ISBN 978-92-64-04048-9
OECD Environmental Outlook to 2030

Chapter 2

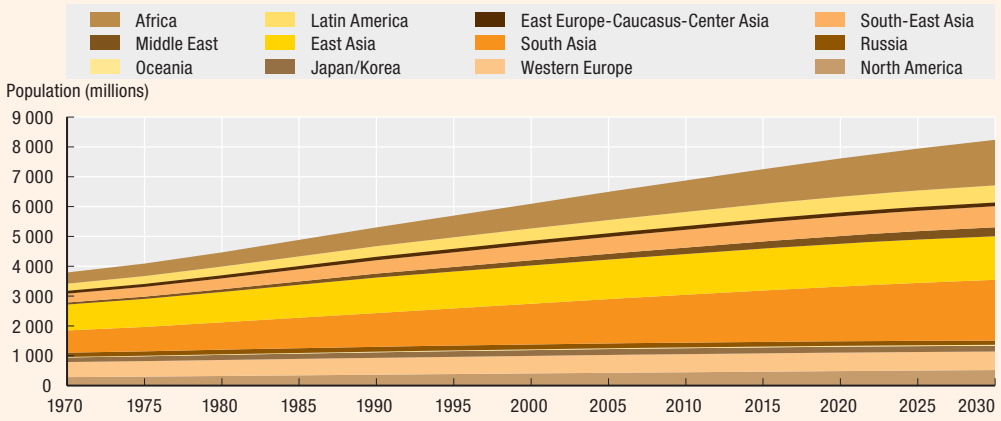
Population Dynamics and Demographics

This chapter examines the close relationship between population growth and demographics and the environment. Between 2005 and 2030, world population is expected to grow from 6.5 to 8.2 billion people. The enlarging population, mostly in developing countries, will put more pressure on the environment through increased production and consumption. The demographic features of ageing and migration are particularly relevant from an environmental perspective. Ageing populations have specific consumption patterns, some of which – such as expanded leisure time and income for travel – are associated with increasing environmental impacts. Migration can exacerbate pressures on local environments by increasing density in receiving regions. Environmental conditions will also influence population dynamics, such as through environmental refugees and environment-related disease outbreaks. The number of environmental refugees is expected to grow in the coming decades as a result of the impacts of climate change.

KEY MESSAGES

- Between 2005 and 2030, it is projected that world population will grow from 6.5 to 8.2 billion people. Almost all of the global increase in population will originate in the developing world; the OECD's share of world population will drop from 23% in 1980 to 15% in 2030.
- In addition to the general population growth, two demographic features are particularly relevant from an environmental perspective – ageing and migration:
  - The number of people aged over 60 will increase from 0.7 to 1.9 billion between 2005 and 2050; three out of four of these people will live in the developing world. In 2050, the grey dependency ratio – *i.e* the number of people over 65 years of age that are "dependent" economically on those of working age – will reach 46 to 100 in the USA, 60 in Europe, and 70 in Japan (compared to 20, 27, and 28 in 2005 respectively).
  - Over the same period, 98 million people (net number) will migrate, mainly within regions or from less developed to more developed countries.

World population (millions) 1970-2030



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Environmental implications

The growing population will put increasing pressure on the environment, through increased production and consumption.

Ageing populations have specific consumption patterns, some of which – such as increased leisure time and income for travel – are associated with increasing environmental impacts.

Migration, which can also be driven by environmental degradation, can exacerbate pressures on local environments by increasing density in receiving regions and contributing to desertification in sending ones. It can also increase vulnerability to disasters.

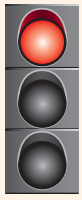
Consequences of inaction

Environmental conditions will also influence population dynamics, as is apparent from environmental refugees and environment-related disease outbreaks. The number of environmental refugees* is expected to increase in the coming decades as a result of the impacts of climate change. This might exacerbate security issues.

* Note that the notion is not an official category, which explains why there is no systematic collection of data.

Introduction

Population dynamics are a key driver of environmental change for a number of reasons. People are a driver of economic growth, putting demands on services which have impacts on the environment, and putting direct pressures on the environment by consuming natural resources (including land for food cultivation, housing and infrastructure; energy and wood for fuel; and water) and causing pollution (to air, soil, water, etc.) Population dynamics also affect labour,[1] which is a major driver of growth (in numbers and via labour productivity) in this *OECD Environmental Outlook* Baseline.



Continuing environmental degradation in some regions will generate additional migrations by the most vulnerable clusters of the population.

Human impacts on the environment vary with changes in levels and modes of consumption and the technologies involved (Prugh and Ayres, 2004). The increasing consumption of the global consumer class, rising population and increasing incomes in developing countries will accelerate environmental pressures from energy, transport, water use and waste production. Chapter 1 on consumption, production and technology sheds some light on expected trends in consumption patterns for households in both OECD and developing countries. It analyses the relationships between consumption patterns and population dynamics, economic development, ageing and changing lifestyles. Income dynamics and income disparities will matter. So will sociological trends: the declining number of people living in each household generates additional per capita levels of consumption of land and energy. At the same time, each urban area has a specific ecological footprint, linked to the efficiency of its use of land, energy and other resources and its capacity to manage housing, develop collective transport systems, collect and treat waste, and secure urban safety.

In turn, the environment is a driver of population dynamics. Environmentally stressed areas are subject to specific migrations, as testified by the number of environmental refugees (25 million people in 1994, according to UNEP, half of them in Africa). The situation is likely to deteriorate further, as the number of people living in medium to high water-stressed areas is expected to increase by 60% from 2005-2030 under the OECD Baseline (see also Chapter 10 on freshwater). The increasing frequency of extreme weather events, changes in regional food production patterns and, in the longer term, sea level rise, are likely to result in migrations. Environment-related disease outbreaks can also affect population dynamics (see also Chapter 12 on health and environment).

The combination of increasing population density and environmental degradation in many areas worldwide accelerates vulnerability to disasters, for example in the Philippines. Poverty is generally recognised as one of the most important causes of vulnerability to environmental threats (UNEP, 2002).

Keys trends and projections

Population projections

Under the *OECD Environmental Outlook* Baseline, global population is expected to increase from slightly under 6.5 billion in 2005 to 8.2 billion in 2030. The OECD Baseline is based on the medium projection of the United Nations (see United Nations, 2005), in which global population is expected to stabilise at around 9.1 billion inhabitants by the middle of this century. This projection assumes that there will be no demographic catastrophe, and that progress in medical technology will be incremental (see Box 2.1).

Box 2.1. **Assumptions and key uncertainties**

The projections presented in this chapter are based on a number of assumptions:

- The United Nations' medium projections for population are based on the hypothesis that total fertility in all countries converges toward 1.85 children per woman. However, if every second woman in the world has one child more than anticipated, the world population would be 10.6 billion by 2050 instead of 9.1 billion; the population would be 7.7 billion if every second woman in the world has one child less than anticipated. On a country basis, the pace of convergence towards the 1.85 fertility rate may alter the projections by 2030.
- The United Nations' projections on the number of old and very old people only partially incorporate the increases in life-span longevity that have been seen recently (Oeppen and Vaupel, 2002). Additional increases in life expectancy would significantly increase the size of the ageing population, with resulting consequences for consumption patterns, and the social and economic demand for pensions, health-care and other age-related services.
- Hypotheses about labour participation modify economic growth projections, as the contribution of employment to growth is expected to decline, and labour productivity will increasingly become the major factor in economic growth. Should labour participation rates stabilise in OECD countries, macroeconomic projections would not be expected to change significantly (labour would substitute for capital, and production costs in labour-intensive industries would decrease), but the consequences are unclear for migration (*e.g.* would a higher participation rate affect immigration policies and international flows of migrants?) and environmental pressures (*e.g.* what are the environmental consequences of a more or less labour-intensive growth pattern?).
- Migration is an uncertain factor in population and labour force projections.
- In this chapter, countries are considered as single entities. This fails to account for sub-national discrepancies, especially in very large countries.* A disaggregated approach or one focused on ecosystems would provide a more accurate understanding of the environmental consequences of demographic trends.

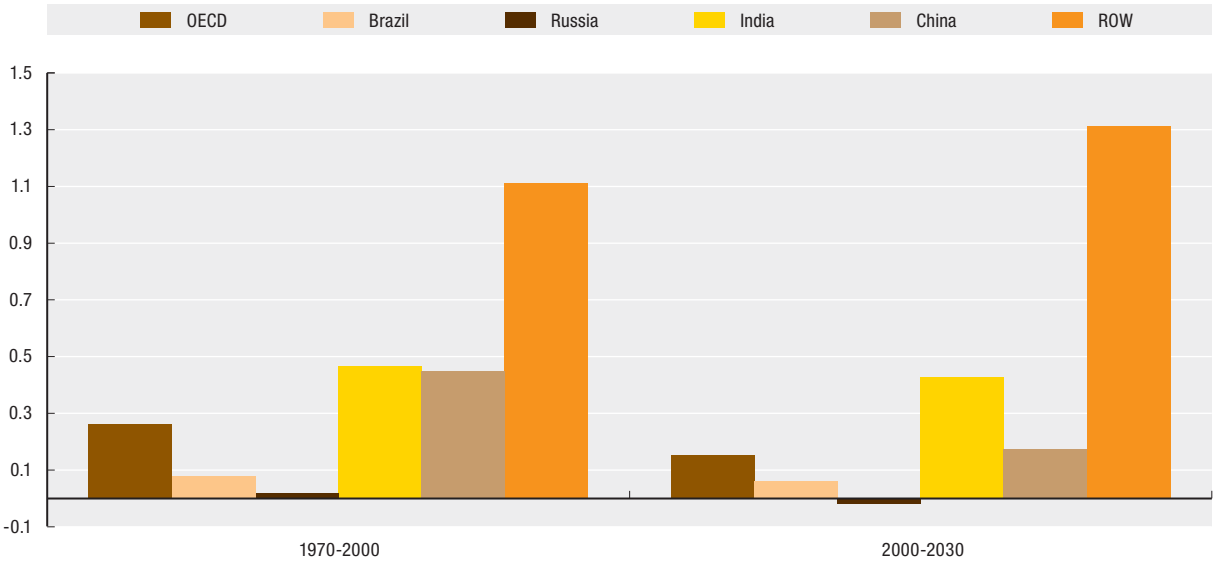
* See OECD (2003) for an analysis of differences in the structure of population at sub-national level in a number of OECD countries (especially Canada, Portugal, USA, France, Spain, Mexico and Australia).

The fundamental dynamic affecting word population trends is that fertility decreases in a country as the country develops. Economic development, then, is a key factor underlying demographic trends and explaining the contrasted patterns between developed and developing countries, and their convergence over time.

Ninety-five per cent of the global population growth to 2030 will take place in developing countries (Figure 2.1), with the 50 least developed countries experiencing especially rapid population growth. In contrast, the population in OECD countries is expected to stabilise; the share of OECD countries in the world population will drop from 23% in 1980 to 15% in 2030. Note that half the global population growth will come from nine countries only, including India, the USA and China,[2] while in 51 countries (including Germany, Italy, Japan, and the Community of Independent States), population is expected to be lower in 2050 than in 2005.

Figure 2.1. **Population growth by region, 1970-2030**

In billions



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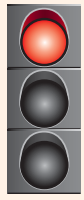
Source: Based on UN, 2004.

The significant population growth in developing countries to 2030 will place additional pressures on the environment, both in growing cities and in rural areas where populations are increasing. Without appropriate infrastructure (housing, energy, transport) and environment-related services, new urban dwellers will generate additional pressures on the environment. In rural areas the poorest people tend to have a high dependence on natural resources. In turn, the increased land and resource pressure is likely to deepen poverty and fuel migration.

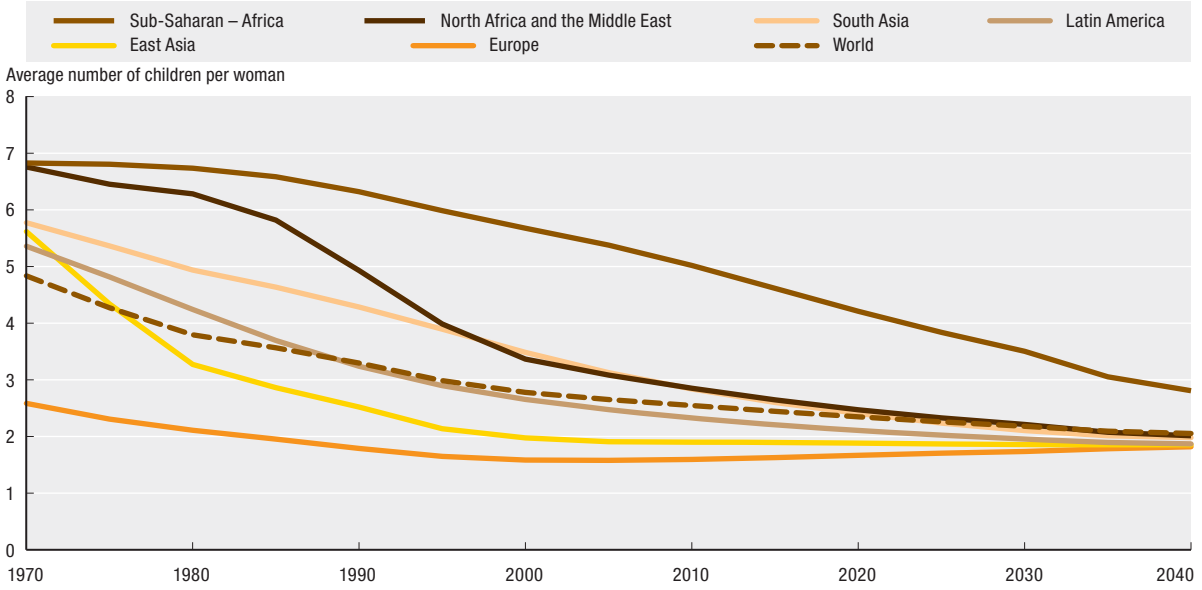


Further population growth to 2030 will place additional pressures on the environment unless accompanied by improved environmental policies and infrastructure.

The different dynamics between developed and developing economies result from varied mixes of fertility and mortality trends, which are linked to poverty and to economic growth (Figure 2.2) The link with migrations will be discussed in the following section.

Most industrialised countries already have below-replacement fertility levels, at 1.56 children per woman in 2005. The United Nations expects this will remain so to 2050,

Figure 2.2. **Fertility rates by region, 1970-2040**



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Source: Based on UN, 2004.

when the fertility rate is expected to be about 1.85 children per woman. At the same time, mortality rates are low in these countries, and still decreasing.

By contrast, least developed countries are expected to experience high fertility rates to 2030. These rates will on average remain above replacement level over the 2005-2030 period, although they will decline from the current 5 children per woman to an expected 3.36 children by 2030. In the rest of the developing world, the steady decline in fertility rates which started in the 1960s will continue, and below-replacement levels are likely to be reached in most countries by 2030 (2.01 children per woman, compared to 2.51 in 2005). These countries are also experiencing declining mortality rates, though this trend is being shattered by the HIV/AIDS epidemic in heavily-affected countries.

Countries of the former Soviet Union have a specific profile reflecting the degradation of social and sanitary services which has increased mortality rates. The Russian Federation and the Ukraine in particular are witnessing higher mortality than in the 1960s, and life expectancy in these countries is shorter than it used to be.

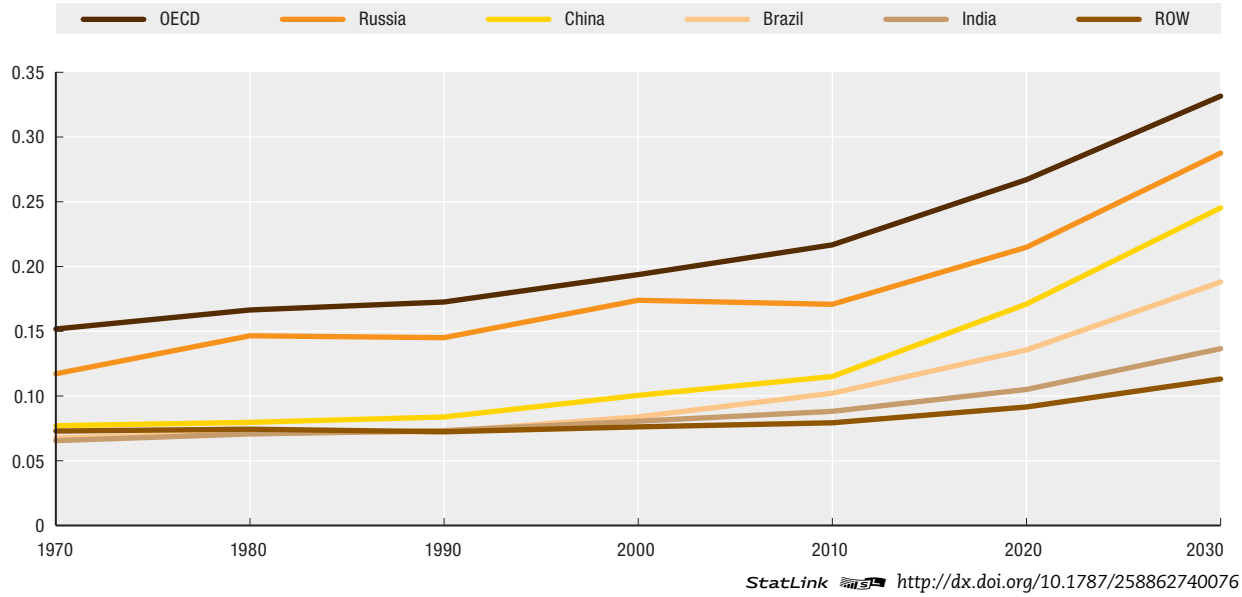
Population structure: ageing of populations

Ageing has (favourable and less favourable) consequences on the environment through consumption patterns (housing and land use, transport, tourism, food and drugs, etc.) and sensitivity to environmental constraints (*e.g.* vulnerability to heat-related, illnesses and air pollution effects on respiratory systems). It is associated with population influxes into sunbelts, coastal areas and river valleys, in OECD countries and elsewhere. It has macroeconomic consequences as well, due to public spending and related services – such as pensions, health care, long-term care, education and unemployment transfers – and to age-related trade-offs between current consumption and saving for future generations (ECFIN, 2006). Ageing also affects labour force participation rates, standards of living, urban planning and mobility.

The ageing of the population is a result of the combination of declining fertility and longer life expectancy. It is a dominant trend in OECD countries (see Figure 2.3), especially in North America, Europe, Korea and Japan. UN projections (United Nations, 2005) now show that ageing will occur even faster in the developing world. By 2050, the world is expected to host 1.9 billion people aged over 60 years, 1.2 billion more than it did in 2005. A projected 80% of these over 60-year-olds will live in the developing world. Over the same period, the number of people aged 80 years or more will be multiplied by 4.6: from 86 million in 2005, to 394 million in 2050.

Figure 2.3. **The grey dependency ratio**

Selected countries, 1970-2030



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Note: Ratio of people aged 65 years and over to those of working age.

Source: Based on UN, 2004.

One consequence of ageing is a decrease in labour force participation (see also Chapter 3 on economic development). Between 2000 and 2030 the Baseline projects that labour force participation in OECD countries will fall due to a combination of demographic changes and downward pressures from government policies. Thus, by 2030 it projects that labour force participation rates will vary from 49-71% in most OECD regions. However, most countries are likely to employ policies to maintain or increase labour force participation. European economies have set an employment rate target of 70%, which should be reached by 2020.

In this area, policies may influence the decisions of members of the working-age population (particularly women) to participate in the labour force. Indeed, female employment rates, which are very uneven across OECD countries and worldwide, are likely to rise, making them a major driver of change in the workforce. Raising the age of retirement is also being implemented or considered by a number of OECD countries. Migration is yet another option to enlarge the labour force. These policies will have specific environmental consequences. Typically, migration will reallocate people across territories (see below).

Migrations, international and domestic

Migrations change the distribution of population across countries and lands; they can be domestic or international. International migrations directly connect OECD and non-OECD countries. From an environmental perspective, they can add pressures on regions which are already stressed (*e.g.* aggregating people into over-crowded urban areas, or contributing to desertification). They can also be fuelled by environmental pressures. In some circumstances, migrations can exacerbate tensions and security issues.

According to the United Nations, between 2005 and 2050, migrations to more developed countries will more than offset the natural population decline in these countries (United Nations, 2005). Over this period, 98 million migrants will leave the less developed regions (less than 4% of the expected population growth in these regions), and the same amount will reach more developed countries (net figure[3]). However, most migrants to the world's rich countries do not come from among the world's poorest, but from middle-income countries or from the middle and upper reaches of the income distribution of low-income countries (Goldin, 2006).

The United Nations anticipates that the countries which will be major net receivers of international migrants are the USA (which will account for half of the annual flow, on average), Germany (thus reversing the current trend of population decline), Canada, the UK, Italy and Australia (United Nations, 2005). Major senders include China, Mexico, India, Indonesia and the Ukraine.

In a survey of recent trends, OECD (2005) suggests that migration flows to OECD countries are largely stable. They predominantly take place within a given region, and follow traditional routes, although some countries emerge as prominent sources of migrants, *e.g.* China and Russia. The share of labour-related migrations is rising, in particular for qualified migrants. This work confirms the strength of sub-regional flows, typically in sub-Saharan Africa, Latin America and Europe. Central and Eastern Europe tend to receive an increasing number of migrants from neighbouring countries, attracted by the new European Union member states; the region is also a source of migration to nearby OECD countries, in particular Austria, Germany and Italy. In Latin America, migrations within the region remain strong, but flows towards OECD countries keep growing; the USA, obviously, but also Europe (the UK and Italy, in particular), via Spain, are the primary destinations. Sub-Saharan Africa experiences essentially sub-regional flows.

New routes from Asia have changed the picture since the late 1960s. Migrants from Asia constitute a major and growing share of the populations received in OECD countries, typically in the USA (34% of migrants received by the USA originated in this region), Canada and Australia (the share of Asian population amounts to 50% of migrants in these countries), and the UK. Asian migrants form a dominant share of temporary, qualified migrants. An increasing variety of routes lead to migration between countries with cultural and historical similarities and it is expected that such routes will be increasingly crowded under demographic pressure.

Domestic migrations change the distribution of a population across a given territory. Rural-to-rural migration – for example, people moving to forest frontiers or to the coasts for new land and resources – can affect biodiversity through loss of species and genetic material, habitat loss and fragmentation, and disruption of ecosystem processes. Increasing migration to regions that are particularly at risk from natural hazards can increase vulnerability, a challenge that is likely to be exacerbated in the future by the impacts of a changing climate.

The distinction between rural and urban settlements (which is sometimes not clear-cut), and the move from city centres to suburbia, also modify both the pressures on the environment and the opportunities to mitigate them. Major impacts relate to land use (competition between natural habitat, agriculture, and human settlements) and environmental pressures, typically in and around big cities (urban sprawl), mountainous areas, coastal areas and internal seas. These make land and urban planning even more relevant from an environmental perspective (see Chapter 5 on urbanisation).

From 2005 to 2030, the world's urban population is expected to increase by more than 2 billion people. Urban conglomerations and mega-cities affect air pollution, and the demand (and opportunities) for environmental services (water and sanitation, waste management). Local environments are particularly deteriorated in slum areas, where it is estimated that 1 billion people (30% of city dwellers) now live. The United Nations Human Settlements Programme anticipates that this number could double by 2030 (UN-Habitat, 2003), a trend fuelled by migration from rural to urban areas.

Notes

1. Via age structure and participation rates, defined as the share of the adult population that considers itself as part of the labour force.
2. Chinese authorities expect the Chinese population to peak at 1.43 billion in 2020.
3. These anticipations are based on past trends, supplemented by an assessment of the policy stance of countries on international migration flows.

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ISBN 978-92-64-04048-9
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*.

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.

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*).

Table of Contents

II. Impacts of Environmental Change

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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