6.3	–7.8	0.4	0.8	0.8	–19.2	–5.2
Greece	–2.6	–1.1	–1.6	2.9	2.2	2.2	–0.7	–6.1
Hungary	–9.0	–2.4	–4.1	3.4	1.7	1.2	–2.5	–0.1
Iceland	–1.3	–2.8	–6.8	1.2	3.4	1.1	. .	–2.6
Ireland	–9.8	–6.0	–8.8	1.3	1.2	0.9	–4.7	–0.8
Italy	–9.3	–5.0	–4.8	0.6	1.0	1.1	–8.5	–4.9
Japan	–1.6	–1.3	–2.4	0.3	0.6	0.6	–3.2	–3.4
Korea	–10.9	–5.2	–3.3	1.6	1.6	1.9	–7.9	–6.1
Luxembourg	–18.9	–8.1	–8.6	0.2	0.9	0.7	6.3	–4.6
Mexico	–0.4	–0.9	–9.3	1.6	1.6	1.4	–0.7	. .
Netherlands	–9.9	–6.1	–8.2	0.2	1.0	0.6	–17.5	–6.6
New Zealand	–0.3	–0.5	–1.6	0.7	3.0	2.6	. .	0.2
Norway	–9.8	–3.6	–1.7	0.2	1.8	2.9	0.2	–5.1
Poland	–9.4	–7.3	–2.9	4.3	2.2	2.4	–7.8	–12.7
Portugal	–2.2	–0.4	–1.4	2.3	2.5	2.7	–2.8	–2.4
Slovakia	–13.2	–7.7	–8.2	2.4	2.0	1.2	–12.5	–3.7
Spain	–6.3	–1.8	–3.4	1.8	1.8	2.3	–7.2	. .
Sweden	–7.1	–4.6	–3.9	0.3	1.2	1.8	–3.5	–6.6
Switzerland	–7.0	–5.4	–6.4	0.1	0.5	0.7	–2.7	–6.9
Turkey	2.2	0.4	1.0	3.3	2.3	1.8	–2.1	. .
United Kingdom	–12.7	–7.7	–7.4	0.8	1.1	1.0	–14.4	–7.8
United States	–5.9	–2.9	–4.9	1.8	2.5	1.6	–4.6	–0.6
EU	–10.5	–4.7	–5.4	0.7	1.1	1.2		
OECD Europe	–9.7	–4.6	–4.9	1.0	1.3	1.3		
OECD	–6.5	–2.9	–4.2	1.4	1.8	1.5		

1. 1998-98 for New Zealand and Mexico (nitrogen dioxide); 1994-98 for Mexico (sulphur dioxide and VOC); 1990-99 for Australia, Canada, Japan and Korea; 1990-2000 for Ireland, Italy, Luxembourg, Turkey and the United States.
2. Australia and Poland 1995-99; Mexico: 1994-98; Canada and Luxembourg: 1990-97; Belgium, Czech Republic, France, Greece, Hungary, Korea, Mexico, Portugal, Slovakia, Spain and Switzerland: 1990-98.
3. Germany: 1991-99; Hungary: 1993-99; Poland 1995-99; Slovakia: 1992-98; Korea: 1990-95; Canada: 1990-96; Belgium, France, Greece, New Zealand, Portugal: 1990-98.

Source: OECD Environmental Database, Cooperative Programme for Monitoring and Evaluation of Air Pollutants in Europe (EMEP), European Environmental Agency.

Table A.4. **Reducing air pollution in cities: performance indicators**[1]

	SO_2		NO_x		Particulate matter	
	1990[2]	1999[3]	1990[4]	1999[5]	1990[6]	1999[7]
	Average annual concentration in $\mu g/m^3$					
Australia	. .	. .	59.1	32.0	. .	. .
Austria	19.1	5.9	43.5	32.8	44.1	35.7
Belgium	26.0	13.0	51.0	43.0	. .	27.0
Canada	16.0	14.7	40.0	32.3	39.0	35.4
Czech Republic	37.0	10.0	24.0	20.0	58.3	25.0
Denmark	16.8	3.8	47.6	46.4	66.4	47.5
Finland	12.7	3.4	36.2	30.6	59.8	38.7
France	34.0	. .	46.0	36.0	24.0	22.0
Germany	55.0	7.0	44.0	38.0	46.0	30.0
Greece	39.4	19.2	63.2	58.8	48.0	54.6
Hungary	17.4	17.5	37.2	41.6	68.2	53.2
Iceland	3.8	3.7	14.8	29.0	23.6	27.0
Ireland	23.0	16.0	46.0	70.0	28.0	11.0
Italy	24.2	15.1	98.4	70.7	128.1	66.5
Japan	19.0	12.0	39.0	40.2	42.0	33.2
Korea	114.6	23.1	45.6	52.1	144.1	67.2
Luxembourg	28.3	9.6	51.3	43.1	15.0	11.0
Mexico	113.1	40.8	67.6	56.5	67.0	54.4
Netherlands	20.1	8.1	48.8	41.0	38.3	39.8
New Zealand	2.8	12.7	14.7	20.3	25.0	27.3
Norway	9.0	. .	48.5	43.0	18.0	. .
Poland	36.0	9.4	36.0	23.4	44.0	19.2
Portugal	35.1	6.2	25.4	37.6	72.0	42.0
Slovakia	29.0	19.8	40.1	39.3	54.0	43.6
Spain	38.0	16.6	80.3	58.6	55.5	41.2
Sweden	8.2	3.5	30.1	21.2	9.0	5.0
Switzerland	16.3	7.1	45.9	34.8	38.1	33.4
Turkey	206.9	55.8	58.0	45.0	108.6	48.4
United Kingdom	35.6	15.4	62.3	53.5	16.8	8.7
United States	23.0	15.0	44.0	39.0	30.0	24.0

1. National total except for Australia, Austria, Denmark, Finland, Hungary, Italy, Korea, Mexico, Netherlands, New Zealand, Portugal, Sweden, Switzerland, Turkey and the United Kingdom for SO_2: weighed average (by population of the cities) of concentrations in selected towns.
2. 1993 for Mexico (Guadalajara and Monterey); 1994 for Italy (Rome, Turin and Genoa).
3. 1997 for Hungary (Pecs and Gyor) and the United States; 1998 for Canada and Italy; 2000 for Austria, Japan, Luxembourg, Mexico, Portugal, Turkey and the United Kingdom.
4. 1991 for Finland (Turku) and Portugal (Porto); 1993 for Finland (Tampere), Mexico (Guadalajara and Monterey) and Slovak Republic; 1994 for Czech Republic and Italy (Rome and Genoa).
5. 1997 for Hungary (Pecs and Gyor), Norway, Turkey and the United States; 1998 for Canada and Italy; 2000 for Austria, Japan, Luxembourg, Mexico, Portugal and the United Kingdom.
6. 1991 for Austria (Graz) and Finland (Oulu); 1992 for Hungary (Budapest) and the Netherlands (Vlaardingen and the Hague); 1993 for Mexico (Guadalajara and Monterey) and Portugal (Lisbon); 1994 for the Netherlands (Rotterdam); 1995 for Hungary (Miskolc, Pecs and Gyor) and Mexico (Mexico City).
7. 1996 for Hungary (Miskolc), Portugal (Lisbon) and Sweden; 1997 for Finland (Oulu), Hungary (Budapest, Pecs and Gyor), Italy (Rome), Switzerland (Zurich) and the United States; 1998 for Canada, Italy (Milan and Turin), Korea, Switzerland (Basle) and Turkey (Izmir); 2000 for Austria, Japan, Luxembourg, Mexico, Turkey (Ankara) and the United Kingdom.

Source: OECD.

Table A.5. **Reducing water pollution: main indicators**

	Biochemical oxygen demand		Nitrates		Total phosphates		Nitrogen balance on agricultural land	
	Selected rivers						National	
	Mg O_2/litre		Mg N/litre		Mg P/litre		Kg N/ha	
	Average 1980-85	Average last 3 years	Average 1980-85	Average last 3 years	Average 1980-85	Average last 3 years	1985-87	1995-97
Australia	. .	. .	. .	. .	. .	. .	7	7
Austria	2.2	2.2	1.2	1.3	0.2	0.1	35	27
Belgium	6.6	. .	3.8	. .	0.7	. .	189	181
Canada	. .	. .	0.1	0.1	0.1	0.0	6	13
Czech Republic	8.5	4.6	5.1	3.5	. .	0.3	99	54
Denmark	3.9	2.0	3.5	2.6	0.3	0.1	154	118
Finland	. .	. .	0.2	0.3	0.0	0.0	78	64
France	5.2	3.2	2.8	3.1	0.4	0.4	59	53
Germany	3.6	2.4	3.5	3.3	0.5	0.2	88	61
Greece	. .	. .	1.3	1.5	0.4	0.4	58	38
Hungary	4.4	2.9	2.2	1.6	0.4	0.3	47	–15
Iceland	. .	. .	. .	. .	. .	. .		
Ireland	1.7	1.8	2.2	2.9	0.1	0.1	62	79
Italy	. .	. .	2.0	2.1	0.3	0.2	44	31
Japan	2.3	1.4	. .	. .	. .	. .	145	135
Korea	. .	2.8	. .	2.6	. .	0.1	173	253
Luxembourg	3.8	2.7	4.1	4.1	0.6	0.4		
Mexico	3.7	15.9	1.9	0.6	. .	0.1	28	20
Netherlands	2.8	3.1	4.4	3.3	0.5	0.2	314	262
New Zealand	. .	. .	. .	. .	. .	. .	5	6
Norway	. .	. .	0.3	0.3	0.0	0.0	72	73
Poland	5.0	4.3	1.8	1.9	0.3	0.3	48	29
Portugal	2.6	2.1	3.6	4.4	0.1	0.2	62	66
Slovak Republic	5.1	3.3	2.0	2.2	0.1	0.2		
Spain	4.7	3.6	1.7	3.1	0.6	0.2	40	41
Sweden	. .	. .	0.4	0.5	0.0	0.1	47	34
Switzerland	. .	. .	1.5	1.5	0.1	0.1	80	61
Turkey	2.1	2.7	1.3	1.0	0.3	0.2	17	12
United Kingdom	3.4	2.9	4.6	5.2	0.8	0.9	107	86
United States	1.8	1.6	1.1	. .	0.2	0.1	25	31

Table A.6. **Improving natural resource management: main indicators for water supply**

	Total freshwater abstractions				
	Amounts		Relative to renewable resources	Per unit of GDP	
	Billion m^3	Average annual percentage change 1990-1999[1]	Per cent	Litres per $GDP	Average annual percentage change 1990-1999[1]
Australia	24.1	. .	6.8	58.2	. .
Austria	3.6	–0.7	4.2	18.9	–2.6
Belgium	7.4	. .	45.1	31.8	. .
Canada	47.3	1.2	1.7	72.4	–1.5
Czech Republic	2.0	–6.5	12.4	15.5	–6.3
Denmark	0.8	–6.2	12.3	5.9	–8.3
Finland	2.3	–0.1	2.1	20.0	–1.6
France	30.3	–3.0	15.9	23.9	–4.2
Germany	40.6	–2.3	22.3	22.2	–3.6
Greece	8.7	. .	12.1	59.4	. .
Hungary	5.7	–1.3	4.7	54.6	–2.7
Iceland	0.2	–1.0	0.1	21.9	–4.3
Ireland	1.2	. .	2.6	20.1	. .
Italy	56.2	0.0	32.1	45.0	–1.4
Japan	89.1	0.0	21.2	30.0	–1.8
Korea	24.8	2.7	34.3	42.8	–4.0
Luxembourg	0.1	0.2	3.7	3.5	–4.7
Mexico	78.4	. .	16.2	102.7	. .
Netherlands	4.4	–10.7	4.9	12.8	–12.7
New Zealand.	2.0	. .	0.6	34.8	. .
Norway	2.6	. .	0.7	26.0	. .
Poland	11.3	–2.6	17.9	31.4	–6.0
Portugal	11.1	3.7	15.2	74.6	1.4
Slovak Republic	1.1	–6.6	1.4	22.5	–10.0
Spain	40.9	1.7	36.8	62.1	–0.2
Sweden	2.7	–2.1	1.5	14.2	–2.8
Switzerland	2.6	–0.5	4.8	13.2	–1.2
Turkey	38.9	3.2	16.6	100.1	–1.7
United Kingdom[2]	11.2	–0.8	17.4	8.6	–3.0
United States	492.3	1.0	19.9	67.1	–1.4

1. 1989-99 for Luxembourg; 1992-99 for Iceland; 1990-98 for Belgium, Denmark, Hungary and Switzerland; 1991-98 for Germany and Portugal; 1989-98 for Italy; 1990-97 for Australia, Austria, France, Greece, Japan and Korea; 1991-97 for Spain and Turkey; 1991-95 for Canada; 1990-94 for Ireland and Norway; 1991-96 for Netherlands; 1990-95 for Sweden and the United States.
2. England and Wales only.

Source: OECD Environmental Database.

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Table A.7. **Improving natural resource management: main indicators for fisheries**

	Fish catch (tonnes)	Fishing activity			Transfers to the fishing industry	Aquaculture
	Per cent change	Per cent change			Per cent of landed value	Per cent change
		Tonnage	Employment	Number of vessels		
	1990-2000	1985-2001[1]			2001[2]	1985-2000[3]
Australia	1	78	12	–81	8	300
Belgium	–28	7	–19	–38	12	273
Canada	–39		–17	–32	38	1 267
Denmark	4	–26	–22	–52	4	83
Finland	15	140	–45		88	50
France	–4	15		–45	19	18
Germany	–37	–84	82	40	37	–2
Greece	–25	–40	42	241	67	3 900
Iceland	32	140	–29	15	4	3 900
Ireland	27			–67	75	325
Italy	–19	–27		–2	13	106
Japan	–48	–42	–41	–49	26	15
Korea	–26	6	–69	2	15	–18
Mexico	–3		36	104	. .	390
Netherlands	22	45	13	5	. .	–36
New Zealand	63		–46	–18	. .	617
Norway	69	–4	–36	–16	8	1 294
Poland	–51		–54	. .	10	80
Portugal	–41	–42		–38	9	33
Spain	–12	–27		–16	27	17
Sweden	35				31	67
Turkey	33	21	159		. .	2 533
United Kingdom	–2	–18	7		12	660
United States	–15		–77		36	32

1. 1985-2000 for Japan (number of vessels); 1985-1997 for Australia (employment), Canada, Germany (employment), Greece (employment), Japan (tonnage), Netherlands (employment), New Zealand (tonnage), Turkey, United States.
2. 2000 for Belgium, Canada, Denmark; 1999 for Ireland.
3. 1990-2000 for Belgium.

Source: Food and Agricultural Organization, OECD and World Bank.

Table A.8. **Improving natural resource management: main indicators for forestry**

	Forest cover	Average annual change	Production of roundwood		Timber use
	Per cent		Thousand m^3		Harvest as per cent of growth
	Latest available year	1990-2000	1970	2000	
Australia	19.4	–0.2	12 033	30 493	
Austria	47.6	0.2	11 813	13 276	60
Belgium	22.2	–0.2		4 510	85
Canada	45.3	0.0	121 625	187 444	44
Czech Republic	34.1	0.0		14 441	74
Denmark	10.5	0.2	2 293	3 086	59
Finland	75.5	0.0	45 130	54 263	83
France	31.4	0.4	37 853	50 170	68
Germany	30.1	0.0	37 246	49 106	37
Greece	22.8	0.9	3 046	2 171	60
Hungary	18.9	0.4	5 034	5 902	57
Iceland	1.3	0.5	0	0	0
Ireland	8.8	3.0	382	2 673	65
Italy	23.3	0.3	11 667	9 329	27
Japan	66.8	0.0	49 802	18 121	32
Korea	65.2	–0.1	3 636	4 041	6
Luxembourg	34.4	0.3		259	52
Mexico	33.4	–1.1	31 601	45 666	17
Netherlands	9.2	0.3	945	1 039	62
New Zealand	29.5	0.5	8 706	18 898	57
Norway	39.2	0.4	8 542	8 173	41
Poland	29.7	0.2	18 473	25 652	60
Portugal	37.9	1.7	6 370	9 450	77
Slovak Republic	42.2	0.9		5 213	49
Spain	32.3	0.6	13 653	14 810	52
Sweden	73.5	0.0	59 967	61 800	66
Switzerland	31.7	0.4	4 190	10 428	53
Turkey	26.9	0.2	37 239	17 767	43
United Kingdom	10.5	0.6	3 492	7 451	68
United States	32.6	0.2	327 945	500 434	60

Source: OECD and Food and Agricultural Organization FORIS database.

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Table A.9. **Reducing and improving the management of municipal waste: main indicators**

	Waste generation					Initial treatment for waste disposal						Waste disposal costs
	Period	Relative to population	Relative to population	Relative to consumption	Relative to consumption	Year	Total	Recycling	Composting	Incineration total	Landfill	
		Kg per capita latest available year	Annual growth, per cent	Kg per US$ 1 000, 1995 prices and PPPs	Annual growth, per cent		1 000 tonnes	Per cent, total				Per cent of GDP
Australia		. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	0.10[3]
Austria	1990-1999	563	3.4	46.1	1.4	1999	3 096	37	17	16	31	1.47
Belgium	1990-2000	545	2.9	46.3	1.2	1999	5 473	40	16	27	17	0.83
Canada[1]	1992-1998	328	0.7	25.1	–1.0	1998	9 926	30	11	. .	. .	0.19[3]
Czech Republic	1996-2000	334	1.9	54.2	0.7	2000	3 434	. .	. .	. .	. .	. .
Denmark	1995-2000	664	3.3	61.4	2.2	2000	3 546	22	16	52	10	1.08
Finland	1994-1999	465	2.4	49.0	–1.4	1999	2 400	32	0[2]	8	60	0.11
France	1989-1999	524	1.2	46.4	0.2	1999	30 744	10	8	33	48	0.57
Germany	1993-1998	538	0.1	45.1	–0.9	1998	44 094	34	7	21	37	0.85[4]
Greece	1990-2001	428	3.4	44.8	1.6	1997	3 900	8	0	0	91	0.38[3]
Hungary	1990-2000	445	–1.6	86.2	–2.2	2000	4 084	0	0	9	91	. .
Iceland	1990-2000	704	0.8	52.4	–1.4	2000	192	9	2	9	81	0.26[3]
Ireland	1990-1998	555	0.6	53.0	–3.1	2000	2 302	8	1	0	91	0.10
Italy	1990-2000	507	3.7	39.9	2.1	1997	27 425	7	9	6	78	. .
Japan	1990-1999	406	–0.1	34.6	–1.4	1999	51 446	13	0	78	9	0.07[3]
Korea	1990-2000	361	–6.6	50.3	–10.5	2000	16 950	41	0[2]	12	47	0.49
Luxembourg	1992-1999	642	1.8	38.7	0.8	1999	227	0	15	59	26	. .
Mexico	1991-2000	316	2.5	63.5	1.3	2000	30 733	2	0	0	98	0.06[3]
Netherlands	1990-2000	609	2.0	53.3	–0.1	2000	9 691	23	24	41	13	0.58
New Zealand[1]	1990-1999	378	1.5	37.7	0.0	1999	1 450	0	0	0	100	. .

Table A.9. **Reducing and improving the management of municipal waste: main indicators** *(cont.)*

	Waste generation					Initial treatment for waste disposal						Waste disposal costs
	Period	Relative to population	Relative to population	Relative to consumption	Relative to consumption	Year	Total	Recycling	Composting	Incineration total	Landfill	
		Kg per capita latest available year	Annual growth, per cent	Kg per US$ 1 000, 1995 prices and PPPs	Annual growth, per cent		1 000 tonnes	Per cent, total				Per cent of GDP
Norway	1992-2000	613	2.1	50.8	–0.9	2000	2 755	22	9	15	55	0.26[3]
Poland	1990-2000	316	0.8	64.0	–3.8	2000	12 226	0	2	0	98	0.27
Portugal	1990-2000	443	4.0	51.3	1.2	2000	4 531	6	6	21	67	0.24
Slovakia	1993-2000	316	0.7	58.2	–2.9	2000	1 706	3	6	15	76	. .
Spain[1]	1990-2000	518	4.8	51.9	2.6	1999	18 377	5	18	6	72	0.25
Sweden	1990-1998	452	2.4	47.5	2.1	1998	4 000	25	8	35	33	0.37[3]
Switzerland	1990-2000	652	0.7	41.8	0.2	2000	4 681	32	14	48	6	0.30[3]
Turkey	1989-1998	385	0.9	101.4	–2.0	1998	24 945	0	1	0	99	. .
United Kingdom	1990-1999	567	2.0	44.8	–0.2	1999	33 200	9	2	8	81	0.40
United States	1990-1999	764	0.3	35.7	–1.9	1999	208 520	22	6	15	57	0.25
OECD average		523	0.5	41.9	–1.2		566 052	17	6	20	57	
EU average		530	1.6	45.9	0.5		193 005	17	9	18	55	

1. Data exclude non-household waste.
2. Included in recycling.
3. For this country no information about business sector costs was available. An estimate, based on the average for countries without private specialised enterprises has been added. This estimated correction amounts to 0.03 per cent of GDP.
4. For Germany, no figure for the costs incurred by private specialised waste companies was available. An estimated figure of 0.19 per cent of GDP has been added, based on the cost of the Duales system and estimates of the quantity of non-sales packaging that is recycled

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Table A.10. **Improving living conditions in developing countries: OECD non-energy imports from developing countries**

	Least-developed countries		Other low-income countries		All developing countries	
	Share in total imports, per cent	Average annual growth,[1] per cent	Share in total imports, per cent	Average annual growth,[1] per cent	Share in total imports, per cent	Average annual growth,[1] per cent
	2001	1990-2001	2001	1990-2001	2001	1990-2001
Australia	0.2	7.9	12.6	15.1	22.1	11.8
Austria	0.3	13.1	2.7	9.1	7.6	5.8
Belgium	1.6	5.7	4.5	9.9	11.7	8.8
Canada	0.1	5.1	4.8	17.0	11.9	13.0
Czech Republic	0.1	8.9	4.1	39.7	7.7	20.5
Denmark	0.3	0.9	4.3	9.6	7.4	5.9
Finland	0.5	16.6	4.5	13.7	9.2	8.4
France	0.6	1.0	5.4	11.2	13.0	6.3
Germany	0.5	5.6	5.5	9.2	11.3	4.6
Greece	0.7	7.0	5.1	13.4	13.4	7.9
Hungary	0.1	10.8	5.3	33.5	10.8	24.8
Iceland	0.1	20.0	4.2	21.7	10.4	19.0
Ireland	0.3	5.6	2.9	17.9	7.6	18.1
Italy	0.4	–1.1	4.9	9.8	13.4	3.7
Japan	0.2	–4.7	24.6	14.0	39.0	9.9
Korea	0.1	–2.6	14.3	12.1	24.5	9.2
Luxembourg	0.1		0.7		1.5	
Mexico	0.0	–6.3	0.6	13.5	4.0	14.9
Netherlands	0.4	5.9	7.7	12.3	16.2	7.5
New Zealand	0.1	4.2	10.2	18.6	17.2	12.6
Norway	0.4	–17.5	4.3	14.4	9.4	0.1
Poland	0.4	12.4	4.9	22.7	10.3	18.5
Portugal	0.6	–0.1	2.1	6.1	6.8	3.0
Slovak Republic	0.0		2.7		5.3	
Spain	0.5	3.2	5.5	13.9	13.1	9.3
Sweden	0.2	7.3	2.7	6.8	5.7	3.1
Switzerland	0.1	–1.2	2.5	10.2	5.8	2.7
Turkey	0.2	–2.4	5.7	11.4	12.7	6.7
United Kingdom	0.4	6.8	4.7	9.6	12.8	8.3
United States	0.5	9.1	12.6	16.8	35.2	13.3

Note: 1992 for Hungary and Poland; 1993 for Belgium and Czech Republic; 1994 for Korea.
1. Nominal, in dollar terms.

Source: OECD Foreign Trade Statistics Database.

Table A.11. **Improving living conditions in developing countries: official development assistance (ODA)**

	Total ODA as per cent of GNI		Average annual real growth of ODA	Social and adminis-trative share in total ODA	Share untied bilateral ODA	Share of ODA going to low-income countries
	1990-91	2000-01	1995-2001	2000-01	2001	2000-01
Australia	0.4	0.3	0.6	50.7	59.3	60.5
Austria	0.3	0.3	0.2	42.4	59.2a	67.6
Belgium	0.4	0.4	3.5	42.3	89.8	70.9
Canada	0.5	0.2	–2.6	30.6	31.7	69.8
Denmark	1.0	1.1	4.4	22.8	93.3	76.1
Finland	0.7	0.3	5.0	42.2	87.5	67.9
France	0.6	0.3	–6.6	38.9	66.6	57.3
Germany	0.4	0.3	–1.2	42.3	84.6	58.1
Greece	…	0.2	8.2	70.9	17.3	23.7
Ireland	0.2	0.3	11.9	57.6	100.0	80.1
Italy	0.3	0.1	–2.3	23.4	7.8	62.9
Japan	0.3	0.3	3.0	20.6	81.1	70.1
Luxembourg	0.3	0.8	18.1	69.8	96.7[1]	62.6
Netherlands	0.9	0.8	5.0	26.2	91.2	70.5
New Zealand	0.2	0.3	5.6	49.2	. .	59.5
Norway	1.2	0.8	1.7	41.8	98.9	67.1
Portugal	0.3	0.3	6.7	36.7	57.7	85.7
Spain	0.2	0.3	7.3	34.9	68.9	55.7
Sweden	0.9	0.8	4.4	32.2	86.5	68.6
Switzerland	0.3	0.3	3.0	18.3	96.1	68.7
United Kingdom	0.3	0.3	5.8	25.3	93.9	73.6
United States	0.2	0.1	3.2	42.2	. .	58.8
Total of above countries	0.3	0.2	1.8	32.1		65.2

1. 2000.

Source: Development Assistance Committee Database.

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Table A.12. **Ensuring adequate and sustainable retirement income: main indicators**

	Projected increases in old age pension spending[1]	Low income rate of the elderly[2]	Relative disposable income of the elderly[2]	Private pension funds 1999	Average age of withdrawal, 1994-1999		Participation rate, 2001, per cent		
								Aged 55-64	
	Change in per cent of GDP	Per cent of the elderly with income less than 50 per cent of median disposable income	Per cent of the disposable income of all individuals	Per cent of GDP	Male	Female	Aged over 65	Male	Female
Australia	1.6	16.1	67.6	63.8	59.7	61.3	6.0	60.0	36.9
Austria	2.2	14.9	86.6	3.6			2.8[1]	42.1[1]	17.5[1]
Belgium	3.3	13.8	77.9	6.1			1.3	36.6	15.7
Canada	5.8	2.5	97.4	45.7	62.6	61.1	6.0	61.3	41.7
Czech Republic	6.8			3.8			4.0	55.0	24.5
Denmark	2.7	9.2	73.0	24.4	62.4	61.5	4.6	65.5	51.8
Finland	4.8	7.5	79.0	10.7	59.8	60.0	3.7	51.2	49.5
France	3.9	10.7	89.7	6.3	59.3	59.8	1.2	43.8	34.1
Germany	5.0	10.4	85.6	3.2	60.5	60.8	3.0	50.6	32.4
Greece		29.2	76.8	4.6	61.7	62.2	5.0	57.0	23.6
Hungary	1.2	6.0	85.2	2.2			3.1	36.3	15.4
Iceland				86.0			19.9	92.8	81.7
Ireland		16.7	74.6	57.8			7.9	66.1	29.5
Italy	–0.3	15.3	84.1	3.0	59.3	58.4	3.4	57.8	26.6
Japan	0.6			18.7	69.1	66.0	21.8	83.4	49.2
Korea	8.0			3.2	67.1	67.5	29.6	71.3	47.9
Luxembourg		6.7[3]		. .			0.0	38.1	14.3
Mexico		32.9	85.3	2.4			30.5	80.5	27.6
Netherlands	4.8	1.9	86.3	119.3	61.6	60.1	3.1	52.0	26.9
New Zealand	5.7			. .			8.6	74.6	51.7

Table A.12. **Ensuring adequate and sustainable retirement income: main indicators** *(cont.)*

	Projected increases in old age pension spending[1]	Low income rate of the elderly[2]	Relative disposable income of the elderly[2]	Private pension funds 1999	Average age of withdrawal, 1994-1999		Participation rate, 2001, per cent		
							Aged over 65	Aged 55-64	
	Change in per cent of GDP	Per cent of the elderly with income less than 50 per cent of median disposable income	Per cent of the disposable income of all individuals	Per cent of GDP	Male	Female		Male	Female
Norway	8.0	19.1	74.1	7.4	64.2	64.7	13.2	73.6	63.2
Poland	–2.5	8.4[3]		. .			7.5	41.5	24.1
Portugal				11.4	65.3	66.5	19.0	63.7	41.9
Slovak Republic							1.1	43.0	11.2
Spain	8.0	11.3[3]		2.3	61.1	61.1	1.6	61.4	23.6
Sweden	1.6	3.0	89.2	. .	63.3	61.8	9.4	73.5	67.4
Switzerland		8.4[3]		97.3[4]			11.4	82.4	56.1
Turkey		23.1	92.7	. .			18.1	50.8	18.4
United Kingdom	–0.7	11.6	77.8	84.1	62.0	61.2	4.8	64.4	44.6
United States	1.8	20.3	91.7	74.4	65.1	64.2	13.1	68.1	53.0

1. Deng *et al.* (2001).
2. Förster and Pellizzari (2000).
3. Smeeding (2002).
4. 1998.

Source: Förster and Pellizzari (2000); Jesuit and Smeeding (2002), *Luxembourg Income Study*; OECD *Labour Force Statistics*, Scherer (2002).

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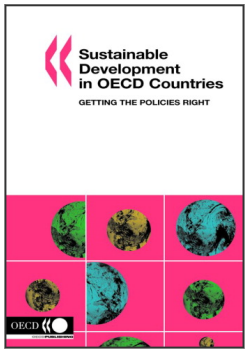

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