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OECD Environmental Outlook to 2030

Chapter 10

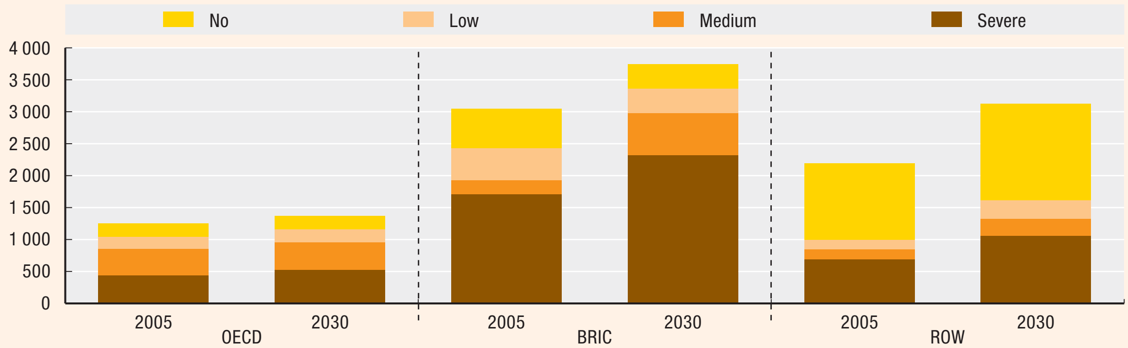
Freshwater

Significant water scarcities already exist in some regions of the OECD and many regions of non-OECD countries. More than 3.9 billion people (47% of the world population) are expected to live in areas with severe water stress by 2030, mostly in non-OECD countries. This chapter examines trends and projections in water stress, public water supply, urban waste water treatment, nitrogen pollution and soil erosion by water. It highlights the good policy principles to address the main water challenges. Much progress remains to be made to integrate water management into sectoral (e.g. agriculture) and land use policies, ensure a more consistent application of the polluter pays and user pays principles through water pricing and reduce subsidies that increase water problems.

KEY MESSAGES

Significant water scarcities already exist in some regions of the OECD and many regions of non-OECD countries. An estimated 3.9 billion people (47% of the world population) are expected to be living in areas with high water stress by 2030, mostly in non-OECD countries (see graph).

People living in areas of water stress, by level of stress (millions of people)



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More than 5 billion people (67% of the world population) are expected to be without a connection to public sewerage in 2030 – 1.1 billion more than today.

Nearly 55 million tonnes of nitrogen are projected to reach coastal waters from inland sources by 2030 (an increase of 4% since 2000). Soil erosion by water will increasingly undermine soils' capacity to support food production. Areas with a high level of erosion risk from water are projected to increase by more than a third to some 27 million km^2 in 2030 (21% of the world land area).

Many OECD countries in recent years have successfully reduced water use per capita and in total, indicating that the right policies can lead to more efficient water use and a decoupling of water use from economic growth/population growth, while taking account of social factors.

OECD countries are committed to increasing official development assistance to the water sector, though recent trends are not sufficient to meet the Millennium Development Goal (MDG) of halving the world's population without access to water and sanitation by 2015.

Policy options

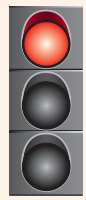
- Put in place the necessary policy frameworks to secure the substantial financing required for non-OECD countries to build and operate water supply and waste water treatment infrastructure and for OECD countries to upgrade theirs.
- Address nutrient pollution of water from diffuse sources (agriculture, atmospheric deposition) and point sources (urban sewage), in both OECD and non-OECD countries.
- Develop policy mechanisms to take into account the economic, environmental and social costs and benefits of water used in agriculture, and to ensure that it is sustainable in the long run. Agriculture is by far the major user of water and is responsible for much of its pollution.
- Improve water governance and river basin management, and ensure optimal pricing for water services worldwide.
- Foster international co-operation on shared river basins to avoid major disruptions to countries' water supply and address transboundary water pollution issues.

Consequences of inaction

- Achieving the MDG of halving the population without access to water and sanitation by 2015 is expected to cost about USD 10 billion per year. But this figure could be far outweighed by the costs of inaction if the MDG is not achieved, in terms of impacts on human health and economic productivity.
- Climate change will pose new challenges for water management, including through impacts on water systems and hydrology, and the potential for increased stress for human populations and ecosystems. Government will need to factor adaptation to long-term climate change predictions into national water management strategies.

Introduction

Clean water sustains human life and ecosystems. Water scarcity[1] affects human health and contaminated drinking water kills an alarming 1.7 million people a year, mostly children under the age of five in non-OECD countries (see also Chapter 12 on health and environment). Lack of, or inadequate, water policy is an indicator of poverty: the 2.6 billion people without access to improved sanitation and the 1.1 billion without access to improved drinking water sources[2] are to be compared, respectively, with the 2.5 billion people who earn less than USD 2/day and the 1.5 billion people with less than USD 1/day.



1.1 billion people lack access to clean drinking water, and 2.6 billion lack access to improved sanitation.

The world's soaring demand for freshwater and pressures on water quality are also causing increasing environmental stress.[3] Some 24% of mammal and 12% of bird species associated with inland waters are threatened. About a third of known freshwater fish species[4] are also thought to be threatened.

Water policy is attracting growing international attention (Box 10.1) and more and more countries aim to enshrine the right of access to (sufficient, affordable and safe) drinking water in national legislation. But water continues to be used inefficiently in many areas. Key challenges identified by UN-Water as priorities for the decade include coping with water scarcity; access to drinking water, sanitation and hygiene; and disaster risk reduction (UN World Water Assessment Programme, 2006). Overcoming the crisis in access to water and sanitation is one of the greatest human development challenges of the early 21st century (UNDP, 2006). Other future challenges include adaptation to climate change and more severe and frequent weather events, such as flooding and droughts; impacts on food security and increasing risk of human migrations, often adding to water supply problems; as well as contamination threats by chemicals, heavy metals and other toxic contaminants.

Key trends and projections[5]

Water stress

In the OECD area, the greatest demands for water come from irrigation (43%), electrical cooling and industry (42%), and public water supply (15%) (OECD, 2007a). But because of losses through evaporation and plant transpiration, the share of irrigation in total water consumption is much higher. In the developing world, agriculture is by far the main user.[6] According to the OECD *Outlook* Baseline, agricultural production will increase two times faster in developing countries than in OECD countries, further exacerbating water scarcity in those regions (see also Chapter 14 on agriculture). Almost all of the projected 34% population increase to 2030 will occur in developing countries, and growing urbanisation in both OECD and non-OECD countries will also increase demand for public water supply (see also Chapter 5 on urbanisation). Electricity and industrial production will increase

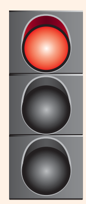
Box 10.1. **The advent of water as an international priority**

The Global Water Partnership (GWP) and the World Water Council (WWC) were created in 1996 in the wake of the Dublin Conference on Water and the Environment and the Rio Earth Summit, both held in 1992. The GWP brings together government agencies, public institutions, private companies, professional organisations, multilateral development agencies and others committed to the Dublin-Rio principles. It is financed by governments. The WWC is an "international multi-stakeholder platform" for over 300 member organisations representing more than 50 countries. Since 1997 the WWC has organised the World Water Forum, held every three years and in which the OECD participates; the latest was in Mexico in 2006 and the next will be in Istanbul in 2009. In 2002, the GWP and WWC joined forces to address the key issue of financing water infrastructure.

In 2003, the "Camdessus Panel" warned that the Millennium Development Goals would not be achieved unless annual investments in water and sanitation services in developing countries were doubled from the 2003 level (Winpenny, 2003). These conclusions were adopted at the G8 meeting in Evian (2003) and the need to implement them in Africa was endorsed at the G8 meeting in Gleneagles (2005). In 2004 the UN Secretary-General's Advisory Board on Water and Sanitation was set up to galvanise action on water and sanitation, and to help mobilise resources to achieve the water and sanitation MDG. Chaired by Angel Gurría, now Secretary-General of the OECD, a "Task Force on Financing Water for All" was established in 2005 to continue the work initiated by the Camdessus Panel. A Task Force report was presented to the 4th World Water Forum in Mexico. It highlights the need to harness local financing and to fund necessary investments in agricultural water management (van Hofwegen, 2006). Some of the key areas for further work identified in this report have since been taken up in the OECD's horizontal work programme on water for 2007-2008.

much faster in non-OECD countries than in OECD countries (see also Chapter 17 on energy). Overall, pressures on water use are thus projected to increase at a much higher pace in developing countries than in OECD countries.

According to the Baseline,[7] 44% of the world population already lives in areas of high water-stress[8] and the situation is projected to worsen, with an additional 1 billion people projected to be living in areas with severe water stress by 2030 (Table 10.1). More than half the population affected by severe water stress is (and will continue to be) found in the BRICs. The main increase in population affected will be in India and, to a lesser extent, in China, Africa and the Middle East. The latter region is projected to experience its fastest population growth in the most arid areas. The relatively limited projected increase in China to 2030 (an additional hundred million people affected) reflects China's one-child policy and lack of land for expanding agriculture. The *OECD Environmental Outlook* Baseline projects a decrease in agricultural water consumption in China to 2050, largely as a result of uptake of improved irrigation technology. But this is expected to be more than offset by a dramatic increase in non-agricultural water uses associated with economic development, most prominently industrial use and, to a lesser extent, urban household demand (Chinese Academy of Sciences, 2000).



More than 40% of the world's population lives in areas affected by high water-stress, and this will increase to 2030.

Table 10.1. **Population and water stress, 2005 and 2030**

Millions of people

Region	Degree of water stress	2005	% of total in 2005	2030	% of total in 2030	% change 2005-2030
OECD	**Severe**	**438**	35%	**525**	38%	**20%**
	Medium	415	33%	434	32%	5%
	Low	186	15%	198	14%	6%
	No	211	17%	211	15%	0%
	Total	**1 250**	100%	**1 368**	100%	**9%**
BRIC	**Severe**	**1 710**	56%	**2 319**	62%	**36%**
	Medium	216	7%	661	18%	207%
	Low	506	17%	381	10%	–25%
	No	619	20%	378	10%	–39%
	Total	**3 051**	100%	**3 740**	100%	**23%**
ROW	**Severe**	**688**	31%	**1 057**	34%	**54%**
	Medium	164	7%	272	9%	66%
	Low	143	7%	287	9%	101%
	No	1 198	55%	1 512	48%	26%
	Total	**2 193**	100%	**3 128**	100%	**43%**
World	**Severe**	**2 837**	44%	**3 901**	47%	**38%**
	Medium	794	12%	1 368	17%	72%
	Low	35	13%	866	11%	4%
	No	2 028	31%	2 101	26%	4%
	Total	**6 494**	100%	**8 236**	100%	**27%**

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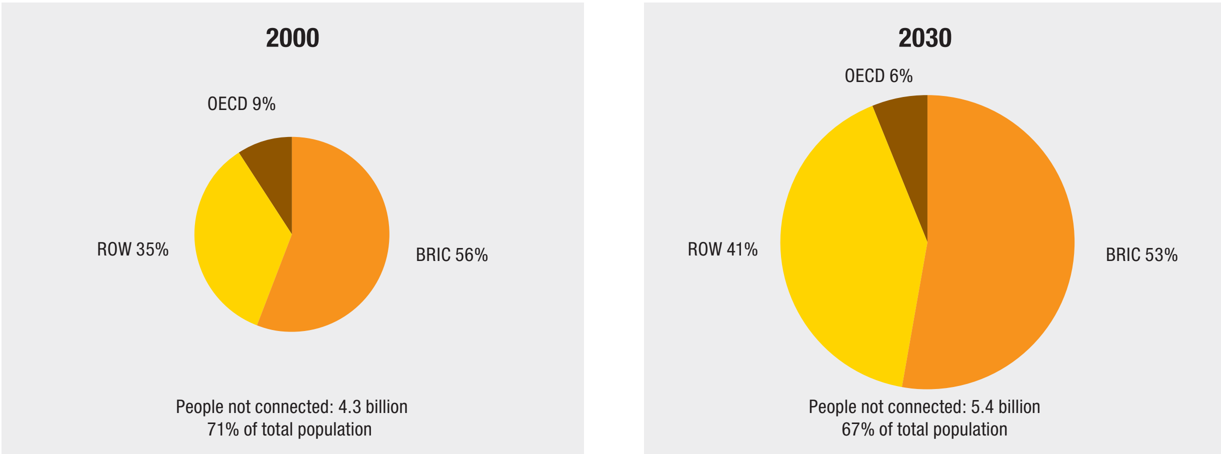
Source: OECD Environmental Outlook Baseline.

Public water supply and urban waste water treatment

Most OECD countries have been able to ensure adequate access to a safe water supply for human needs and significant efforts have been made in the OECD area to treat organic pollution from urban waste water. Since 2000 sustainable access to improved drinking water sources and sanitation facilities have become key policy objectives for non-OECD countries, as part of the UN Millennium Development Goals (MDG) and as agreed at the 2002 World Summit on Sustainable Development.[9]

According to the OECD *Outlook* Baseline, some of the recent progress in public sewerage connection rates is projected to continue to 2030. Despite this, it is projected that there will be 1.1 billion more people worldwide in 2030 who are not connected to public sewerage compared with 2000 (Figure 10.1). By 2030 the situation will have (further) improved in the OECD area but deteriorated in the BRIC area, with the latter still accounting for half of the world population not connected. The situation is of most concern in the rest of the world where the number of people not connected will dramatically increase (to 2.4 billion), accounting for 80% of the 2030 population in these regions. In many areas of the developing world, waterborne sanitation systems may not be the most sustainable option, and other improved facilities may be more suitable. Even when considering other solutions, in 2004 only around one-third of the sub-Saharan African population had access to improved sanitation facilities (WHO/UNICEF, 2006).[10] According to UN projections based on 1990-2004 trends, the MDG target for sanitation will not be met by 2015.

Figure 10.1. **People not connected to public sewerage systems, 2000 and 2030**



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Source: *OECD Environmental Outlook* Baseline.

Nitrogen pollution[11]

In the OECD a third of main rivers have phosphorus and nitrate concentrations higher than, respectively, 0.2 mg P/litre and 2.5 mg N/litre (OECD, 2007a). In combination, these levels contribute to algal growth in receiving coastal waters. Point source discharges to surface water have been reduced in OECD countries, especially from industrial and urban waste water systems, though the level of treatment (nutrient removal in sensitive areas) could still be improved. In contrast, little progress has been made to tackle pollution arising from agricultural runoff and other non-point sources of pollution. Similar to OECD countries, non-OECD countries are expected to expand the share of houses connected to sewage systems for public health reasons, though waste water treatment may only be considered at a later stage. Many industrial sources are not yet equipped with/connected to waste water treatment plants in non-OECD countries, thereby adding to the projected total nutrient loading.

According to the Baseline, the global release of nitrogen compounds by rivers to coastal marine systems (and associated risks of eutrophication of coastal waters) is projected to increase by 4% to 2030. This masks differences between the OECD area, where some improvement is expected, and other areas (BRIC, rest of the world) where the projected increase is a continuation (though at much lower rate) of the trend observed in past decades (Table 10.2). The highest increase in nitrogen pollution will be in the BRIC countries and, to a lesser extent, in the rest of the world (outside the OECD area). There are, however, large differences between sub-regions and countries. River nitrogen exports will decrease by 5% in North America, 4% in OECD Europe and over 20% in Japan (agricultural land contraction) and Russia (reduced atmospheric deposition). In contrast, river nitrogen exports are projected to increase by 5% in Oceania, 3% in Brazil, 16% in China and over 40% in India.

Nitrogen surplus from agriculture is projected to increase significantly in China and India, while in the United States and OECD Europe it may decrease or stabilise, following a marked increase in US voluntary agri-environmental incentive programmes and the introduction of cross-compliance in EU agricultural policies (see Chapter 14 on agriculture). There is a wide range in nitrogen surplus per hectare, driven by intensity and management practices; highest surpluses occur in Asian regions and OECD Europe.

Table 10.2. **Source of river nitrogen exports to coastal waters, 2000 and 2030**

Million tonnes

Area	2000				2030				% change (total)	
	Nature[a]	AGR[b]	Urban[c]	Total	Nature[a]	AGR[b]	Urban[c]	Total	2000-30	1970-2000
OECD	6.4	4.4	1.8	12.6	5.7	4.3	2.0	12.0	*–5*	*10*
BRIC	11.9	8.6	1.4	21.9	9.0	12.9	2.4	24.3	*11*	*57*
ROW	12.7	5.0	0.9	18.6	10.8	6.5	1.6	18.9	*2*	*26*
Total (world)	31.0	18.0	4.1	53.1	25.5	23.7	6.0	55.2	*4*	*33*

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a) N deposition on and biological fixation in non-cultivated areas.
b) N surplus on cultivated areas.
c) N effluents from public sewerage.

Source: *OECD Environmental Outlook* Baseline.

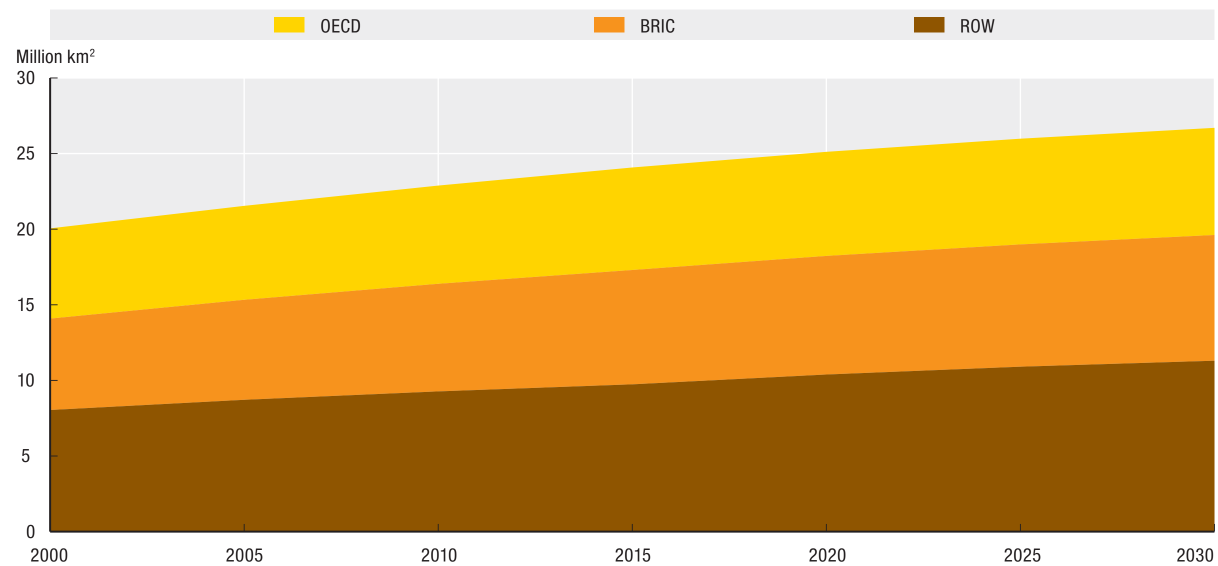
Only a small share of the world population is (9%) or will be in 2030 (16%) connected to advanced (N-removal) sewage treatment plants according to the *Outlook* projections. Most household sewage is therefore discharged untreated (or treated without N-removal) into rivers.[12] Nitrogen from urban sewage is projected to increase very strongly in India, China and the Middle East, where population and urbanisation are likely to outstrip the construction of public sewerage and waste water treatment plants.

Soil erosion by water

The capacity of soils to support food production can be seriously impaired by surface water runoff. Worldwide, areas with a high level of erosion risk from water are projected to increase from 20 million km^2 in 2000 to nearly 30 million in 2030 (Figure 10.2). The increase will occur in all regions.

Figure 10.2. **Land area under high soil erosion risk by surface water runoff, 2000-2030**

Million km^2



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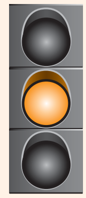
Source: *OECD Environmental Outlook* Baseline.

Policy implications



Water use can be decoupled from economic growth with the right policies – about half of all OECD countries have stabilised or decreased their total water use since 1980.

Both OECD and non-OECD countries must apply "good policy principles" to address the main water challenges. Some of these good policy principles have been successfully applied in OECD countries, while some have not. For example, OECD countries have made progress towards a whole-basin approach and towards expanding the use of water pricing mechanisms to manage demand (OECD, 2006b). Nevertheless, much progress remains to be made to: *i)* co-ordinate water management policies with sectoral (*e.g.* agriculture) and land use policies; *ii)* ensure a more consistent application of the polluter-pays and user pays principles; and *iii)* reduce subsidies that increase water problems (*e.g.* over-abstraction, pollution). A major remaining challenge is to design and implement water management policies that better reflect ecosystem needs for freshwater, as well as human needs. There is a need to assess the economic efficiency and environmental effectiveness of water pollution abatement measures in different sectors (municipal, industrial, agricultural) in the context of river basin management. Making wider use of markets and improving the coherence of decision-making (water governance), together with technological developments,[13] have been identified as key elements of effective water management (OECD/IWA, 2003). These options are described in detail below.

Market-based approaches

Currently, many water supply systems do not include their own investment and running costs in water prices. This reduces the financial sustainability of service provision. In the OECD area, such below-cost pricing is prevalent in publicly-funded irrigation systems, and households' drinking water bills do not fully reflect actual supply costs for many utilities. Moreover, the scarcity value of water resources is rarely reflected in the pricing of public water supply (though there are some cases of seasonal pricing). This can create incentives for consumers to over-use water.[14] The costs of not incorporating scarcity into groundwater pricing (and thus not matching the rate of groundwater extraction with the available resource base in a given region) may include the adjustment costs of changing water supply infrastructure or the need to relocate population to areas with adequate water availability. This vicious circle of government inaction and market failure, combined with the low substitutability of the resource, can trap regions in a "resource lock-in" (OECD, 2008).

As water becomes ever scarcer (due to both drought and degraded water quality), water pricing is increasingly seen as a necessary public policy instrument to encourage more responsible use (Jones, 2003). OECD countries should work towards full cost recovery pricing (where the price of water services should at least cover the capital, operation, maintenance and environmental costs[15]). Fuller cost recovery can provide an incentive to use water more efficiently, while generating revenues to support necessary investment in infrastructure. In Denmark, water consumption decreased from 155 litres per head per day in 1993 to 125 litres per day in 2003, following a 54% increase of the water bill. A similar pattern was observed in the Czech Republic. Both countries now rank among the "low-use" group by OECD standards.

A key issue in water pricing is how to ensure affordable access by the poorest communities to adequate water supply and sanitation services. Available evidence suggests that in half of OECD countries, affordability of water charges for low-income households is either a significant issue now or might become one in the future (OECD, 2003a). There is a wide range of practice in OECD countries to address affordability, including targeted support to low-income groups,[16] which is more efficient and environmentally effective than providing across-the-board subsidies through low water prices.

Only about half of OECD countries charge for abstracting surface water or groundwater or for the direct pollution of water (*i.e.* outside the public water supply and sanitation system). Abstraction charges can create incentives for efficient water use and can reduce water withdrawals. Similarly, water-pollution charges are likely to reduce discharges efficiently (see Box 10.2) – provided they are set at similar rates across sectors (which is often not the case). The charges should be levied according to the quality of receiving waters; quantitative information on the benefits of reducing pollution is a prerequisite to the formulation of efficient water quality objectives.

The use of tradable water rights can help to allocate limited water resources to their most productive uses. For example, Australia has been reforming its water policies since 1994 to introduce a fully market-based system for apportioning the amount of water available. But this potential remains largely unexploited, and the capacity to enhance efficient resource allocation is often hampered (*e.g.* by poor documentation). In Mexico, for example, water trading between irrigators and other users, such as industrial plants, requires government approval. In the arid west of the United States, trade of abstraction rights for surface water is subject to complicated rules. In Spain, the Environment Ministry is in the process of clarifying historical abstraction rights to enhance water trading. OECD-wide, transactions in water rights have remained largely marginal, and there are few examples of trade other than between farmers. As a consequence of recent droughts, however, there is increased trading between farmers and public water supply utilities.

While the long-term objective of optimal pricing – *i.e.* "internalising" the full marginal social costs (including environmental costs) into decisions that affect the use of water and water quality – is also valid in developing countries,[17] achieving it is probably unrealistic for most in the short term. In areas where more than 60% of the population lives on less than USD 2 per day, public budgets and external finance will need to play a role in covering capital costs (OECD, 2005, and see below). In areas where non-payment of water bills is widespread due to the poor quality of water services, cost recovery should correspond with noticeable improvements in service quality in order to gain consumer trust.

Water governance and the whole-basin approach

A number of countries (*e.g.* Australia, France, Spain) aim to manage water resources and pollutant discharges in a common, consistent framework at the river-basin level. An important development in this area is the European Union Water Framework Directive which calls for integrated river basin management planning in all EU member countries by 2009.[18] Because such integrated policies clarify the link between water use and water pollution, they are likely to be more efficient in meeting water management objectives. For example, they can enable a comparison between the costs of cleaning water downstream before it is supplied with the costs of discouraging pollution upstream. Integrated policies also facilitate cost recovery (OECD, 2004). When river-basin authorities have access to the cost of treatment for water supply operators, this provides them with a wealth of

Box 10.2. **Policies for water management by agriculture**

OECD countries are at very different stages in developing water pricing systems in agriculture (OECD, 2006c). However, most of the costs of investment in irrigation fall on the taxpayer and on other water users (through cross-subsidies). And it is mainly national treasuries that have financed dams, reservoirs and delivery networks, as well as a large part of the cost of installing local and farm infrastructure. Governments generally attempt to recover some of these costs through user charges, but revenues are rarely enough to cover even operation and maintenance costs. As a rule, in the absence of water rights farmers have free access to (or are charged only a nominal fee for) water that they pump themselves. And several countries (including Mexico, Turkey and the United States, at least in some federal irrigation districts) continue to offer preferential tariffs for electricity used to pump water for irrigation.

Not enough has been done to address diffuse pollution from agriculture. Even though the switch to low-dose agents has significantly reduce pesticide consumption in the OECD area, most surface water and groundwater samples still contain pesticides, sometimes at levels harmful for human health and the environment. In the few OECD countries where they have been introduced, pesticide taxes have not created enough incentives to reduce treatment frequency. Taxes should apply rates that reflect the products' human and environmental toxicity. Even though the use of fines has helped reduce the use of nitrogen in the few OECD countries where farm fertiliser accounts have been introduced, it would be more cost-effective to replace the complex mix of regulatory and incentive measures used by most countries by a tax based on the nitrogen surplus for the whole agricultural sector, as measured by the soil surface nitrogen balance (OECD, 2007b). A rebate could be granted to farmers based on the nutrient content of their output, thereby applying the polluter-pays principle while leaving flexibility in the choice of crops and farming techniques. Moreover a tax on phosphorous surpluses could be piggy-backed on the administrative set-up for the tax on nitrogen surpluses.

The economic distortions caused by the underpricing of water used in agriculture have been compounded in many instances by other agricultural support policies, particularly those linked to the production of particular commodities. Such linked support draws resources, including water, into the activity being supported, thereby driving up both the price of water to other users and the volume of agricultural subsidies. Moreover, since fertiliser use is highly responsive to the price of commodities, agricultural support misaligns farmer incentives and aggravates pollution of water (OECD, 2006c). See Box 10.3 for information on policy simulations which included reducing agricultural production support.

information on the costs of upstream pollution, which they can use to estimate the rates at which pollutant releases should be charged. River basin management also facilitates water allocation among competing uses within the basin as well as the control of inter-basin transfers. In Spain, river basin authorities are purchasing water rights for over-exploited water bodies.

There is a need to extend water policy to risk management to address the trend of increasing flood/drought damage.[19] With respect to floods, a more proactive land use policy across an entire watershed combined with enforcement of zoning provisions (making "room for rivers") can help. But a lot remains to be done. Measures such as "green corridors" along rivers and streams, reinstatement of flood control plains, or better control of deforestation and preservation of wetlands often are not binding and the issuance

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Box 10.3. Policy package simulations: impacts on water projections

Chapter 20 on environmental policy packages describes how a mix of policies was simulated to reflect global action to address many of the key environmental challenges identified in this *Outlook*. A number of the policies simulated in the policy mix would affect the water projections to 2030, including the scaling back of agricultural support measures, increasing connections to public sewerage at the same rate as urbanisation, and increased removal of nitrogen from waste water.

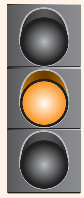
of building permits continues to be left to local authorities' discretion. The insurance and re-insurance industry may have an increasing role to play in facilitating the management of natural hazards (OECD, 2003b). More broadly, in the absence of proper (enforcement of) land use planning, and with increasing incidence of extreme weather events due to climate change (see Chapter 7), it may become necessary for potential flood/drought victims to assume a greater share of the risk through higher flood/drought insurance premiums or reduced compensation. There is also a need for early warning systems and observatories to enhance risk management. For example, based on experience gained in actuarial science, the Australian government has developed innovative information technology tools to improve drought risk management in agriculture (Grant *et al*., 2007).

Parties to the Helsinki Convention on Transboundary Watercourses have recently agreed to implement pilot projects of payments for ecosystem services that would apply to water related ecosystems like forests and wetlands, which are constituent parts of river basins (UN-ECE, 2006). However, policies to enhance forests' role in water management ("ecosystem services") should not imply giving more subsidies to forest owners (to improve forest management) or to farmers (to convert farmland to forest). That would run the risk of repeating in the forestry sector the mistakes that policy reforms are now seeking to address in the agricultural sector. The reform of agricultural policy underway in OECD countries has in itself important implications for farmland conversion to forests: where price support to commodities is reduced, there is less incentive to expand agricultural production on marginal land. Instead of seeking compensation for any foregone revenues (from timber sales or from farming), any forestry payments should reward the provision of well-targeted (climate and/or water-related) environmental services.

Financing investment in infrastructure

Countries will need to mobilise significant financial resources in the next few decades, including in the OECD, to replace ageing water infrastructure to extend services to those currently unserviced (especially in non-OECD countries), and to meet increasingly stringent environmental and health standards.[20] Based on income categories,[21] projected annual (current and investment) expenditure on water and waste water services by 2025 has been estimated at around USD 600 billion for OECD countries (half of which is for Mexico and the United States) and USD 400 billion for BRIC countries (half of which is for China; OECD, 2007c).

Though estimates vary significantly, the investment cost of implementing the Millennium Development Goals (MDG) for drinking water and sanitation would be around USD 10 billion a year over 15 years. This is more than three times the current level of official development assistance[22] (ODA) to water supply and sanitation, which has only slightly increased in recent years after a downward trend in the second half of the 1990s (OECD/DAC, 2006). The WHO and UNICEF estimate that meeting these MDGs would mean doubling the efforts of the past 15 years for the sanitation target and by one-third for the MDG drinking water target (WHO/UNICEF, 2006). However, the potential economic benefits of meeting the MDG for drinking water and sanitation far outweigh the costs (see also Chapter 12 on health and environment). In developing regions, the WHO estimated the economic return on one USD investment to be USD 5 to USD 28 (WHO, 2004). This is mainly due to time savings associated with better access to water supply and sanitation services, although avoided health impacts are also important. The cost of not meeting this MDG (cost of inaction) has been estimated at some USD 130 billion a year (Hutton and Haller, 2004).



OECD countries are committed to increase ODA to the water sector, though recent efforts are not sufficient to meet the MDG of halving the world's population without access to water and sanitation by 2015.

Key drivers of water infrastructure development include financing, demand management, economies of scale, public involvement and equity, competition and climate change (OECD, 2007c). Services liberalisation can also contribute to achieving universal access to water and sanitation services (OECD/World Bank, 2006). However, both the 2003 Camdessus Panel and the 2006 Gurría Task Force on Financing Water for All (Box 10.1) highlight that problems with the governance of the water sector hamper its ability to mobilise and to attract finance from a range of possible sources, including public spending, international development assistance, private financing and through charging for the use of water services. Over the longer term, a sustainable financing system should rely primarily on water charges, with provisions for affordable access by the poor. Local capital markets and innovative financing mechanisms also have a strong role to play in harnessing sufficient financing for water supply and sanitation infrastructure. The first step for enhancing access to finance for local governments is to increase their capability and creditworthiness to engage in financial actions (van Hofwegen, 2006). In Africa, ensuring adequate financing remains a key challenge for improving the water and sanitation sector, which has been the infrastructure sector least attractive to private investors (OECD/African Development Bank, 2007). An OECD Task Team of officials from development agencies and environment ministries was set up in 2006 to work on developing guidance for sustainable financial planning of water supply and sanitation investments in developing countries, with a particular focus on Africa.

Water management in the context of climate change

As a natural resource, water is obviously influenced by climatic factors. The projected change in climate will significantly affect the hydrological cycle, and in response water management frameworks will need to adapt to the impacts of climate change (see also Chapter 7 on climate change). A warmer climate will be accompanied by shifts in precipitation patterns and increased rates of evapotranspiration which are likely to

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aggravate water stress, especially in regions where available water is heavily managed and demand for water is growing rapidly. Extreme weather events will be exacerbated by climate change, including an increase in warm spells and heat waves, extreme precipitation, the area affected by drought[23] and coastal and river delta flooding. Warmer weather is likely to translate into increased occurrence and intensity of water quality problems (*e.g.* harmful algal blooms as surface waters warm and salt-water intrusion resulting from storm surge and coastal flooding) (IPCC, 2007).

Water policies have potentially large implications for climate change and *vice versa*. For example, saving water also means saving energy, as extracting, transporting and treating water comes at a high energy cost. For example, the EU Nitrates Directive aims to reduce nitrogen run-off from agriculture to freshwater resources. These measures would also reduce N_2O emissions from the agriculture sector; N_2O is a potent GHG (UNFCCC, 2006). Water policies also affect the vulnerability of water systems to changes in the climate. For example, subsidising agricultural or urban water use leads to inefficient and excessive water use, which in turn aggravates vulnerability to any temporary or long-term changes in physical supply of freshwater due to climate change. Co-benefits of appropriate water pricing or water pollution policies include both sustainable water resources management as well as resilience to climate change.

Climate change policy also has significant spillovers to other policy areas (*e.g.* energy, agriculture, forestry, urban development) that affect water management. For example, measures to preserve forest areas reduce greenhouse gas emissions, increase sink activity from forests, conserve water (*e.g.* by reducing runoff), and regulate water storage and flows. Similarly, restoring wetlands, natural waterways or coastal zone management can re-establish natural habitats for plants and animals, provide flood protection, protect freshwater supplies (*e.g.* from saltwater intrusion) and build resilience to future climate change.

Most OECD government sustainable water management strategies are developed to address current problems in the water sector looking 10 to 20 years ahead and have yet to seriously factor in long-term climate change predictions (Levina and Adams, 2006). However, some attention to these issues is emerging in OECD countries. For example, Germany recently hosted a conference on climate change and the European water dimension to discuss the need for adaptation plans in water-related sectors (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2007). The EU has identified an initial set of policy options to mitigate the impacts of and adapt to water scarcity and drought in a context of climate change (Commission of the European Communities, 2007). Information on the nature of climate change (regional temperature and precipitation predictions under plausible futures) and on the costs and benefits of climate change measures in the water sector could contribute to better water management in the face of climate change. The latter entails looking at the direct benefits and costs of policy as well as at the nearer term[24] co-benefits of adaptation (or mitigation) choices in other policy areas.

Notes

1. Although most of the planet is covered by water, only 2.5% of it is fresh, while the rest is salt. Of the freshwater, two-thirds is locked up in glaciers and permanent snow cover (although this is changing with the decrease in snow and ice extent).
2. 2004 data (WHO/UNICEF, 2006).

3. The flows of about 60% of the world's largest rivers have been interrupted by dams.
4. Only 10% of freshwater fish species have been studied in detail.
5. This section only includes the four themes for which OECD modelling work has been carried out (water stress, public water supply and urban waste water treatment, nitrogen pollution and soil erosion by water).
6. Globally agriculture uses roughly 70% of available water resources (see also Chapter 14 on agriculture).
7. These projections are likely to underestimate water stress in some regions, as the WaterGap model used assumes no impact of climate change on rainfall distribution to 2030. See this chapter's annex for a discussion of the assumptions and uncertainties regarding the projections.
8. Areas with a ratio of withdrawals to available resources that exceeds 0.4 – see annex to this chapter.
9. For both improved drinking water sources and improved sanitation, the MDG goal is to halve the proportion of people who lack access by 2015, from the reference year 1990. Achieving this would require providing services to an additional 1.1 billion people and sanitation to an additional 1.6 billion people between 2004 and 2015 (WHO/UNICEF, 2006).
10. Defined as facilities which are not shared/public and consist of: *i)* flush or pour-flush to piped sewer system, septic tank or pit latrine; *ii)* ventilated improved pit latrine; *iii)* pit latrine with slab; and, *iv)* composting toilet.
11. Even though phosphorus equally contributes to eutrophication, this section focuses on nitrogen because nitrogen compounds are relatively mobile and easy to measure, and the load on the environment easier to model.
12. Even less sewage is treated for phosphorus removal.
13. A recent study commissioned by the European Commission estimates that water efficiency in the EU could be improved by nearly 40% through technological improvements alone. This includes reduction of leakage in water supply networks and more efficient household appliances; conveyance efficiency of irrigation systems; application efficiency of irrigation water; changes in irrigation practices, use of more drought-resistant crops and reuse of treated sewage effluent in agriculture; changes in industrial processes, higher recycling rates or the use of rainwater by industry. *http://ec.europa.eu/environment/water/quantity/scarcity_en.htm*.
14. The widespread failure to charge for irrigation water at rates that reflect the scarcity of the resource has resulted in the over-use of water in agriculture.
15. Pursuant to the OECD Council *Recommendation on Water Resource Management Policies: Integration, Demand Management and Groundwater Protection* [C(89)12/Final] (*http://webdomino1.oecd.org/horizontal/oecdacts.nsf/linkto/C(89)12*).
16. For example, additional direct income support, appropriately designed increasing block water tariffs where those who only use a small amount of water pay very little for it, subsidised connection fees, *etc*.
17. Where buying water from "water sellers" is often more expensive than paying for a public water supply. The other alternatives are also costly in terms of social or opportunity costs, in particular drinking unsafe water or walking long distances to public water pumps as many do in less developed countries.
18. Another key objective of the Water Framework Directive is to achieve good chemical and ecological status of all EU surface water bodies by 2015.
19. The EU directive on the assessment and management of flood risks requires drawing up of flood risk maps and flood management plans.
20. For example, in the European Union the lead concentration limit of 10 µg/l of the 1998 EU Drinking Water Directive is to be met by 2013, which will involve replacing mains in the private part of the water supply system.
21. Based on an assumption that 0.35 to 1.20% of GDP is required to finance water and waste water services in high income countries; 0.54 to 2.60% of GDP in middle income countries, and 0.70 to 6.30% of GDP in low income countries. Other estimates also exist in the literature.
22. Including the 22 DAC countries' bilateral ODA as well as multilateral ODA.
23. In the EU, the number of areas and people affected by droughts went up by almost 20% between 1976 and 2006 (Commission of the European Communities, 2007). One of the most

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widespread droughts occurred in 2003 when over 100 million people and a third of the EU territory were affected. The cost of the damage to the European economy was at least EUR 8.7 billion. The total cost of droughts over the past 30 years amounts to EUR 100 billion. The yearly average cost quadrupled over the same period.

24. The benefits of mitigation are long-term. Even if strong action was taken today, there will be no discernible effect (identifiable benefit) on rates of warming (and rainfall distribution) for considerable periods of time (Pearce, 2000).

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ANNEX 10.A1

Key Assumptions and Uncertainties in the Water Projections

The degree of water stress is assumed to be proportional to the ratio between annual average water abstractions and annual average water availability in a river basin. The WaterGap model (Alcamo *et al*., 2003) projects water abstractions by households, industry and irrigation as a function of population, GDP and technology. It projects water availability[1] as a function of land cover and climatic conditions (assuming no impact of climate change on rainfall distribution between now and 2030). Data on withdrawals are well established in the OECD area, as well as those on water availability for half of the world area (where there are long-term hydrological gauges). However, while irrigation is the main water user in most river basins, there is strong uncertainty about future development of irrigated areas and volumes. Moreover, the water stress indicator does not take account of seasonal patterns in water supply and demand, a main factor driving irrigation.

Projections of connection to public sewerage are a function of income and World Health Organization (WHO) projections regarding the Millennium Development Goals. Data of the WHO/UNICEF Joint Monitoring Programme (JMP) on improved sanitation facilities were used to estimate the share of the population connected to public sewerage in non-OECD countries. However, the JMP may underestimate the number of people who do not have access to sanitation (OECD, 2006a).

River nitrogen (N) exports to coastal waters are assumed to be 70% of the sum of *i)* runoff and leaching from non-cultivated areas, fed by atmospheric N deposition and biological fixation; *ii)* N surplus from agriculture (diffuse pollution); and, *iii)* N effluents from public sewerage (point sources). It is therefore underestimated as it excludes diffuse urban sources (population not connected to public sewerage) and direct discharges from (large) industry into water bodies. Based on empirical studies in Europe, the remaining 30% of the N load is the assumed share of retention in-stream and from leaching, assuming a half-life of nitrate in groundwater of two to three years.

Atmospheric N deposition from natural origins (in particular lightning) and sectoral emissions (transport, power generation, agriculture) is based on estimates (Dentener *et al*., 2006) applied to projections for NOx and NH_3 emissions, using the global atmospheric transport model TM3 (see also Chapter 8 on air pollution). Biological fixation is estimated based on coefficients for the various natural ecosystems (Cleveland *et al*., 1999).

The agricultural soil surface N surplus is estimated as the annual balance between N "inputs" (biological fixation, atmospheric deposition, use of chemical fertilisers and livestock manure) and N "outputs" (removals by crop harvest and forage grazing and ammonia volatilisation) at the country level.[2] Regional changes in crop production are downscaled to the country level on the basis of distribution in the FAO projection to 2030. Projections on fertiliser use are also derived from the FAO (N in crop harvest as a share of N fertiliser inputs, Bruinsma, 2003). Crop N content is obtained from crop-specific data (Bouwman *et al.*, 2005). Biological fixation is estimated for both leguminous crops and free living organisms in farmland. Ammonia (NH3) volatilisation is estimated for animal housing and grazing systems (Bouwman *et al.*, 1997), on the basis of crop type, manure or fertiliser application mode, soil type and climate (Bouwman *et al.*, 2002). The extent to which the N surplus ends up in surface water is uncertain, as the (soil surface) balance does not take account of changes of N in soil organic matter.

Projections of N loads from urban sewage (including industry connected to public sewerage) are a function of GDP per capita. Part of the N load is discharged into sewers, of which part is removed in waste water treatment (WWT) plants. N effluents are estimated as the part that is not removed during treatment plus the amount that is collected via public sewerage but not treated. WWT plants are distinguished according to their N-removal rates (up to 80% for most advanced treatment). It was assumed that the N-removal rates would be doubled by 2030 (up to the current maximum of 80%).

Risks of soil erosion from water runoff are a function of the land erodibility index (based on soil properties and topography), rainfall erosivity index (based on monthly precipitation) and land cover. However, this compound index does not capture cultivation practices, such as tillage (bound to exacerbate the erosion risk) or contour ploughing and terracing (both enhancing soil conservation).

Notes

1. Defined as precipitation net of evapotranspiration (from vegetation and soils) at the grid cell level.
2. The balance is calculated for each grid cell and then aggregated to the country level. It includes areas used for biofuel production.

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OECD Environmental Outlook to 2030

Introduction: Context and Methodology

Purpose of the report

The purpose of the *OECD Environmental Outlook* is to help government policy-makers to identify the key environmental challenges they face, and to understand the economic and environmental implications of the policies that could be used to address those challenges.

The *Outlook* provides a baseline projection of environmental change to 2030 (referred to as "the Baseline"), based on projected developments in the underlying economic and social factors that drive these changes. The projections are based on a robust general equilibrium economic modelling framework, linked to a comprehensive environmental modelling framework (see below, and Annex B, for more details). Simulations were also run of specific policies and policy packages that could be used to address the main environmental challenges identified, and their economic costs and environmental benefits compared with the Baseline.

This is the second *Environmental Outlook* produced by the OECD. The first *OECD Environmental Outlook* was released in 2001, and provided the analytical basis on which ministers adopted an *OECD Environmental Strategy for the First Decade of the 21st Century*. This second *Outlook:*

- extends the projected baseline used in the first *Outlook* from 2020 to 2030, and even 2050 for some important areas;
- is based on a stronger and more robust modelling framework;
- focuses on the policies that can be used to tackle the main challenges;
- expands the country focus to reflect developments in both OECD and non-OECD regions and their interactions.

Many of the priority issues and sectors identified in this *Outlook* are the same as those highlighted as needing most urgent policy action in the first *OECD Environmental Outlook* (2001) and in the *OECD Environmental Strategy for the First Decade of the 21st Century*. These include the priority issues of climate change, biodiversity loss and water scarcity, and the key sectors exerting pressure on the environment (agriculture, energy and transport). Added to these is a new priority issue: the need to address the health impacts of the build-up of chemicals in the environment. The 2001 *Outlook* indicated the environmental challenges expected in the next couple of decades; this *Outlook* not only deepens and extends this analysis, it also focuses on the policy responses for addressing these challenges. It finds that the solutions are affordable and available if ambitious policy action is implemented today, and if countries work together in partnership to ensure comprehensive action, avoid competitiveness concerns and share the responsibility and costs of action fairly and equitably. This latest *Outlook* analyses the policies that can be used to achieve the *OECD Environmental Strategy*. It will provide the main analytical material to support discussions on further implementation of the *OECD Environmental Strategy* at the OECD Meeting of Environment Ministers planned for early 2008.

Policy context

Why develop an environmental outlook? Many of the economic or social choices that are being made today – for example, investments in transport infrastructure and building construction, fishing fleets, purchase of solar heating panels – will have a direct and lasting affect on the environment in the future. For many of these, the full environmental impacts will not be felt until long after the decisions have been taken. These factors make policy decisions difficult: the costs of policy action to prevent these impacts will hit societies today, but the benefits in terms of improved environmental quality or damage avoided may only be realised in the future. For example, the greenhouse gases released today continue to build up in the atmosphere and will change the future climate, with serious impacts for the environment, the economy and social welfare.

But politicians tend to reflect the short-term interests of the voting public, not the long-term needs of future generations. They also tend to focus on the immediate costs and benefits to their own populations of a given policy approach, rather than on the global impacts. But many of the main environmental challenges countries face in the early 21st century are global or transboundary in nature, including global climate change, biodiversity loss, management of shared water resources and seas, transboundary air pollution, trade in endangered species, desertification, deforestation, etc. Building public understanding and acceptance of the policies that are needed to address these challenges is essential for policy reform.

These political challenges are exacerbated by uncertainty about the future. Often the exact environmental impacts of social and economic developments are poorly understood or disputed. In some cases, scientific uncertainty about environmental or health impacts is a main cause of policy inaction, while in others it is used as a justification for precautionary action. Scientific understanding and consensus about environmental change has been developing rapidly in a number of areas in recent years, for example through the 2005 Millennium Ecosystem Assessment and the 2007 IPCC Fourth Assessment Report on the Science of Climate Change. Despite the improvements in the scientific understanding of such issues, a gap remains in the development and implementation of effective environmental policies based on this scientific understanding.

This *Environmental Outlook* examines the medium to long-term environmental impacts of current economic and social trends, and compares these against the costs of specific policies that could be implemented today to tackle some of the main environmental challenges. The purpose is to provide more rigorous analysis of the costs and benefits of environmental policies to help policy-makers take better, more informed policy decisions now.

Many environmental problems are complex and inter-connected. For example, species loss is often the result of multiple pressures – including hunting, fishing or plant harvesting, loss of habitat through land use change or habitat fragmentation, impacts of pollutants – and thus a mix of policy instruments is needed to tackle the various causes of this loss. These policy packages need to be carefully designed in order to achieve the desired environmental benefits at the lowest economic cost. This *Outlook* examines the policy packages that could be used to tackle some of the key environmental challenges, and the framework conditions needed to ensure their success.

The transboundary or global nature of many of the most pressing environmental challenges identified in this *Outlook* require countries to increasingly work together in partnership to address them. The ways in which OECD environment ministries can work together in partnership with other ministries, stakeholder partners and other countries are explored in this *Outlook*.

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A special focus on the emerging economies in the *Outlook*

This *Outlook* identifies the main emerging economies as the most significant partners for OECD countries to work with in the coming decades to tackle global or shared environmental problems. This is because these countries are responsible for an increasingly large share of the global economy and trade, and thus have an increasing capacity to address these challenges, in part because their economies are so dynamic. Moreover, the pressures that they exert on the environment are also growing rapidly.

In some chapters, where data are available and relevant, the BRIICS countries (Brazil, Russia, India, Indonesia, China and South Africa) are highlighted for attention as a country grouping. In other chapters, the smaller country grouping of BRIC (Brazil, Russia, India and China) is examined, or even further disaggregated to each of these four countries individually. The BRIC grouping is used for most of the modelling projections and simulations in the *Outlook*.

Modelling methodology and sources of information

The analysis presented in this *Environmental Outlook* was supported by model-based quantification. On the economic side, the modelling tool used is a new version of the OECD/World Bank JOBS/Linkages model, operated by a team in the OECD Environment Directorate and called ENV-Linkages. It is a global general equilibrium model containing 26 sectors and 34 world regions and provides economic projections for multiple time periods. It was used to project changes in sector outputs and inputs of each country or region examined to develop the economic baseline to 2030. This was extended to 2050 to examine the impacts of policy simulations in specific areas, such as biodiversity loss and climate change impacts. The economic baseline was developed with expert inputs from, and in co-operation with, other relevant parts of the OECD, such as the Economics Department, the International Energy Agency and the Directorate for Food, Agriculture and Fisheries.

The Integrated Model to Assess the Global Environment (IMAGE) of the Netherlands Environmental Assessment Agency (MNP) was further developed and adjusted to link it to the ENV-Linkages baseline in order to provide the detailed environmental baseline. IMAGE is a dynamic integrated assessment framework to model global change, with the objective of supporting decision-making by quantifying the relative importance of major processes and interactions in the society-biosphere-climate system. The IMAGE suite of models used for the *Outlook* comprises models that also appear in the literature as models in their own right, such as FAIR (specialised to examine burden sharing issues), TIMER (to examine energy), and GLOBIO3 (to examine biodiversity). Moreover, for the *Outlook* the IMAGE suite included the LEITAP model of LEI at Wageningen and the WaterGap model of the Center for Environmental Systems Research at Kassel University. IMAGE and associated models provided the projections of impacts on important environmental endpoints to 2030, such as climate, biodiversity, water stress, nutrient loading of surface water, and air quality. Annex B provides a more detailed description of the modelling framework and main assumptions used for the *Outlook* report.

The Baseline Reference Scenario presents a projection of historical and current trends into the future. This Baseline indicates what the world would be like to 2030 if currently existing policies were maintained, but *no new policies* were introduced to protect the environment. It is an extension of current trends and developments into the future, and as such it does not reflect major new or different developments in either the drivers of environmental change or environmental pressures. A number of major changes are possible in the future, however, that would significantly alter these projections. A few of these were examined as "variations" to the Baseline, and their impacts are described in Chapter 6 to show how these changes might affect the projections presented here.

Because the Baseline reflects no new policies, or in other words it is "policy neutral", it is a reference scenario against which simulations of new policies can be introduced and compared. Simulations of specific policy actions to address key environmental challenges were run in the modelling framework. The differences between the Baseline projections and these policy simulations were analysed to shed light on their economic and environmental impacts.

The simulations undertaken for the *Environmental Outlook* exercise are illustrative rather than prescriptive. They indicate the type and magnitude of the responses that might be expected from the policies examined, rather than representing recommendations to undertake the simulated policy actions. As relevant, some of the policy simulation results are reflected in more than one chapter. The table below summarises the policy simulation analyses and lists the different chapters containing the results.

Sensitivity analysis was undertaken to test the robustness of key assumptions in ENV-Linkages, and some of the results of this analysis are presented in Annex B. This, in conjunction with the Baseline variations described in Chapter 6, provides a clearer picture for the reader of the robustness of the assumptions in the Baseline.

Throughout the *Outlook*, the analysis from the modelling exercise is complemented by extensive data and environmental policy analysis developed at the OECD. Where evidence is available, specific country examples are used to illustrate the potential effects of the policies discussed. Many of the chapters in this *Outlook* have been reviewed by the relevant Committees and Expert Groups of the OECD, and their input has strengthened the analysis.

The *Outlook* is released at about the same time as a number of other forward-looking environmental analyses, such as UNEP's Fourth Global Environment Outlook (GEO-4); the IPCC Fourth Assessment Report (AR-4); the International Assessment of Agricultural Science and Technology for Development supported by the World Bank, FAO and UNEP; and the CGIAR Comprehensive Assessment of Water Use in Agriculture. Through regular meetings and contacts, efforts have been made by the organisations working on these reports to ensure co-ordination and complementarity in the studies, and to avoid overlap. The *OECD Environmental Outlook* differs from most of the others in its emphasis on a single baseline reference scenario against which specific policy simulations are compared for the purpose of policy analysis. Most of the others explore a range of possible "scenarios", which provide a useful communication tool to illustrate the range of possible futures available, but are less amenable to the analysis of specific policy options. The *OECD Environmental Outlook* also looks at developments across the full range of environmental challenges, based strongly on projected developments in the economic and social drivers of environmental change, while many of the other forward-looking analyses focus on a single environmental challenge.

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Table I.1. **Mapping of the *OECD Environmental Outlook* policy simulations by chapter**

Simulation title	Simulation description	Chapters in which the results are reflected	Models used
Baseline	The "no new policies" Baseline used throughout the *OECD Environmental Outlook*.	All chapters	ENV-Linkages; IMAGE suite
Globalisation variation	Assumes that past trends towards increasing globalisation continue, including increasing trade margins (increasing demand by lowering prices in importing countries) and reductions in invisible costs (*i.e.* the difference between the price at which an exporter sells a good and the price that an importer pays).	4. Globalisation 6. Key variations to the standard expectation	ENV-Linkages; IMAGE suite
High and low growth scenarios	Variation 1: High economic growth – examines impacts if recent high growth in some countries (*e.g.* China) continues, by extrapolating from trends from the last 5 years of growth rather than the last 20 years. Variation 2: Low productivity growth – assumes productivity growth rates in countries converge towards an annual rate of 1.25% over the long-term, rather than 1.75% as in the Baseline. Variation 3: High productivity growth – assumes productivity growth rates in countries converge towards an annual rate of 2.25% over the long-term.	6. Key variations to the standard expectation	ENV-Linkages
Greenhouse gas taxes	Implementation in participating countries of a tax of USD 25 on CO_2eq, increasing by 2.4% per annum. OECD 2008: only OECD countries impose the tax, starting in 2008. Delayed 2020: all countries apply the tax, but starting only in 2020. Phased 2030: OECD countries implement the tax from 2008; BRIC countries from 2020, and then the rest of the world (ROW) from 2030 onwards. All 2008: in a more aggressive effort to mitigate global GHG emissions, all countries implement the USD 25 tax from 2008.	7. Climate change 13. Cost of policy inaction (Delayed 2020) 17. Energy 20. Environmental policy packages	ENV-Linkages; IMAGE suite
Climate change stabilisation simulation (450 ppm)	Optimised scenario to reach a pathway to stabilise atmospheric concentrations of GHG at 450 ppm CO_2eq over the longer term and limit global mean temperature change to roughly 2 °C. A variation on this case was developed to explore burden-sharing, using a cap and trade approach to implementation.	7. Climate change 13. Cost of policy inaction 17. Energy 20. Environmental policy packages	ENV-Linkages; IMAGE suite
Agriculture support and tariff reform	Gradual reduction in agricultural tariffs in all countries to 50% of current levels by 2030. Gradual reduction in production-linked support to agricultural production in OECD countries to 50% of current levels by 2030.	9. Biodiversity 14. Agriculture	ENV-Linkages
Policies to support biofuels production and use	Demand for biofuels growing in line with the IEA *World Energy Outlook* (2006) scenario. DS: a scenario whereby growth in biofuel demand for transport is driven by exogenous changes, keeping total fuel for transport close to the Baseline. OilS: a high crude oil price scenario to determine the profitability of biofuel in the face of increasing costs of producing traditional fossil-based fuels. SubS: a subsidy scenario in which producer prices of biofuels are subsidised by 50%.	14. Agriculture	ENV-Linkages
Fisheries	Global fisheries cap and trade system, representing a 25% reduction in open fisheries catch, with trading allowed within six geographical regions.	15. Fisheries and aquaculture	ENV-Linkages
Steel industry CO_2 tax	Implementation of a carbon tax of 25 USD per tonne CO_2, applied respectively to OECD steel industry only, all OECD sectors, and all sectors worldwide.	19. Selected industries – steel and cement	ENV-Linkages
Policy mix	Three variations of policy packages were modelled, depending on the participating regions: OECD countries only OECD + BRIC Global The policy packages included: • reduction of production-linked support and tariffs in agriculture to 50% of current levels by 2030. • tax on GHG emissions of USD 25 tax CO_2eq, increasing by 2.4% per annum (phased with OECD starting in 2012, BRIC in 2020, ROW in 2030). • moving towards, although not reaching, Maximum Feasible Reduction in air pollution emissions, phased over a long time period depending on GDP/capita. • assuming that the gap to connecting all urban dwellers with sewerage will be closed by 50% by 2030, and installing, or upgrading to the next level, sewage treatment in all participating regions by 2030.	8. Air pollution 10. Freshwater 12. Health and environment 20. Environmental policy packages	ENV-Linkages; IMAGE suite

Structure of the report

The *OECD Environmental Outlook* is divided into two main parts:

i) *The World to 2030 – the Consequences of Policy Inaction:* describes the Baseline, *i.e.* the projected state of the world to 2030 in terms of the key drivers of environmental change and the developing environmental challenges, as well as analysing some possible variations to the Baseline.

ii) *Policy Responses:* focuses on the policy responses at both the sectoral level and in terms of implementing a more comprehensive and coherent policy package.

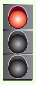
The first part describes the key elements of the Baseline to 2030, including the main drivers of environmental change (consumption and production patterns, technological innovation, population dynamics and demographic change, economic development, globalisation, and urbanisation) and the key environmental challenges (climate change, air pollution, biodiversity, freshwater, waste and material flows, health and environment). For each of these, the key recent trends and projections to 2030 are presented, as well as some of the policy approaches that are being used to address the environmental challenges. Chapter 6 describes some key variations to the Baseline – for example, how the Baseline would differ if key economic drivers (such as economic growth or global trade) were changing faster than projected in the Baseline. The chapter also explores other sources of uncertainty in the *Outlook* projections. Finally, this first part of the report examines the consequences and costs of policy inaction – essentially the environmental, health and economic impacts embodied in the "no new policies" Baseline scenario.

The second part of the *Outlook* report examines the possible policy responses to address the key environmental challenges, and assesses the economic and environmental impact of these responses. The key sectors whose activities affect the environment are examined, with a brief summary of the trends and outlook for their impacts, followed by an assessment of the policy options that could be applied in that sector to reduce negative environmental impacts. This section assesses the environmental benefits of specific policy options and their potential costs to the sector involved and/or economy-wide (and disaggregated by region where appropriate). This analysis can be used by environment ministries in discussing specific policy options for tackling environmental challenges with their colleagues in other ministries, such as finance, agriculture, energy or transport. The sectors examined include those that were prioritised in the *OECD Environmental Strategy* – agriculture, energy and transport – and also other sectors which strongly affect natural resource use or pollution, such as fisheries, chemicals and selected industries (steel, cement, pulp and paper, tourism and mining).

In addition to analysing sector-specific policies, this part of the *Outlook* also examines the effects of a package of policies (the EO policy package) to tackle the main environmental challenges. The analysis of this EO policy package highlights the potential synergies between policies (*i.e.* where the benefits of combining two or more policies may be greater than the simple sum of their benefits as separate policies), or potential conflicts where policies may undermine each other. Chapter 21 outlines the key framework conditions needed to ensure the successful identification and implementation of appropriate environmental policies at the national level, in particular institutional capacity and policy implementation concerns. Chapter 22, on global environmental co-operation, highlights the issues for which OECD countries will need to work together in partnership with other countries in order to reduce overall costs of policy implementation and maximise benefits. It also assesses the costs of inaction.

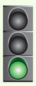
Traffic lights in the *OECD Environmental Outlook*

As with the 2001 *Outlook*, this report uses traffic light symbols to indicate the magnitude and direction of pressures on the environment and environmental conditions. Traffic lights are used to highlight the key trends and projections in the summary table in the Executive Summary, in the Key Messages boxes at the start of each chapter and throughout the chapters. The traffic lights were determined by the experts drafting the chapters, and then refined or confirmed by the expert groups reviewing the report. They represent the following ratings:



Red lights are used to indicate environmental issues or pressures on the environment that require urgent attention, either because recent trends have been negative and are expected to continue to be so in the future without new policies, or because the trends have been stable recently but are expected to worsen.

Yellow lights are given to those pressures or environmental conditions whose impact is uncertain, changing (*e.g.* from a positive or stable trend toward a potentially negative projection), or for which there is a particular opportunity for a more positive outlook with the right policies.



Green lights signal pressures that are stable at an acceptable level or decreasing, or environmental conditions for which the outlook to 2030 is positive.

While the traffic light scheme is simple, thus supporting clear communication, it comes at the cost of sensitivity to the often complex pressures affecting the environmental issues examined in this *Outlook*.

While each of the individual chapters discusses the regional developments for the drivers or environmental impacts analysed, Annex A also provides an easily accessible "summary" of the economic, social and environmental developments in the Baseline for each region. Annex B provides a more detailed analysis of the modelling framework used in the development of the *OECD Environmental Outlook*. A number of background working papers, which provide further information on specific issues addressed in the *Outlook*, were developed to complement the report (see: *www.oecd.org/environment/outlookto2030*).

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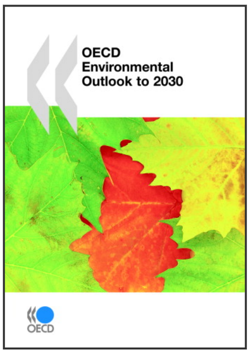
Acronyms and Abbreviations

BRIC	Brazil, Russia, India and China
BRIICS	Brazil, Russia, India, Indonesia, China and South Africa
CBD	Convention on Biological Diversity
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalents
CSD	Commission on Sustainable Development
DAC	OECD Development Assistance Committee
EJ	Exajoules
EU15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EU25	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
EUR	Euro (currency of European Union)
FAO	Food and Agriculture Organization of the United Nations
GBP	Pound sterling
GDP	Gross domestic product
GHG	Greenhouse gas
GJ	Gigajoules
GNI	Gross national income
Gt	Giga tonnes
GW	Gigawatt
HFC	Hydrofluorocarbon
IEA	International Energy Agency
IMAGE	Integrated Model to Assess the Global Environment
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land use, land use change and forestry
MAD	Mutual Acceptance of Data
MDGs	Millennium Development Goals
MEA	Multilateral environmental agreement
MNP	Netherlands Environmental Assessment Agency
MSA	Mean species abundance

Mt	Million tonnes
MWh	Megawatt-hour
NO_2	Nitrogen dioxide
N_2O	Nitrous oxide
NO_x	Nitrogen oxides
ODA	Official development assistance
ppb	Parts per billion
ppm	Parts per million
PFC	Perfluorocarbon
PM	Particulate matter
$PM_{2.5}$	Particulate matter, particles of 2.5 micrometres (µm) or less
PM_{10}	Particulate matter, particles of 10 micrometres (µm) or less
ppmv	Parts per million by volume
ROW	Rest of world
RTA	Regional trade agreement
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
SF_6	Sulphur hexafluoride
TWh	Terawatt hour
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VOC	Volatile organic compound
WHO	World Health Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization



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