THE EUROPEAN ENVIRONMENT

STATE AND OUTLOOK 2010

SYNTHESIS

European Environment Agency


SOER
2010

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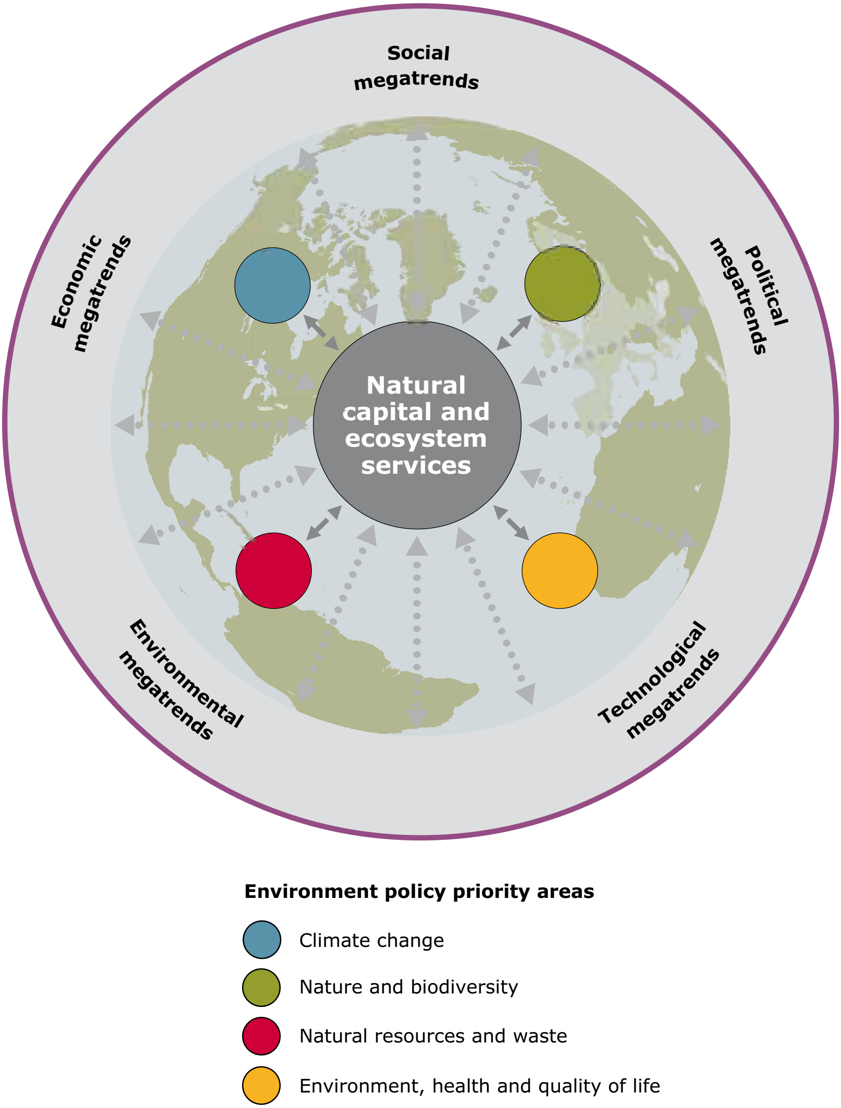
Social megatrends
Political megatrends
Technological megatrends
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Key messages

Environmental policy in the European Union and its neighbours has delivered **substantial improvements** to the state of the environment. However, **major environmental challenges remain** which will have significant consequences for Europe if left unaddressed.

What differs in 2010, compared to previous *EEA European environment — State and outlook* reports, is an enhanced understanding of the links between environmental challenges combined with unprecedented global megatrends. This has allowed a deeper appreciation of the human-made systemic risks and vulnerabilities which threaten ecosystem security, and insight into the shortcomings of governance.

The prospects for Europe's environment are mixed but there are opportunities to make the environment more resilient to future risks and changes. These include unparalleled environmental information resources and technologies, ready-to-deploy resource accounting methods and a renewed commitment to the established principles of precaution and prevention, rectifying damage at source and polluter pays. These overarching findings are supported by the following **10 key messages**:

- **Continuing depletion of Europe's stocks of natural capital and flows of ecosystem services** will ultimately undermine Europe's economy and erode social cohesion. Most of the negative changes are driven by growing use of natural resources to satisfy production and consumption patterns. The result is a significant environmental footprint in Europe and elsewhere.

- **Climate change** — The EU has reduced its greenhouse gas emission and is on track to meet its Kyoto Protocol commitments. However, global and European cuts in greenhouse gas emissions are far from sufficient to keep average world temperature increases below 2 °C. Greater efforts are needed to mitigate the effects of climate change and put in place adaptation measures to increase Europe's resilience.

- **Nature and biodiversity** — Europe has established an extensive network of protected areas and programmes to reverse the loss of endangered species. However, widespread alteration of landscapes, degradation of ecosystems and loss of natural capital mean that the EU will not meet its target of halting biodiversity loss by 2010. To improve the situation we must prioritise biodiversity and ecosystems in policymaking at all scales, particularly addressing agriculture, fisheries, regional development, cohesion and spatial planning.

- **Natural resources and waste** — Environmental regulation and eco-innovation have increased resource efficiency through a relative decoupling of resource use, emissions and waste generation from economic growth in some areas. However, absolute decoupling remains a challenge, especially for households. This indicates scope not only to improve production processes further, but also to alter consumption patterns to reduce environmental pressures.

- **Environment, health and quality of life** — Water and air pollution have declined but not enough to achieve good ecological quality in all water bodies or to ensure good air quality in all urban areas. Widespread exposure to multiple pollutants and chemicals and concerns about long-term damage to human health together imply the need for more large-scale pollution prevention programmes and the use of precautionary approaches.

- **Links between the state of Europe's environment and various global megatrends** imply increasing systemic risks. Many key drivers of change are highly interdependent and likely to unfold over decades rather than years. These interdependencies and trends, many of them outside Europe's direct influence, will have significant consequences and potential risks for the resilience and sustainable development of Europe's economy and society. Better knowledge of the linkages and associated uncertainties will be essential.

- **The notion of dedicated management of natural capital and ecosystem services** is a compelling integrating concept for dealing with environmental pressures from multiple sectors. Spatial planning, resource accounting and coherence among sectoral policies implemented at all scales can help balance the need to preserve natural capital and use it to fuel the economy. A more integrated approach of this sort would also provide a framework for measuring progress more broadly and underpin coherent analyses across multiple policy targets.

- **Increased resource efficiency and security can be achieved**, for example, using extended life cycle approaches to reflect the full environmental impacts of products and activities. This can reduce Europe's dependence on resources globally and promote innovation. Pricing that takes full account of resource use impacts will be important for steering business and consumer behaviour towards enhanced resource efficiency. Clustering sectoral policies according to their resource needs and environmental pressures would improve coherence, address shared challenges efficiently, maximise economic and social benefits and help avoid unintended consequences.

- **Implementing environmental policies and strengthening environmental governance** will continue to provide benefits. Better implementation of sectoral and environmental policies will help ensure that goals are achieved and provide regulatory stability for businesses. A broader commitment to environmental monitoring and up-to-date reporting of environmental pollutants and wastes, using the best available information and technologies, will make environmental governance more effective. This includes reducing long-term remediation costs through early action.

- **Transformation towards a greener European economy** will ensure the long-term environmental sustainability of Europe and its neighbourhood. In this context, shifts in attitudes will be important. Together, regulators, businesses and citizens could participate more widely in managing natural capital and ecosystem services, creating new and innovative ways to use resources efficiently and designing equitable fiscal reforms. Using education and various social media, citizens can be engaged in tackling global issues such as meeting the 2 °C climate target.

The seeds for future actions exist: the task ahead is to help them take root and flourish.

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1 The state of the environment in Europe

Europe relies heavily on natural capital and ecosystems at home and abroad

The Europe addressed in this report is home to around 600 million people and covers about 5.85 million km^2. The biggest shares of both population and land area are in the European Union (EU) — around 4 million km^2 and close to 500 million people. With an average of 100 people per km^2, Europe is one of the most densely populated regions of the world; some 75 % of the total population lives in urban areas (1) (2).

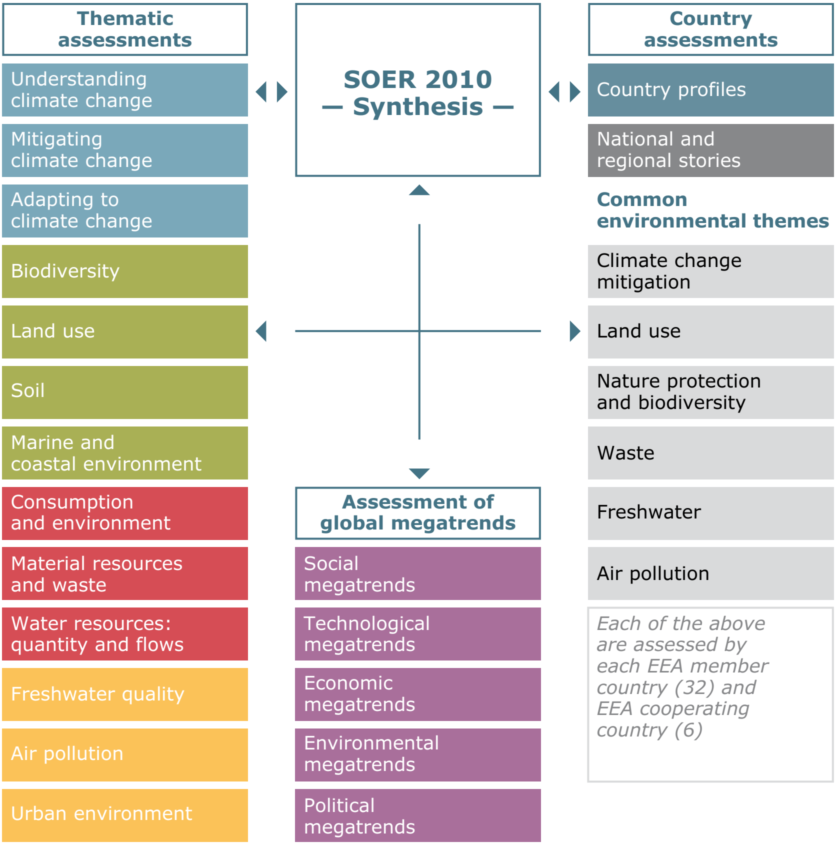
Europeans depend heavily on the stocks of natural capital and flows of ecosystem services that lie within and beyond Europe's borders. Two fundamental questions arise from this dependency. Are the stocks and flows today being used sustainably to supply essential benefits, such as food, water, energy, materials, as well as climate and flood regulation? Are today's environmental resources, i.e. air, water, soil, forests, biodiversity, secure enough to be able to sustain people and economies in good health in the future?

Access to reliable up-to-date information about the environment provides a basis for action

To answer such questions, citizens and policymakers require accessible, relevant, credible, and legitimate information. According to various polls, people concerned about the state of the environment see that providing more information on environmental trends and pressures is one of the most effective ways of tackling environmental problems, along with fines and strong enforcement (3).

The aim of the European Environment Agency (EEA) is to provide such timely, targeted, relevant and reliable information on the environment to support sustainable development and help achieve significant and measurable improvements in Europe's environment (4). A further requirement is that the EEA publishes

Figure 1.1 **Structure of *The European environment — State and outlook 2010* (SOER 2010) (ᴬ)**



Note: For additional information, please visit www.eea.europa.eu/soer.

Source: EEA.

regular assessments of the state and outlook for the environment in Europe: this report is the fourth in the series ([5]) ([6]) ([7]).

The European environment — State and outlook 2010 (SOER 2010) ([A]) provides an assessment of the most up-to-date information and data from 32 EEA member countries and six cooperating countries in the Western Balkans. It also addresses four regional seas: the North-east Atlantic, Baltic, Mediterranean and Black Seas.

Being a European-level report, it complements national-level 'state of the environment' reports across Europe ([B]). Its aim is to provide analyses and insights into the state of, trends in and prospects for Europe, plus an indication of where gaps in knowledge and uncertainties exist, in order to enhance discussions and decisions about critical policies and societal issues.

Reviewing the state of the environment in Europe reveals considerable progress, but challenges remain

There have been many encouraging trends in the environment over the past decade: European greenhouse gas emissions have decreased; the share of renewable energy sources has increased; some air and water pollution indicators show significant improvements across Europe, although this has not yet necessarily resulted in good air and water quality; and materials use and waste generation, although still increasing, are growing at a slower rate than the economy.

In some areas, environmental targets have not been achieved. The target of halting biodiversity loss in Europe by 2010, for example, will not be reached, although large areas across Europe have been designated as protected areas under the EU Habitats and Birds Directives ([8]) ([9]). Also, the overarching target to limit climate change to temperature increases below 2 °C globally during this century is unlikely to be met, in part because of greenhouse gas emissions from other parts of the world.

An indicative summary table of the main trends and progress over the past ten years where EU policy targets have been established shows a mixed picture. Only a few indicators are included to highlight key

Table 1.1 Which countries and regions does this report address?

Region	Sub-region	Sub-group	Countries
EEA member countries (EEA-32)	EU-27	EU-15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom
		EU-12	Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia
	EU candidate countries		Turkey
	European Free Trade Association (EFTA) countries		Iceland, Liechtenstein, Norway, Switzerland
EEA cooperating countries (Western Balkans)	EU candidate countries		Croatia, the former Yugoslav Republic of Macedonia
	EU potential candidate countries		Albania, Bosnia and Herzegovina, Montenegro, Serbia

Note: EEA-38 = EEA member countries (EEA-32) + EEA cooperating countries (Western Balkans).

For practical reasons, the groups used are based on established political groupings (as of 2010) rather than environmental consideration only. Thus there are variations in environmental performance within the groups and substantial overlaps between them. Where possible, this has been highlighted in the report.

trends here; the more detailed analyses that follow show that in some instances, such as waste and greenhouse gas emissions, there are substantial differences by economic sector and country.

Several key environmental issues are not shown in this summary table, either because they lack explicit targets or because it is too early to measure progress against more recently agreed targets. Such issues include, for example, noise, chemicals and hazardous substances, natural and technological hazards. They are, however, considered in subsequent chapters of this report and the results from their analyses have contributed to the conclusions of this report.

The overall emerging picture of progress towards meeting environmental targets, confirms the findings of previous European 'state of the environment' reports, namely that there have been considerable improvements in many areas, but a number of major challenges remain. This picture is also reflected in recent *Annual Environment Policy Reviews* by the European Commission in which up to two-thirds of the 30 environmental indicators selected show a poor performance or worrying trend, while the remainder point to either good performance or at least mixed progress towards environmental targets (10) (11).

Links between environmental pressures point to environmental systemic risks

This report describes the state of and trends in the environment in Europe as well as prospects for the future along a central thread of four environmental issues: climate change; nature and biodiversity; natural resources and waste; and environment, health and quality of life. These four issues have been chosen as entry points as they are the priorities of current European strategic policies in the EU 6th Environment Action Programme (J) (12) and the EU Strategy for Sustainable Development (13), and thereby help to create a direct link with the European policy framework.

The analyses point to the fact that today's understanding and perception of environmental challenges are changing: no longer can they be seen as independent, simple and specific issues. Rather, the challenges are increasingly broad-ranging and complex, part of a web

Table 1.2 **Indicative summary table of progress towards meeting environmental targets or objectives, and highlights of related trends over the past 10 years (c)**

Environmental issue	EU-27 target/objective	EU-27 — on track?	EEA-38 — trend?
Climate change			
Global mean temperature change	To limit increases to below 2 °C globally (a)	☒ (D)	(↗)
Greenhouse gas emissions	To reduce greenhouse gas emissions; by 20 % by 2020 (b)	☑ (E)	↘
Energy efficiency	To reduce primary energy use; by 20 % by 2020 vs. business-as-usual (b)	☐ (E)	↗
Renewable energy sources	To increase energy consumption from renewables; by 20 % by 2020 (b)	☐ (E)	↗
Nature and biodiversity			
Pressure on ecosystems (from air pollution, e.g. eutrophication)	Not to exceed critical loads of eutrophying substances (c)	☒	→
Conservation status (safeguard EU's most important habitats and species)	To achieve favourable conservation status, set up Natura 2000 network (d)	☐ (F)	→
Biodiversity (terrestrial and marine species and habitats)	To halt the loss of biodiversity (e) (f)	☒ (terrestrial) ☒ (marine)	(↘) (↘)
Soil degradation (soil erosion)	To prevent further soil degradation and preserve its functions (g)	☒ (G)	(↗)
Natural resources and waste			
Decoupling (resource use from economic growth)	To decouple resource use from economic growth (h)	☐	↗
Waste generation	To substantially reduce waste generation (h)	☒ (H)	(↗)
Waste management (recycling)	Several recycling targets for different specific waste streams	☑	↗
Water stress (water exploitation)	To achieve good quantitative status of water bodies (i)	☐ (I)	→

Table 1.2 **Indicative summary table of progress towards meeting environmental targets or objectives, and highlights of related trends over the past 10 years (c) (cont.)**

Environmental issue	**EU-27 target/objective**	**EU-27 — on track?**	**EEA-38 — trend?**
Environment and health			
Water quality (ecological and chemical status)	To achieve good ecological and chemical status of water bodies (i) (j)	☐ (I)	→
Water pollution (from point sources, and bathing water quality)	To comply with bathing water quality, urban wastewater treatment (k) (l)	☑	↘
Transboundary air pollution (NO_X, NMVOC, SO_2, NH_3, primary particles)	To limit emissions of acidifying, eutrophying and ozone precursor pollutants (c)	☐	↘
Air quality in urban areas (particulate matter and ozone)	To attain levels of air quality that do not give rise to negative health impacts (m)	☒	→

Legend

Positive developments	**Neutral developments**	**Negative developments**
↘ Decreasing trend	→ Stable	(↘) Decreasing trend
↗ Increasing trend		(↗) Increasing trend
☑ EU on track (some countries may not meet target)	☐ Mixed progress (but overall problem remains)	☒ EU not on track (some countries may meet target)

Source: EEA (c).

of linked and interdependent functions provided by different natural and social systems. This does not imply that the environmental concerns which emerged in the previous century, such as how to reduce greenhouse gas emissions or halt biodiversity loss, are no longer important. Rather, it points towards an increased degree of complexity in the way we understand and respond to environmental challenges.

The report seeks to shed light from various viewpoints on key characteristics of the complex links between environmental issues. It does so by providing a closer analysis of the links between different environmental challenges, as well as between environmental and sectoral trends and their respective policies. For example, reducing the rate of climate change requires not only the reduction of greenhouse gas emissions from power plants, but also the reduction of more diffuse emissions from transport and agriculture as well as changes in household consumption patterns.

Taken together, trends in Europe and globally point towards a number of systemic environmental risks, such as the potential loss or damage to an entire system rather than a single element, which can be made worse by the many interdependencies between them. Systemic risks can be triggered by sudden events or built up over time, with the impact often being large and possibly catastrophic ([14]).

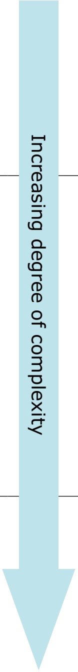
A number of underlying developments in Europe's environment display key characteristics of systemic risk:

- many of Europe's environmental issues, such as climate change or biodiversity loss, are linked and have a complex and often global character;

- they are closely linked to other challenges, such as unsustainable resource use, that span the societal and economic spheres and undermine important ecosystem services;

- as environmental challenges have become more complex and more profoundly linked to other societal concerns, the uncertainties and risks associated with them have increased.

Table 1.3 Evolution of environmental issues and challenges



In the spotlight during	Climate change	Nature and biodiversity	Natural resources and waste	Environment and health
1970s/1980s (until today)		Protect selected species and habitats.	Improve waste treatment to control hazardous substances in waste; reduce impact from waste disposal; reduce impacts from landfills and spills.	Reduce emissions of specific pollutants into air, water, soil; improve wastewater treatment.
1990s (until today)	Reduce greenhouse gas emissions from industry, transport and agriculture; increase share of renewable energy.	Establish ecological networks; manage invasive species; reduce pressure from agriculture, forestry, fisheries and transport.	Recycle waste; reduce waste generation through prevention approach.	Reduce emissions of pollutants from common sources (such as transport-related noise and air pollution) into air, water, soil; improve regulation of chemical substances.
2000s (until today)	Establish economy-wide approaches, provide behavioural incentives and balance drivers of consumption; share global burdens of mitigation and adaptation.	Integrate ecosystem services linked to climate change, resource use and health; account for use of natural capital (i.e. water, land, biodiversity, soil) in decisions on sectoral management.	Improve efficiency of resource use (such as materials, food, energy, water) and consumption in the face of increasing demand, reduced resources and competition; cleaner production.	Reduce people's combined exposure to harmful pollutants and other stressors; better link human and ecosystem health.

Source: EEA.

The report does not present any warnings of imminent environmental collapse. However, it does note that some local and global thresholds are being crossed, and that negative environmental trends could lead to dramatic and irreversible damage to some of the ecosystems and services that we take for granted. In other words, the current insufficient rate of progress observed over the past few decades in addressing environmental issues may severely undermine our ability to deal with potential future negative impacts.

Looking at the state of the environment and future challenges from different perspectives

Subsequent chapters assess, in more detail, key trends in the four environmental priority issues already mentioned.

Chapters 2 to 5 provide an assessment of the state of, trends in and prospects for each of these issues.

Chapter 6 reflects on the many direct and indirect connections across issues from the perspectives of natural capital and ecosystem services, focusing on land, soil and water resources.

Chapter 7 uses another lens by looking out to the rest of the world in terms of key socio-economic and environmental megatrends that can be expected to affect Europe's environment.

The final chapter, Chapter 8, reflects on the findings of the previous chapters and their implications for future environmental priorities. It does this through an additional series of lenses; the lens of managing natural capital and ecosystem services, the lens of a green economy, the lens of strengthened integrated policies and the lens of state-of-the-art information systems, and concludes that:

- better implementation and further strengthening of environmental protection provide multiple benefits;

- dedicated management of natural capital and ecosystem services increases resilience;

- more integrated actions across policy domains can help deliver positive environmental outcomes with co-benefits for the wider economy;

- sustainable natural capital stewardship requires a transition towards a greener, more resource-efficient economy.

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2 Climate change

Climate change could lead to catastrophic impacts if unchecked

While the global climate has been remarkably stable for the past 10 000 years, providing a backdrop for the development of human civilisation, there are now clear signs that the climate is changing (1). This is widely recognised as one of the most prominent challenges facing humankind. Measurements of the global atmospheric concentrations of greenhouse gases (GHG) (A) show marked increases since pre-industrial times, with levels of carbon dioxide (CO_2) far exceeding the natural range of the past 650 000 years. The concentration of atmospheric CO_2 has increased from a pre-industrial level of about 280 ppm to more than 387 ppm in 2008 (2).

Increases in GHG emissions are largely due to the use of fossil fuels, although deforestation, land-use change and agriculture also provide significant but smaller contributions. As a consequence, the average global air temperature in 2009 had risen by 0.7 to 0.8 °C since pre-industrial times (3). Indeed, the Intergovernmental Panel on Climate Change (IPCC) concluded that global warming since the middle of the 20th century is very likely to have been due to human influences (B) (4).

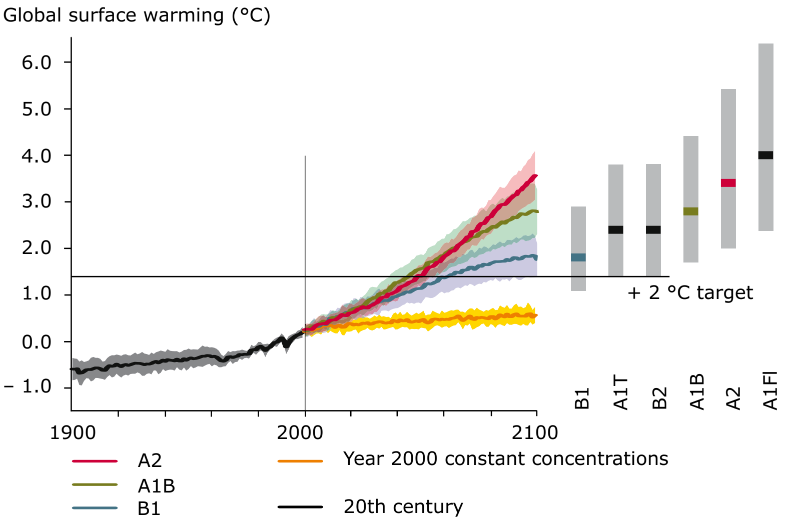
In addition, best estimates of current projections suggest global mean temperatures could rise by as much as 1.8 to 4.0 °C — or 1.1 to 6.4 °C taking into account the full uncertainty range — over the course of this century if global action to limit GHG emissions proves unsuccessful (4). Recent observations give reason to believe that the rate of growth of GHG emissions and many climate impacts are approaching the upper boundary of the IPCC range of projections rather than the lower ones (C) (1) (5).

Changes in climate and temperature increases of such magnitude are associated with a wide range of potential impacts. Already over the last three decades, warming has had a discernible influence at the global scale on observed changes in many human and natural systems

— including shifts in precipitation patterns, rising global mean sea level, the retreat of glaciers and decline in the extent of Arctic sea ice coverage. Furthermore, in many instances river run-off has changed, especially in snow- or glacier-fed rivers ([6]).

Other consequences of changing climatic conditions include increases in global mean ocean temperatures, widespread melting of snow and ice sheets, increased flood risk for urban areas and ecosystems, ocean acidification, and extreme climatic events including heat waves. The impacts of climate change are expected to be felt in all regions of the planet, and Europe is no exception. Unless action is taken, climatic changes are expected to lead to considerable adverse impacts.

Figure 2.1 **Past and projected global surface temperature change (relative to 1980–1999), based on multi-model averages for selected IPCC scenarios**



Note: The bars on the right of the figure indicate the best estimate (solid line within each bar) and the likely range assessed for all six IPCC marker scenarios at 2090–2099 (relative to 1980–1999). The horizontal black line has been added by EEA to indicate the EU Council conclusion and UNFCCC Copenhagen Accord objective of 2 °C maximum temperature increase above pre-industrial (1.4 °C above 1990 because of about 0.6 °C temperature increase from the pre-industrial period to 1990).

Source: Intergovernmental Panel on Climate Change (IPCC) ([a]).

In addition, with increasing global temperatures, there is an increasing risk of passing tipping points that may trigger large-scale, non-linear changes (Chapter 7).

Europe's ambition is to limit global mean temperature increase to below 2 °C

Guiding the political discussions on how to limit dangerous interference with the climate system is the internationally recognised goal to limit the global mean temperature increase since pre-industrial times to below 2 °C ([7]). Meeting this target will require substantial reductions in global GHG emissions. Considering only the atmospheric CO_2 concentration, and applying estimates of global climate sensitivity, this overarching target can be translated into limiting atmospheric CO_2 concentrations to around 350–400 ppm. If all GHG emissions are included, a limit of 445–490 ppm CO_2-equivalent is often cited ([4]) ([8]).

As indicated above, atmospheric CO_2 concentrations are already close to this level and are currently increasing by about 20 ppm per decade ([2]). Thus, to achieve the below 2 °C target, global CO_2 emissions would need to level off in the present decade and be reduced significantly thereafter ([5]). In the long run, reaching this target is likely to require emission cuts of around 50 % compared to 1990 levels by 2050 globally ([4]). For the EU-27 and other industrialised countries this translates to emission cuts of 25–40 % by 2020 and 80–95 % by 2050 — if developing countries also reduce their emissions substantially compared to their respective business-as-usual emission projections.

However, even a 2 °C guardrail provides no guarantee for avoiding all adverse climate change impacts and is subject to uncertainties. The United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties held in Copenhagen in 2009 took note of the *Copenhagen Accord*, which calls for an assessment of its implementation by 2015: *This would include consideration of strengthening the long-term goal (by) referencing various matters presented by the science, including in relation to temperature rises of 1.5 °C* ([7]).

The EU has been reducing its greenhouse gas emissions, and will meet its Kyoto obligation

Meeting the target of limiting global temperatures increases to less than 2 °C will require a concerted global effort — including further substantial GHG emission reductions in Europe. In 2008, the EU was responsible for between 11 and 12 % of global GHG emissions (9) — while being home to 8 % of the world's population. According to current projections taking into account population growth and economic development worldwide, Europe's percentage contribution will decrease, as emissions in emerging economies continue to increase (10).

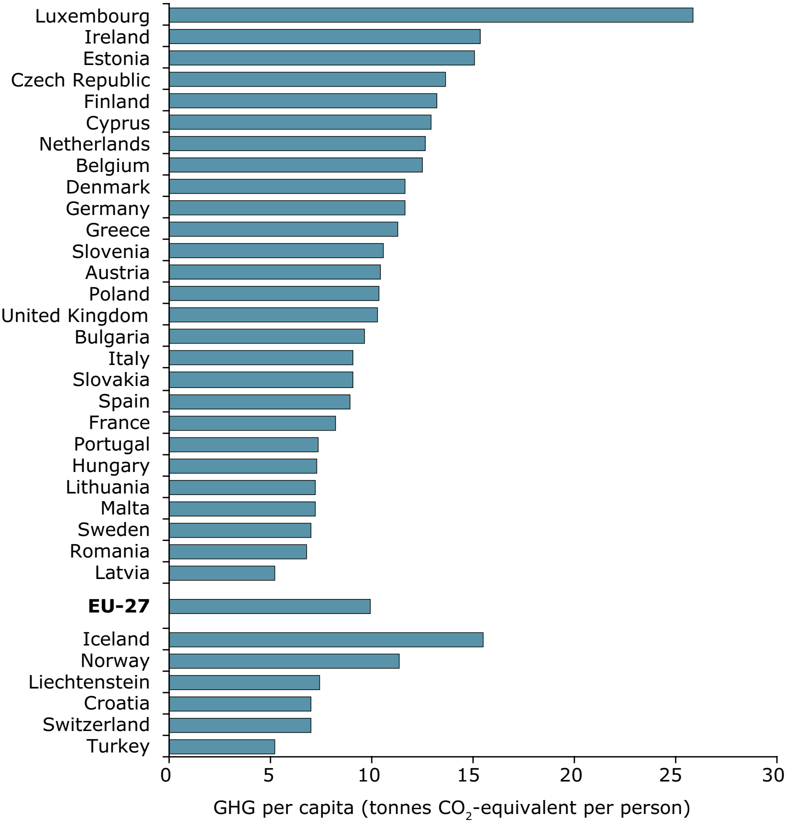
Annual emissions of GHG in the EU in 2008 corresponded to around 10 tonnes of CO_2-equivalent per person (11). In terms of total emissions, the EU is in third place behind China and the USA (12). Meanwhile, the trends in EU GHG emissions relative to economic development — measured as gross domestic product (GDP) — in the EU indicate an overall decoupling of emissions from economic development over time. Between 1990 and 2007, emissions per unit of GDP decreased in the EU-27 by more than a third (11).

However, it should be noted that these emission figures only represent what is emitted within the EU territory, calculated according to agreed international guidelines under UNFCCC. Europe's contribution to global emissions could be greater if European imports of goods and services, with their 'embedded carbon', are taken into account.

Current emission data confirm that the EU-15 Member States are on track to meet their joint target of cutting emissions by 8 % compared to base-year levels — 1990 for most countries — during the first commitment period under the Kyoto Protocol: the years 2008 to 2012. Reductions in the EU-27 have been even greater than in the EU-15; domestic GHG emissions fell by approximately 11 % between 1990 and 2008 (D) (11).

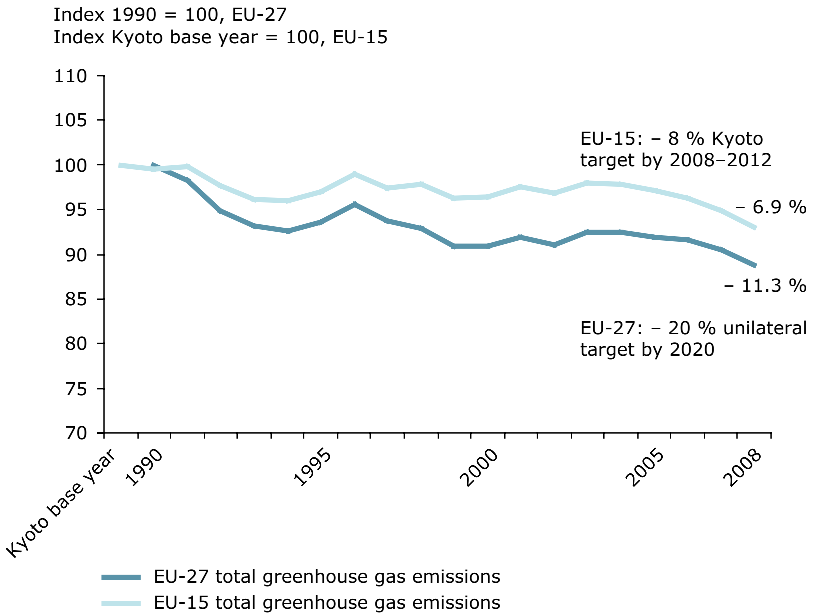
It is worth noting that the UNFCCC and its Kyoto Protocol do not cover all GHGs. Many of the substances controlled under the Montreal Protocol, such as chlorofluorocarbons (CFCs), are also potent GHGs. The phasing out of climate-changing ozone-depleting substances (ODS) under the Montreal Protocol has contributed indirectly to a very significant decrease in GHG emissions: this has reduced GHG emissions globally by more than the reductions expected through compliance with the provisions of the Kyoto Protocol by the end of 2012 ([13]).

Figure 2.2 **Greenhouse gas emissions as tonnes CO_2-equivalent per person by country in 2008**



Source: EEA.

Figure 2.3 Domestic GHG emissions in EU-15 and EU-27 between 1990 and 2008 (D)



Source: EEA.

A closer look at key sectoral greenhouse gas emissions reveals mixed trends

The main sources of man-made GHG emissions globally are the burning of fossil fuels for electricity generation, transport, industry and households — which together account for about two-thirds of total global emissions. Other sources include deforestation — which contributes about a fifth — agriculture, land-filling of waste, and the use of industrial fluorinated gases. Overall, in the EU, energy consumption — power and heat generation and consumption in industry, transport and households — accounts for nearly 80 % of GHG emissions (9).

Historic trends of GHG emissions in the EU over the past 20 years are the result of two sets of opposing factors (11).

On the one hand, emissions have been driven *upwards* by a series of factors, such as:

- increases in the production of electricity and heat by thermal plants, which has increased both in absolute terms and in comparison with other sources;
- economic growth in manufacturing industries;
- increasing transport demand for passengers and freight;
- increasing share of road transport compared with other transport modes;
- increasing number of households;
- and demographic changes over the past decades.

On the other hand, emissions have been driven *downwards* in the same period by factors such as:

- improvements in energy efficiency, in particular by industrial end users and the energy industries;
- fuel efficiency improvements in vehicles;
- better waste management and improved landfill gas recovery (the waste sector achieved the highest relative reductions);
- decreases in emissions from agriculture (by more than 20 % since 1990);
- a shift from coal to less polluting fuels, particularly gas and biomass, for the production of electricity and heat;
- and partly due to the economic restructuring in eastern Member States in the early 1990s.

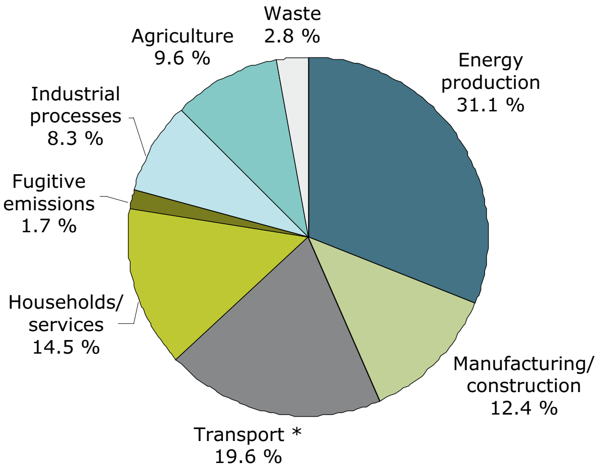
EU GHG emissions trends between 1990 and 2008 were dominated by the two largest emitters, Germany and the United Kingdom, which together were responsible for more than half of the total reduction in the EU. Significant reductions were also achieved by some EU-12 Member States, such as Bulgaria, Czech Republic, Poland and Romania. This overall decrease was partly offset by emission increases in Spain and, to a lesser extent, Italy, Greece and Portugal ([9]).

The overall trends are influenced by the fact that, in many cases, emissions from large point sources have been reduced, while at the same time emissions from some mobile and/or diffuse sources, especially those transport-related, have increased substantially.

In particular, transport still remains a problematic emitting sector. Transport emissions of GHGs increased by 24 % between 1990 and 2008 in the EU-27, excluding emissions from international aviation and marine transport ([9]). While rail freight and inland waterways saw a decline in market share, the number of cars in the EU-27 increased by 22 %, or 52 million cars, between 1995 and 2006 ([14]).

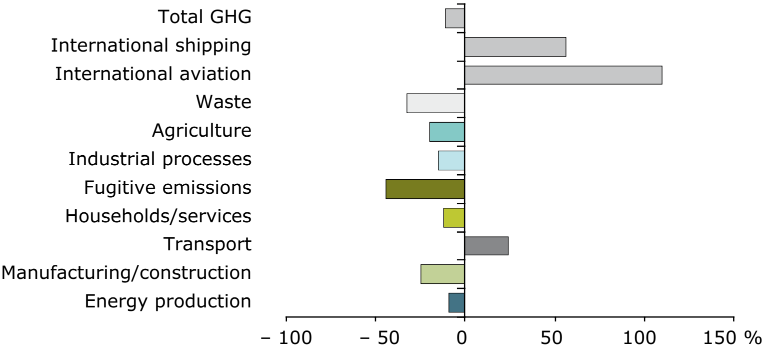
Figure 2.4 Greenhouse gas emissions in the EU-27 by sector in 2008, and changes between 1990 and 2008

Total greenhouse gas emissions by sector in EU-27, 2008



* Excludes international aviation and shipping (6 % of total GHG emissions)

Changes 1990–2008



Note: Emissions from international aviation and international maritime navigation, which are not covered by the Kyoto Protocol, are not included in the top figure. If included in the total, the share of transport would reach around 24 % of total EU-27 GHG emissions in 2008.

Source: EEA.

Box 2.1 Towards a resource-efficient transport system

The increases in greenhouse gas emissions in the transport sector — as well as several other environmental impacts of transport — continue to be closely linked to economic growth.

The EEA's annual *Transport and Environment Reporting Mechanism* (TERM) report monitors the progress and effectiveness of efforts to integrate transport and environment strategies. For 2009, the report highlighted the following trends and findings:

- Freight transport tends to grow slightly faster than the economy, with road and air freight recording the largest increases in the EU-27 (43 % and 35 %, respectively, between 1997 and 2007). The share of rail and inland waterways in the total freight volumes declined during that period.
- Passenger transport continued to grow but at a slower rate than the economy. Air travel within the EU remained the fastest growth area, increasing 48 % between 1997 and 2007. Car journeys remained the dominant mode of transport, accounting for 72 % of all passenger kilometres in the EU-27.
- Greenhouse gas emissions from transport (excluding international aviation and maritime transport) grew by 28 % between 1990 and 2007 in EEA countries (by 24 % in EU-27), and now account for around 19 % of total emissions.
- In the European Union, only Germany and Sweden are on track to meet their 2010 indicative targets for biofuels use (however, see also discussion related to bioenergy production in Chapter 6).
- Despite recent reductions in air pollutant emissions, road transport was the largest emitter of nitrogen oxides and the second largest contributor of pollutants forming particulate matter in 2007 (see also Chapter 5).
- Road traffic remains by far the largest source of exposure to transport noise. The number of people exposed to damaging noise levels, especially at night, is expected to increase unless effective noise policies are developed and implemented in full (see also Chapter 5).

The report concludes that addressing the environmental aspects of transport policy effectively requires a vision for what the transport system should be like by the mid 21st century. The process of establishing a new Common Transport Policy is essentially about creating this vision and then designing policies to achieve it.

Source: EEA ([b]).

Looking ahead to 2020 and beyond: the EU is making some progress

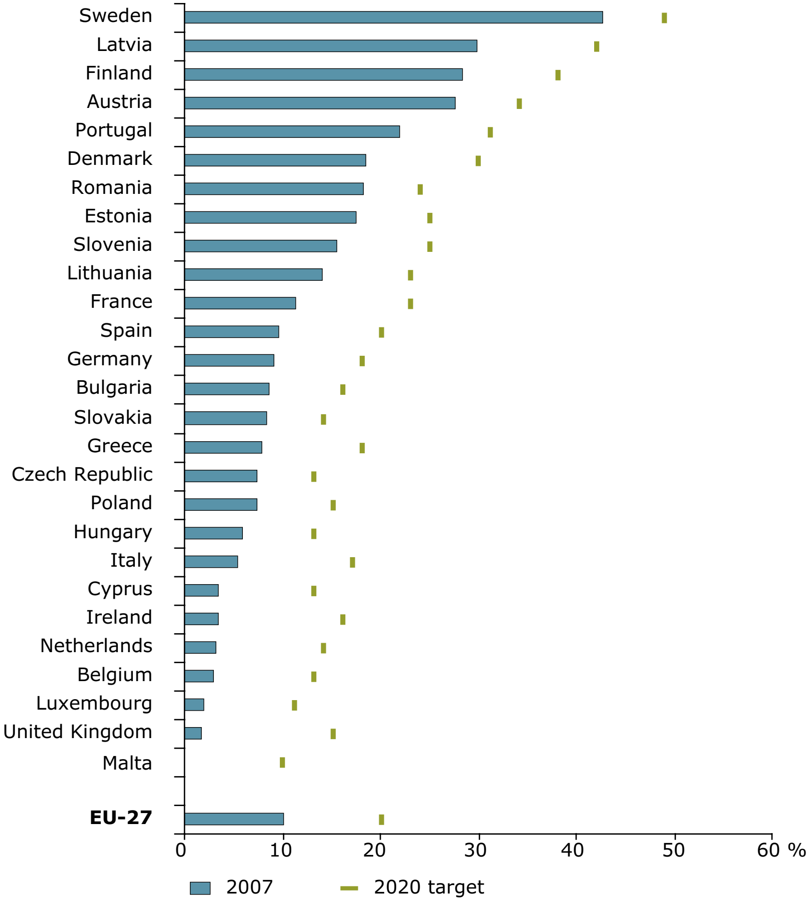
In its Climate and Energy Package (15), the EU has committed to further reduce emissions by (at least) 20 % from 1990 levels by 2020. Furthermore, the EU will commit to reducing emissions by 30 % by 2020, provided that other developed countries commit themselves to comparable emission reductions and developing countries contribute adequately according to their responsibilities and respective capabilities. Switzerland and Liechtenstein (both 20 to 30 % reductions) as well as Norway (30 to 40 %) have made similar commitments.

Current trends show that the EU-27 is making progress towards its 2020 emission reduction target. Projections by the European Commission indicate that EU emissions would be 14 % below 1990 levels by 2020, taking into account implementation of national legislation in place by early 2009. Assuming that the climate and energy package is fully implemented, the EU is expected to reach its 20 % GHG reduction target (16). It is worth noting that part of the additional reduction could be achieved through the use of flexible mechanisms both in the trading and non-trading sectors (E).

Key related efforts include the expansion and strengthening of the EU Emission Trading System (17), as well as setting legally binding targets for increasing the share of renewable energy to 20 % of overall energy consumption, including a 10 % share in the transport sector, compared to a total share of less than 9 % in 2005 (18). Promisingly, the share of renewable sources in energy production has been increasing, and energy generation using biomass, wind turbines and photovoltaics in particular has grown substantially.

Limiting global mean temperature increases to below 2 °C in the longer term and reducing global GHG emissions 50 % or more compared with 1990 by 2050, is generally considered to be beyond what can be achieved with incremental emission reductions. In addition, systemic changes in the way we generate and use energy, and how we produce and consume energy-intensive goods are likely to be required. Thus, further improvements in both energy efficiency and resource-use efficiency need to continue as a key component of GHG emission strategies.

Figure 2.5 **Share of renewable energy in final energy consumption in EU-27 in 2007 compared to 2020 targets (F)**



Source: EEA; Eurostat.

In the EU, significant improvements in energy efficiency occurred in all sectors due to technological development in, for example, industrial processes, car engines, space heating and electrical appliances. Also, energy efficiencies of buildings in Europe have significant potential for long-term improvements ([19]). On a larger scale, smart appliances and smart grids can also help improve the overall efficiency of electricity systems, enabling inefficient generation to be used less frequently through reducing peak loads.

Box 2.2 Rethinking energy systems: super-grids and smart-grids

To enable the incorporation of large amounts of intermittent generation from renewable energy, we will have to rethink the way we move energy from generator to user.

Part of the change is expected to come from enabling large generation at distances far away from the users, and transmitting it efficiently between countries and across seas. Programmes such as the DESERTEC initiative ([c]), the North Seas Countries' Offshore Grid Initiative ([d]) and the Mediterranean Solar Plan ([e]) are aimed at tackling this issue, and provide a partnership between governments and the private sector.

Such super-grids should complement the benefits of a smart grid. Smart-grids can enable consumers of electricity to become more informed about their consumption behaviour and empower them to engage actively in changing it. This kind of system can also assist the deployment of electric vehicles, and in turn to contribute to the stability and viability of such grids ([f]).

Over the long term, deploying such grids can reduce future investments required to upgrade Europe's transmission systems.

Source: EEA.

Climate change impacts and vulnerabilities differ across regions, sectors and communities

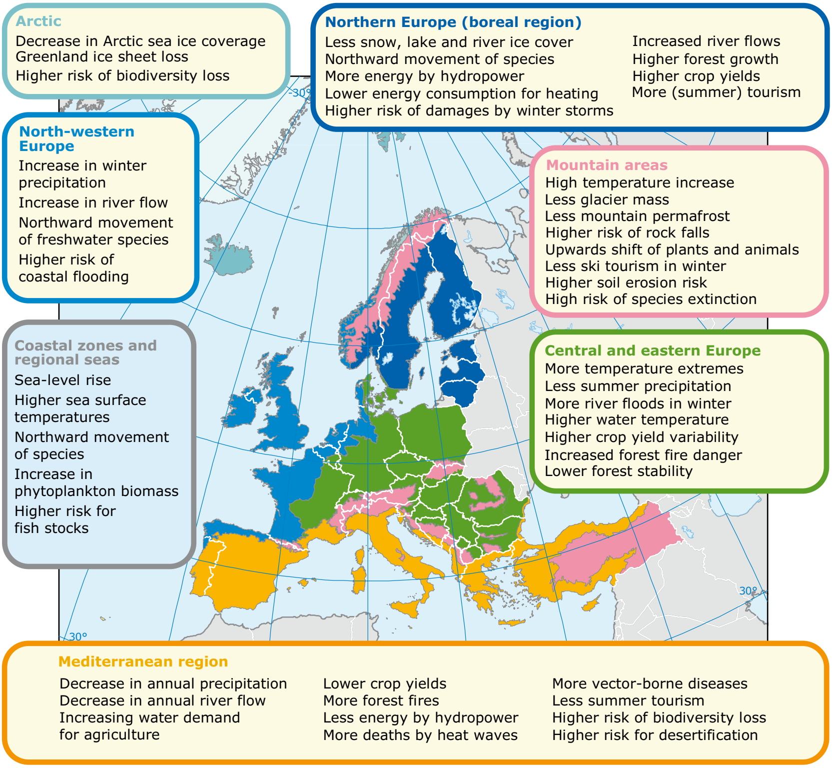
Many key climate indicators are already moving beyond the patterns of natural variability within which contemporary societies and economies have developed and thrived.

The main consequences of climate change expected in Europe include an increased risk of coastal and river floods, droughts, loss of biodiversity, threats to human health, and damage to economic sectors such as energy, forestry, agriculture, and tourism (6). In some sectors, new opportunities may occur regionally, at least for some time, such as improved agricultural production and forestry activities in northern Europe. Projections for climate change suggest that the suitability of some regions for tourism — especially in the Mediterranean — may decline during the summer months, although there may be an increase during other seasons. Similarly, opportunities for expanding tourism in northern Europe may come about. However, over a longer period and with increasing extreme events, adverse effects are likely to dominate in many parts of Europe (6).

The consequences of climate change are expected to vary considerably across Europe, with pronounced impacts expected in the Mediterranean basin, north-western Europe, the Arctic and mountainous regions. For the Mediterranean basin, in particular, increasing mean temperatures and decreases in water availability are expected to exacerbate current vulnerability to droughts, forest fires and heat waves. Meanwhile, in north-western Europe, low-lying coastal areas face the challenge of sea-level rise and an increased risk of associated storm surges. Temperature increases are projected to be greater than average in the Arctic, placing particular pressure on its very fragile ecosystems. Additional environmental pressures may result from easier access to oil and gas reserves, as well as new shipping routes as ice cover decreases (20).

Mountain areas face substantial challenges including reduced snow cover, potential negative impacts on winter tourism and extensive species loss. In addition, permafrost degradation in mountain regions may create infrastructural problems as roads and bridges may not be able to cope. Already today, the vast majority of glaciers in European mountains are in retreat — which also affects water resource management in downstream areas (21). In the Alps, for example, glaciers have lost approximately two-thirds of their volume since the 1850s, and acceleration of glacial retreat has been observed since the 1980s (6). Similarly, coastal and river-flood-prone areas across Europe are particularly vulnerable to climatic changes, as are cities and urban areas.

Map 2.1 **Key past and projected impacts and effects of climate change for the main biogeographical regions of Europe**



Arctic
Decrease in Arctic sea ice coverage
Greenland ice sheet loss
Higher risk of biodiversity loss

Northern Europe (boreal region)
Less snow, lake and river ice cover
Northward movement of species
More energy by hydropower
Lower energy consumption for heating
Higher risk of damages by winter storms
Increased river flows
Higher forest growth
Higher crop yields
More (summer) tourism

North-western Europe
Increase in winter precipitation
Increase in river flow
Northward movement of freshwater species
Higher risk of coastal flooding

Mountain areas
High temperature increase
Less glacier mass
Less mountain permafrost
Higher risk of rock falls
Upwards shift of plants and animals
Less ski tourism in winter
Higher soil erosion risk
High risk of species extinction

Coastal zones and regional seas
Sea-level rise
Higher sea surface temperatures
Northward movement of species
Increase in phytoplankton biomass
Higher risk for fish stocks

Central and eastern Europe
More temperature extremes
Less summer precipitation
More river floods in winter
Higher water temperature
Higher crop yield variability
Increased forest fire danger
Lower forest stability

Mediterranean region
Decrease in annual precipitation
Decrease in annual river flow
Increasing water demand for agriculture
Lower crop yields
More forest fires
Less energy by hydropower
More deaths by heat waves
More vector-borne diseases
Less summer tourism
Higher risk of biodiversity loss
Higher risk for desertification

Source: EEA; JRC; WHO (9).

Climate change is projected to have major impacts on ecosystems, water resources and human health

Climate change is projected to play a substantial role in biodiversity loss and puts ecosystem functions at risk. Changing climatic conditions are responsible, for example, for the observed northward and uphill distribution shifts of many European plant species. These are projected to need, for survival, to move several hundred kilometres to the north during the 21st century — which will not always be possible. A combination of the rate of climate change and habitat fragmentation, which results from obstacles such as roads and other infrastructure, is likely to impede the migration of many plant and animal species, and may lead to species composition changes and a continuing decline in European biodiversity.

The timing of seasonal events, phenology, for plants and the life cycles of animal groups — both terrestrial and marine — alters with climatic change ([6]). Changes in seasonal events, flowering dates and agricultural growing seasons are observed and projected. Phenology shifts have also increased the length of the growing season of several agricultural crops in northern latitudes over recent decades, favouring the introduction of new species that were not previously suitable. At the same time, there has been a shortening of the growing season at southern latitudes. Such changes in the cycles of agricultural crops are projected to continue — potentially severely impacting agricultural practices ([G]) ([6]).

Similarly, climatic changes are expected to affect aquatic ecosystems. Warming of surface water can have several effects on water quality, and hence on human use. These include a greater likelihood for algal blooms to occur and the movement of freshwater species northwards, as well as changes in phenology. Also within marine ecosystems, climatic changes are likely to affect the geographic distribution of plankton and fish, for example a changed timing of the spring phytoplankton bloom, putting additional pressures on fish stocks and related economic activities.

A further major potential impact of climate change, in combination with land-use changes and water management practices, is the intensification of the hydrological cycle — due to changes in temperature, precipitation, glaciers and snow cover. In general, annual river flows are increasing in the north and decreasing in the south, a trend that is projected to increase with future global warming. Large changes in seasonality are also projected, with lower flows in summer and higher flows in winter. As a consequence, droughts and water stress are expected to increase, especially in southern Europe and particularly in summer. Flood events are projected to occur more frequently in many river basins, particularly in winter and spring, although estimates of changes in flood frequency and magnitude remain uncertain.

While information on the impacts of climate change on soil and the various related feedbacks is very limited, changes in the bio-physical nature of soil are likely due to projected rising temperatures, changing precipitation intensity and frequency, and more severe droughts. Such changes can lead to a decline in soil organic carbon stocks — and a substantial increase in CO_2 emissions. Projected increased variations in rainfall patterns and intensity are likely and make soils more susceptible to erosion. Projections show significant reductions in summer soil moisture in the Mediterranean region, and increases in north-eastern Europe ([6]). Furthermore, prolonged drought periods due to climatic changes may contribute to soil degradation and increase the risk of desertification in parts of the Mediterranean and eastern Europe.

Climate change is also projected to increase health risks due to, for example, heat waves and weather-related ailments (see Chapter 5 for further details). This highlights the need for preparedness, awareness-raising and adaptation ([22]). The related risks are very dependent on human behaviour and the quality of health-care services. Furthermore, a number of vector-borne diseases as well as some water- and food-borne disease outbreaks may become more frequent with rising temperatures and more frequent extreme events ([6]). In parts of Europe, there may be some benefits to health, including fewer deaths from cold. It is, however, expected that the benefits will be outweighed by the negative effects of rising temperatures ([6]).

Dedicated adaptation by Europe is urgently needed to build resilience against climate impacts

Even if European and global emission reductions and mitigation efforts over the coming decades prove successful, adaptation measures will still be necessary to deal with the unavoidable impacts of climate change. 'Adaptation' is defined as the adjustment of natural or human systems to actual or expected climate change or its effects in order to moderate harm or exploit beneficial opportunities ([23]).

Adaptation measures include technological solutions ('grey' measures); ecosystem-based adaptation options ('green' measures); and behavioural, managerial and policy approaches ('soft' measures). Practical examples of adaptation measures include early warning systems related to heat waves, drought and water scarcity risk management, water demand management, crop diversification, coastal and river flood defences, disaster risk management, economic diversification, insurance, land use management, and enhancing green infrastructure.

These need to reflect the degree to which vulnerability to climatic change differs across regions and economic sectors, as well as across societal groups — especially the elderly and low-income households, both of which are more vulnerable than others. Furthermore, many adaptation initiatives should not be undertaken as stand-alone actions, but embedded within broader sectoral risk reduction measures, including water-resource management and coastal defence strategies.

The costs of adaption in Europe can potentially be large — and may amount to billions of Euro per year in the medium and long term. However, economic assessments of the cost and benefits are subject to considerable uncertainties. Nevertheless, assessments of adaptation options have suggested that timely adaptation measures make economic, social and environmental sense, as they may reduce potential damages very significantly and pay off many times compared to inaction.

In general, countries are aware of the need to adapt to climate change and 11 EU Member States had adopted a national adaptation strategy by spring 2010 ([H]). At a European scale, the EU White Paper on

Table 2.1 People at risk of being flooded, damage and adaptation cost at EU-27 level — without adaptation and with adaptation

	People at risk of being flooded (thousand/ year)		Adaptation cost (billion EUR/ year)		(Residual) damage cost (billion EUR/ year)		Total cost (billion EUR/ year)	
	Without adaptation	With adaptation	Without adaptation	With adaptation	Without adaptation	With adaptation	Without adaptation	With adaptation
A2								
2030	21	6	0	1.7	4.8	1.9	4.8	3.6
2050	35	5	0	2.3	6.5	2.0	6.5	4.2
2100	776	3	0	3.5	16.9	2.3	16.9	5.8
B1								
2030	20	4	0	1.6	5.7	1.6	5.7	3.2
2050	29	3	0	1.9	8.2	1.5	8.2	3.5
2100	205	2	0	2.6	17.5	1.9	17.5	4.5

Note: Two scenarios are analysed, based on the IPCC's A2 and B1 emission scenarios.

Source: EEA, ETC Air and Climate Change ([h]) ([i]).

Adaptation (24) is a first step towards an adaptation strategy to reduce vulnerability to the impacts of climate change, and complements actions at national, regional and even local levels. Integration of adaptation into environmental and sectoral policy domains — such as those related to water, nature and biodiversity, and resource efficiency — is an important aim.

However, the EU White Paper on Adaptation recognises that limited knowledge is a key barrier and calls for a stronger knowledge base. To address related gaps, the creation of a *European clearinghouse on climate change impacts, vulnerability and adaptation* is foreseen. This aims to enable and encourage the sharing of information and good adaptation practices between all stakeholders.

Responding to climate change also affects other environmental challenges

Climate change is a result of one of the greatest market failures the world has seen (25). The issue is closely intertwined with other environmental issues as well as broader societal and economic developments. Responding to climate change, by mitigating or adapting, can and should therefore not be done in isolation — as responses will undoubtedly affect other environmental issues both directly and indirectly (Chapter 6).

Synergies between adaptation and mitigation measures are possible (for example in the context of land and ocean management) and adaptation can help increase resilience against other environmental challenges. Meanwhile, 'mal-adaptation' is to be avoided; this refers to measures that are either disproportionate, cost-ineffective or conflict with other policy objectives in the long term (such as artificial snow making or air conditioning vis-à-vis mitigation targets) (21).

Many climate change mitigation measures will deliver ancillary environmental benefits including reductions in emissions of air pollutants from fossil fuel combustion. Conversely, reduced air pollutant emissions related to climate change policies are also expected to lead to a fall in pressures on public health systems and ecosystems, for example, through lower urban air pollution or decreased levels of acidification (6).

Climate change policies are already reducing the overall cost of pollution abatement needed to meet the objectives of the EU's Thematic Strategy on Air Pollution (26). It has been suggested that the inclusion of the effects of air pollution on climate change in air quality strategies delivers substantial efficiency gains by reducing particulate matter and ozone precursors in addition to targeting CO_2 and other long-lived GHGs (27).

The implementation of measures to combat climate change is likely to deliver considerable ancillary benefits in air pollution abatement by 2030. This includes lower overall costs of controlling air pollutant emissions of the order of EUR 10 billion per year and a reduction in damage to public health and ecosystems (I) (28). Such reductions are particularly notable for oxides of nitrogen (NO_X), sulphur dioxide (SO_2), and air-borne particles.

Furthermore, the reduction of emissions of black soot and other aerosols — such as 'black carbon', carbon aerosols from fossil fuel combustion and burning of biomass — may have substantial benefits both in improving air quality and limiting the related warming effect. Black carbon emitted in Europe contributes to carbon deposition on ice and snow in the Arctic region, which may accelerate the melting of the ice caps and exacerbate climate change impacts.

However, in other areas ensuring co-benefits between tackling climate change and responding to other environmental challenges may be less straightforward.

There may be, for example, trade-offs between the large-scale deployment of different renewable energy types and the improvement of Europe's environment. Examples of this include the interplay between hydropower generation and goals of the Water Framework Directive (29), the indirect land-use effects of bioenergy production which can greatly reduce or eliminate carbon benefits (30), and the sensitive placement of wind turbines and barrages in order to reduce impacts on marine and bird life.

Conversely, adaptation and mitigation measures that build on an ecosystem perspective have the potential to lead to win-win situations as they both provide adequate responses to climate change challenges and aim to sustain natural capital and ecosystem services in the long term (Chapters 6 and 8).

3 Nature and biodiversity

Biodiversity loss degrades natural capital and ecosystem services

'Biodiversity' includes all living organisms found in the atmosphere, on land and in water. All species have a role and provide the 'fabric of life' on which we depend: from the smallest bacteria in the soil to the largest mammal in the ocean ([1]). The four basic building blocks of biodiversity are genes, species, habitats and ecosystems ([A]). The preservation of biodiversity is fundamental to human well-being and sustainable provisioning of natural resources ([B]). Furthermore it is closely intertwined with other environmental issues, such as the adaptation to climate change or protecting human health.

Europe's biodiversity is heavily influenced by human activities including agriculture, forestry and fisheries, as well as urbanisation. Roughly half of Europe's land area is farmed, most forests are exploited, and natural areas are increasingly fragmented by urban areas and infrastructural development. The marine environment is also heavily affected, not just by unsustainable fisheries, but also by other activities such as offshore extraction of oil and gas, sand and gravel extraction, shipping, and offshore wind farms.

Exploitation of natural resources typically leads to disturbance and changes in the diversity of species and habitats. Conversely, extensive agricultural patterns, as seen in Europe's traditional agricultural landscapes, have contributed to a higher species diversity at a regional level if compared to what could be expected in strictly natural systems. Over-exploitation, however, can lead to degradation of natural ecosystems and ultimately to species extinctions. Examples of such ecological feedbacks are the collapse of commercial fish stocks through overfishing, the decline of pollinators due to intensive agriculture, and reduced water retention and increased flooding risks due to the destruction of moorland.

By introducing the concept of ecosystem services, the *Millennium Ecosystem Assessment* ([2]) turned the debate on biodiversity loss upside down. Beyond conservationist concerns, biodiversity loss has become an essential part of the debate on human well-being and the sustainability of our lifestyle, including consumption patterns.

Loss of biodiversity can thus lead to degradation of 'ecosystem services' and undermine human well-being.

Evidence is growing that ecosystem services are under great pressure globally due to the over-exploitation of natural resources in combination with human-induced climate change ([2]). Ecosystem services are often taken for granted, but are in fact very vulnerable. The soil, for example, is a key component of ecosystems, and supports a rich variety of organisms and provides many regulating and supporting services. Yet it is only, at most, a few meters thick (and often considerably less), and subject to degradation through erosion, pollution, compaction and salinisation (Chapter 6).

Although Europe's population is expected to remain roughly stable over the next decades, the consequences for biodiversity of increasing global resource demand for food, fibres, energy and water, and lifestyle changes are expected to continue to manifest themselves (see Chapter 7). Further land-cover conversion and intensification of land use, both in Europe and in the rest of the world, may

Box 3.1 Ecosystem services

Ecosystems provide a number of basic services that are essential for using Earth's resources sustainably. These include:

- *Provisioning services* — the resources that are directly exploited by humans, such as food, fibres, water, raw materials, medicines;
- *Supporting services* — the processes that indirectly allow exploitation of natural resources, such as primary production, pollination;
- *Regulating services* — the natural mechanisms responsible for climate regulation, nutrient and water circulation, pest regulation, flood prevention, etc.;
- *Cultural services* — the benefits people gain from the natural environment for recreational, cultural and spiritual purposes.

In this framework, biodiversity is the basic environmental asset.

Source: Millennium Ecosystem Assessment ([a]).

negatively affect biodiversity — directly through, for example, habitat destruction and resource depletion, or indirectly through, for example, fragmentation, drainage, eutrophication, acidification and other forms of pollution.

Developments in Europe are likely to affect land-use patterns and biodiversity around the globe — demand for natural resources in Europe already exceeds its own production. The challenge is therefore to reduce Europe's impact on the global environment while maintaining biodiversity at a level where ecosystem services, the sustainable use of natural resources and human well-being are secured.

Europe's ambition is to halt the loss of biodiversity and maintain ecosystem services

The EU is committed to halting the loss of biodiversity by 2010. The main actions have been aimed at selected habitats and species through the Natura 2000 network, biodiversity of the wider countryside, the marine environment, invasive alien species, and adaptation to climate change (3). The 6th EAP mid-term review in 2006/2007 increased the emphasis on the economic valuation of biodiversity loss, resulting in The Economics of Ecosystems and Biodiversity (TEEB) initiative (4) (see Chapter 8).

It has become increasingly clear, however, that despite progress in some areas, the 2010 target will not be met (5) (6) (7) (8).

Recognising the urgent need for increased efforts, the European Council endorsed the long-term biodiversity vision for 2050 and a 2020 headline target, adopted by the Environment Council on 15 March 2010, of *halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss* (9). A limited number of measurable sub-targets will be developed using, for example, baseline data for 2010 (1).

Key policy instruments are the EU Birds and Habitats Directives (10) (11), which aim at favourable conservation status for selected species and habitats. Some 750 000 terrestrial km^2, more than 17 % of Europe's total land area, and more than 160 000 marine km^2 have now been designated under these directives as areas for conservation within the Natura 2000 network. Furthermore, an EU strategy on green infrastructure is in preparation ([12]), building on Natura 2000 and flanking sectoral and national initiatives.

The second main strand of policy action is the integration of biodiversity concerns into sectoral policies for transport, energy production, agriculture, forestry and fisheries. This is aimed at reducing the direct impacts from these sectors, as well as their diffuse pressures, such as fragmentation, acidification, eutrophication and pollution.

The Common Agricultural Policy (CAP) is the sectoral framework in the EU with the strongest influence in this respect. The responsibility for forest policy lies primarily with the Member States under the subsidiarity principle. For fisheries, proposals have been made to further integrate environmental aspects into the Common Fisheries Policy. Other major cross-cutting policy frameworks are the Soil Thematic Strategy under the 6th EAP ([13]), the Air Quality Directive ([14]), the National Emissions Ceilings Directive ([15]), the Nitrates Directive ([16]), the Water Framework Directive ([17]) and the Marine Strategy Framework Directive ([18]).

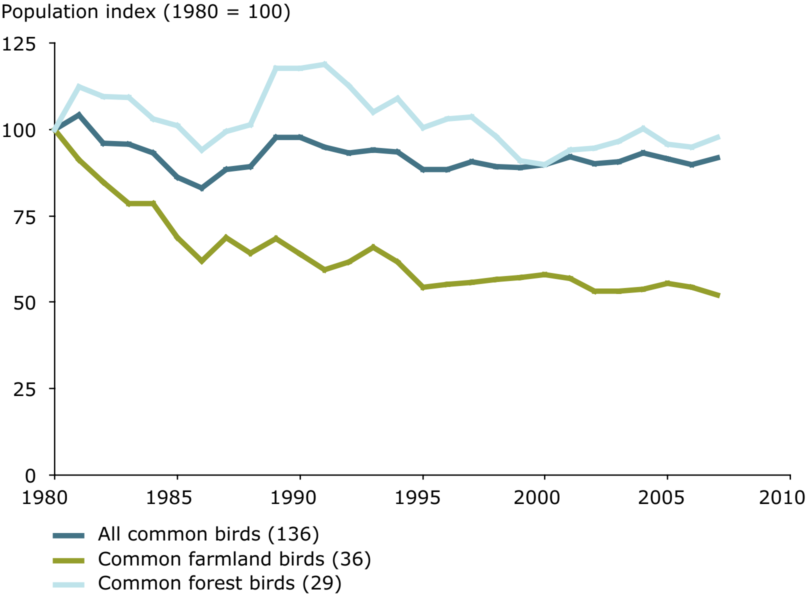
Biodiversity is still in decline

Quantitative data on the status and trends of European biodiversity are sparse, both for conceptual and practical reasons. The spatial scale and level of detail at which ecosystems, habitats and plant communities are discerned is to a certain extent arbitrary. There are no harmonised European monitoring data for ecosystem and habitat quality, and the results of case studies are difficult to combine. Reporting under Article 17 of the Habitats Directive has recently improved the evidence base, but only for the listed habitats ([19]).

Species monitoring is conceptually more straightforward, but resource-intensive and necessarily very selective. Around 1 700 vertebrate species, 90 000 insects and 30 000 vascular plants have been recorded in Europe ([20]) ([21]). This figure does not even include the majority of marine species, or bacteria, microbes and soil invertebrates. Harmonised trend data cover only a very small fraction of the total number of species — they are largely limited to common birds and butterflies. Again, Article 17 reporting under the Habitats Directive provides additional material for target species.

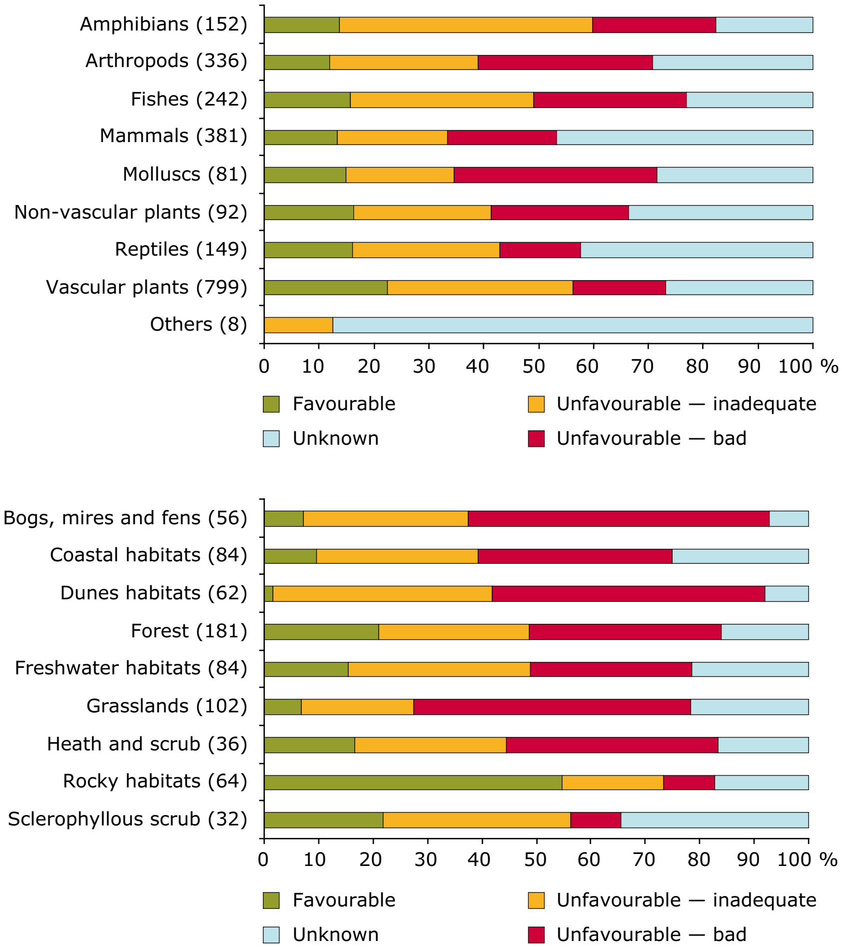
The data for common bird species suggest a stabilisation at low levels during the last decade. Populations of forest birds have declined by around 15 % since 1990, but from 2000 onwards numbers appear stable. Farmland bird populations declined dramatically in the 1980s, mainly due to agricultural intensification. Their populations have remained stable since the mid-1990s, albeit at a low level. General farming trends (such as lower input use, increased set-aside and share of organic farming) and policy measures (such as targeted agri-environment schemes) may have contributed to this (22) (23) (24). Grassland butterfly populations, however, have declined by a further 50 % since 1990, indicating the impact of further intensification of agriculture on the one hand and abandonment on the other.

Figure 3.1 Common birds in Europe — population index



Source: EBCC; RSPB; BirdLife; Statistics Netherlands (ᵇ); SEBI indicator 01 (ᶜ).

Figure 3.2 Conservation status of species (top) and habitats (bottom) of Community interest in 2008



Note: Number of assessments in brackets. Geographical coverage: EU except Bulgaria and Romania.

Source: EEA, ETC Biological Diversity (^{d}); SEBI indicator 03 (^{e}).

The conservation status of the most threatened species and habitats remains worrying despite the now established Natura 2000 network of protected areas. The situation appears worst for aquatic habitats, coastal zones and nutrient-poor terrestrial habitats, such as heaths, bogs, mires and fens. In 2008, only 17 % of the target species under the Habitats Directive were considered to have a favourable conservation status, 52 % an unfavourable status, and the status of 31 % was unknown.

These aggregated data, however, do not allow conclusions about the effectiveness of the protection regime of the Habitats Directive, since time series are not yet available and habitat restoration and species recovery may require more time. Also, no comparison can currently be made between protected and unprotected areas within the species' ranges. For the Birds Directive, however, studies indicate that the bird conservation measures in Natura 2000 have been effective ([25]).

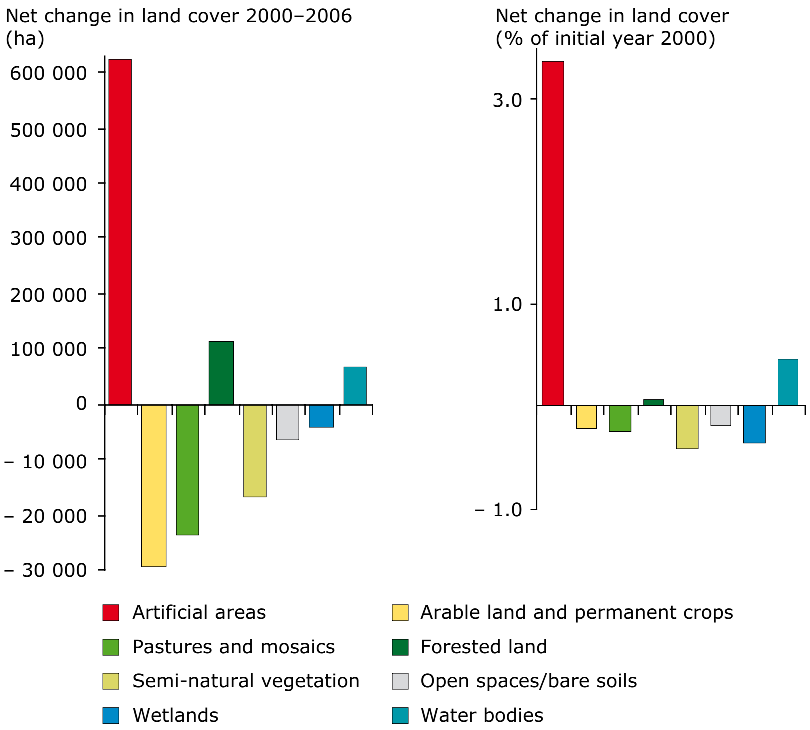
The cumulative number of alien species in Europe has been increasing steadily since the beginning of the 20th century. Out of a total of 10 000 established alien species, 163 have been classified as the worst invasives because they have proved to be highly invasive and damaging to native biodiversity in at least part of their European range ([7]). While the increase may be slowing down or levelling off for terrestrial and freshwater species, this is not the case for marine and estuarine species.

Land conversion drives biodiversity loss and degradation of soil functions

The main land-cover types in Europe are forest, 35 %; arable, 25 %; pasture, 17 %; semi-natural vegetation, 8 %; water bodies, 3 %; wetlands, 2 %; and artificial — built up — areas, 4 % ([C]). The trend of land-cover changes between 2000 and 2006 is rather similar to that observed between 1990 and 2000; however, the annual rate of change was lower — 0.2 % in the period 1990 to 2000 compared with 0.1 % in the period 2000 to 2006 ([26]).

Overall, urban areas have expanded further at the expense of all other land-cover categories, with the exception of forests and water bodies. Urbanisation and expanding transport networks are

Figure 3.3 **Net land-cover changes 2000–2006 in Europe — total area change in hectares and percentage change**



Note: Data coverage is for all 32 EEA member countries — with the exception of Greece and the United Kingdom — and 6 EEA cooperating countries.

Source: EEA, ETC Land Use and Spatial Information (f).

fragmenting habitats, thus making populations of animals and plants more vulnerable to local extinction due to hampered migration and dispersal.

These land-cover changes affect ecosystem services. Soil characteristics play a crucial role here because they influence water, nutrient and carbon cycles. Soil organic matter is a major terrestrial sink of carbon and thus important for mitigating climate change. Peat soils represent the highest concentration of organic matter in all soils, followed by extensively managed grassland and forest: soil carbon losses thus occur when these systems are converted. Loss of these habitats is also associated with decreased water retention capacity, increased flooding and erosion risks and reduced attractiveness for outdoor recreation.

While the slight forest increase is a positive development, the decline of natural and semi-natural habitats — including grassland, bogs, heaths and fens; all with a high content of soil organic matter — is a major cause for concern.

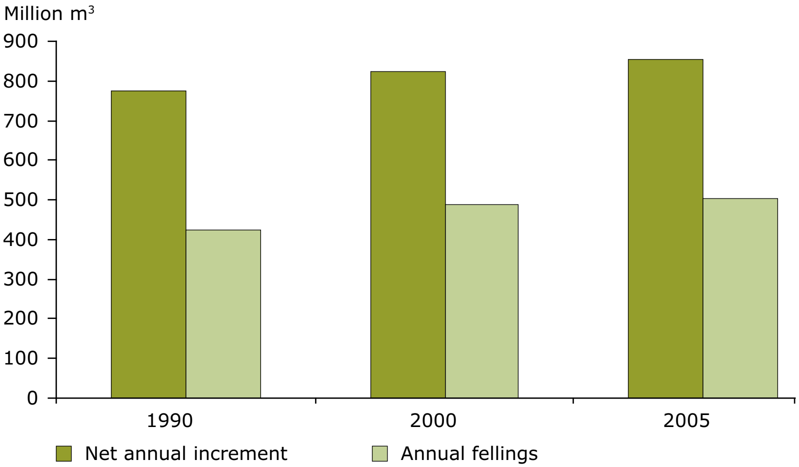
Forests are heavily exploited: the share of old-growth stands is critically low

Forests are crucial for biodiversity and ecosystem service delivery. They provide natural habitats for plant and animal life, protection against soil erosion and flooding, carbon sequestration, climate regulation and have great recreational and cultural value. Forest is the predominant natural vegetation in Europe, but the remaining forests in Europe are far from undisturbed ([D]). Most are heavily exploited. Exploited forests typically lack higher amounts of deadwood and older trees as habitats for species, and they often show a high portion of non-native tree species (for example, Douglas fir). A share of 10 % of old-growth forest has been suggested as a minimum for maintaining viable populations of the most critical forest species ([27]).

Only 5 % of the European forest area is currently considered to be undisturbed by humans ([D]). The largest areas of old-growth forests in the EU are found in Bulgaria and Romania ([28]). Loss of old-growth forest, in combination with increased fragmentation of the remaining stands, partially explains the continuing poor conservation status of many forest species of European concern. Since actual species extinction may occur long after the habitat fragmentation that causes it, we face an 'ecological debt' — some 1 000 old-growth boreal forest species have been identified as being at serious risk of extinction in the long term ([29]).

On the plus side, current total wood harvest remains well below the annual re-growth and total forest area increases. This is supported by socio-economic trends and national policy initiatives to improve

Figure 3.4 **Intensity of forestry — net annual increment in growing stock and annual fellings of forest available for wood supply — 32 EEA member countries, 1990–2005**

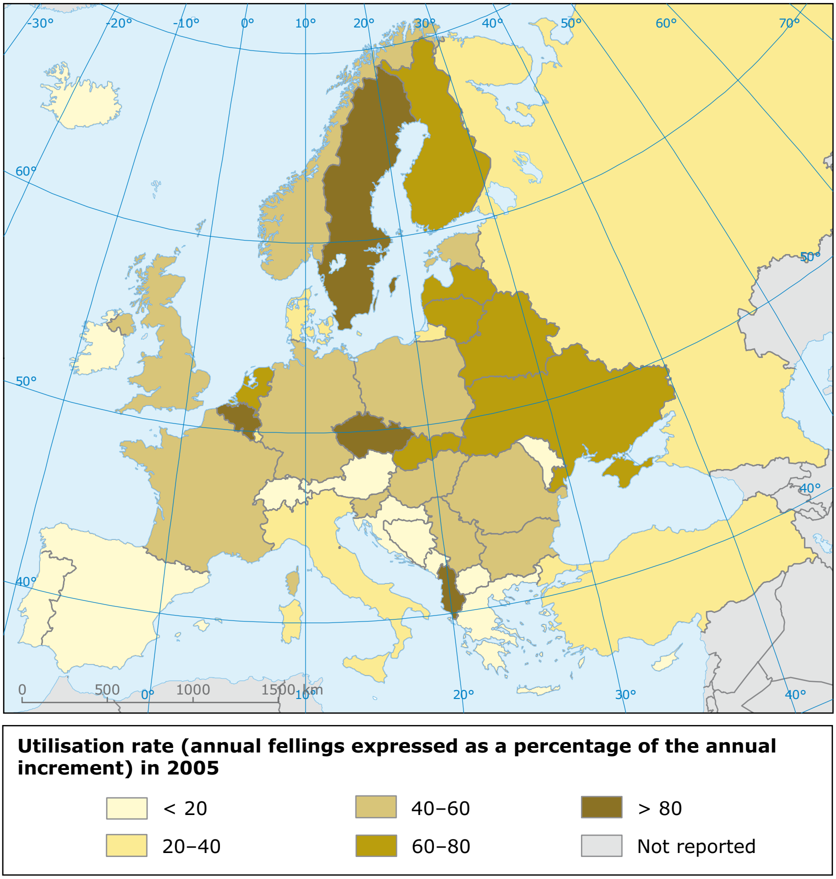


Source: EEA.

forest management, coordinated in the framework of Forest Europe, a cooperation platform at ministerial level of 46 countries, including those of the EU (30).

Forest management is not only aimed at safeguarding wood harvest, but takes a wide range of forest functions into account, and thus serves as a framework for biodiversity conservation and the maintenance of ecosystem services in forests. Nevertheless, many issues remain to be addressed. A recent EU Green Paper (31) focuses on the possible implications of climate change for forest management and protection in Europe and on enhancing monitoring, reporting and knowledge-sharing. There are also concerns regarding the future balance between wood supply and demand in the EU-27 given the planned increases in bioenergy production (32).

Map 3.1 Intensity of forestry — net harvesting rate in 2005



Source: EEA; Forest Europe [9].

Farmland areas decrease but management intensifies: species-rich grasslands are in decline

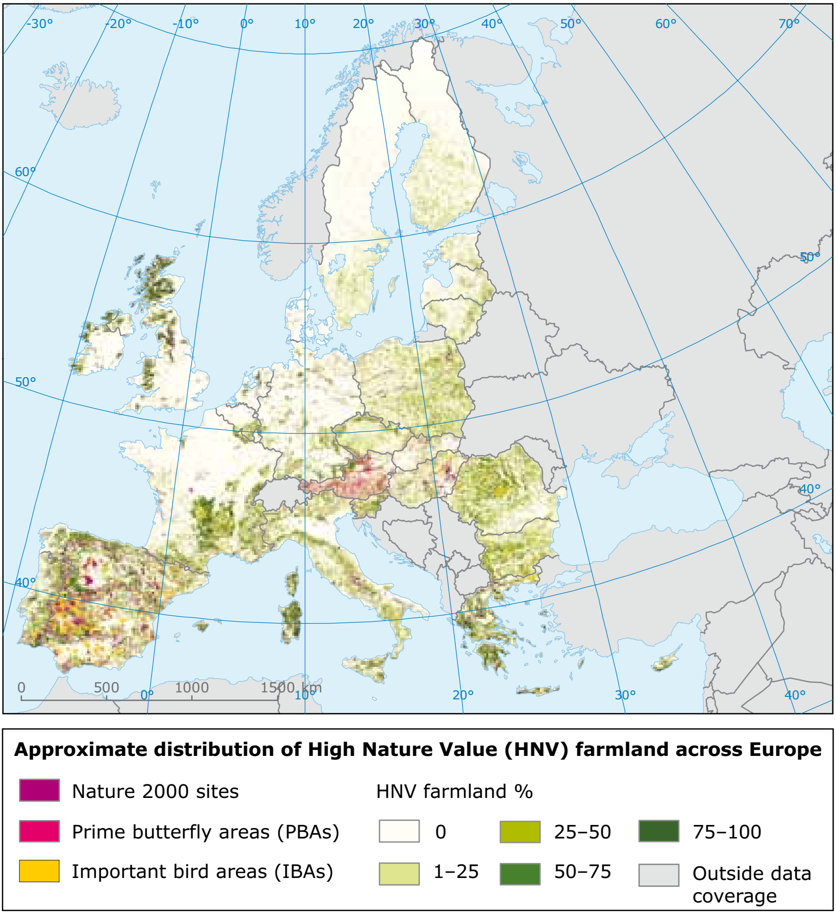
The concept of ecosystem services is probably most obvious for agriculture. The prime objective is food provision, but farmland delivers many other ecosystem services. Europe's traditional agricultural landscapes are a major cultural heritage, attract tourism and offer outdoor recreation opportunities. Farmland soils play a key role in nutrient and water cycling.

European agriculture is characterised by a dual trend: large-scale intensification in some regions, and land abandonment in others. Intensification is aimed at yield increases and requires investment in machinery, drainage, fertilisers and pesticides. It is also often associated with simplified crop rotations. Where socio-economic and biophysical circumstances do not allow this, agriculture remains extensive or is given up. These developments have been driven by a combination of factors including technological innovation, policy support and international market developments, as well as climate change, demographic trends and lifestyle changes. The concentration and optimisation of agricultural production has had major consequences for biodiversity, as has become apparent in the decline of farmland birds and butterflies.

Agricultural areas with high biodiversity, such as extensive grasslands, still make up about 30 % of Europe's farmland. Although its natural and cultural value is recognised in European environment and agriculture policies, the current measures being taken within the framework of the CAP are not sufficient to prevent further decline. The vast majority of High Nature Value (HNV) farmland, about 80 %, is outside protected areas ([E]) ([33]). The remaining 20 % is protected under the Birds and Habitats Directives. Sixty-one of the 231 habitat types of Community interest of the EU Habitats Directive are related to agricultural management, mainly grazing and mowing ([34]).

The assessment reports provided by EU member states under the Habitats Directive ([35]) indicate that the conservation status of these agricultural habitats is worse than the others. Potentially favourable measures under the rural development regulation — the second pillar of the CAP — make up less than 10 % of total CAP expenditure

Map 3.2 Approximate distribution of HNV farmland in EU-27 (E)



Note: Estimate based on land-cover data (Corine, 2000) and additional biodiversity datasets with varying base years (roughly 2000–2006). Resolution: 1 km² for the land-cover data, down to 0.5 ha for additional data-layers. The figures in the map (green shades) correspond to estimated coverage of HNV farmland within 1 km² grid-cells. Because of the error margins in the interpretation of the land-cover data, these figures are best treated as probabilities of occurrence rather than land-cover estimates. Occurrence of HNV farmland in the pink, purple and orange areas is most certain, since these delineations are based on actual habitat and species data.

Source: JRC, EEA (h); SEBI indicator 20 (i).

and appear weakly targeted at HNV farmland conservation. The vast majority of CAP support still benefits the most intensive productive areas and farming systems ([36]). Decoupling subsidies from production ([F]) and obligatory cross-compliance with environmental legislation can ease agricultural pressures on the environment to some extent, but this is not enough to ensure the continuing management that is needed for effective HNV farmland conservation.

Intensification of agriculture poses threats not only to biodiversity *on* farmland, but also to biodiversity *in* farmland soil. The total weight of microorganisms in the soil below a hectare of temperate grassland can exceed 5 tonnes — as much as a medium-sized elephant — and often exceeds the above-ground biomass. These biota are involved in most of the key soil functions. Soil conservation is therefore a major environmental concern as soil degradation processes are widespread in the EU (Chapter 6).

Increasing bioenergy production — for example, in the context of the EU target of increasing the share of renewable energy used in transport to 10 % by 2020 ([37]) — has also increased pressures on agricultural land resources and biodiversity. The conversion of land to certain types of biofuel crop production leads to intensification in terms of fertiliser and pesticide use, increased pollution load and further biodiversity loss. Much depends on where the conversion takes place, and the extent to which European production contributes to reaching the biofuel target. The available information suggests that the trend towards concentration of agriculture in the most productive areas, as well as to further intensity and productivity increases, is likely to continue ([38]).

Terrestrial and freshwater ecosystems are still under pressure despite reduced pollution loads

Apart from the direct effects of land conversion and exploitation, human activities such as agriculture, industry, waste production and transport cause indirect and cumulative effects on biodiversity — notably through air, soil and water pollution. A wide range of pollutants — including excess nutrients, pesticides, microbes, industrial chemicals, metals and pharmaceutical products — end up in the soil, or in ground- and surface water. Atmospheric deposition of eutrophying and acidifying substances, including nitrogen oxide (NO_X), ammonium plus ammonia (NH_X) and sulphur dioxide (SO_2), adds to the cocktail of pollutants. The effects on ecosystems include damage to forests and lakes from acidification; habitat deterioration due to nutrient enrichment; algal blooms caused by nutrient enrichment; and neural and endocrine disruption in species by pesticides, steroidal estrogens and industrial chemicals like PCBs.

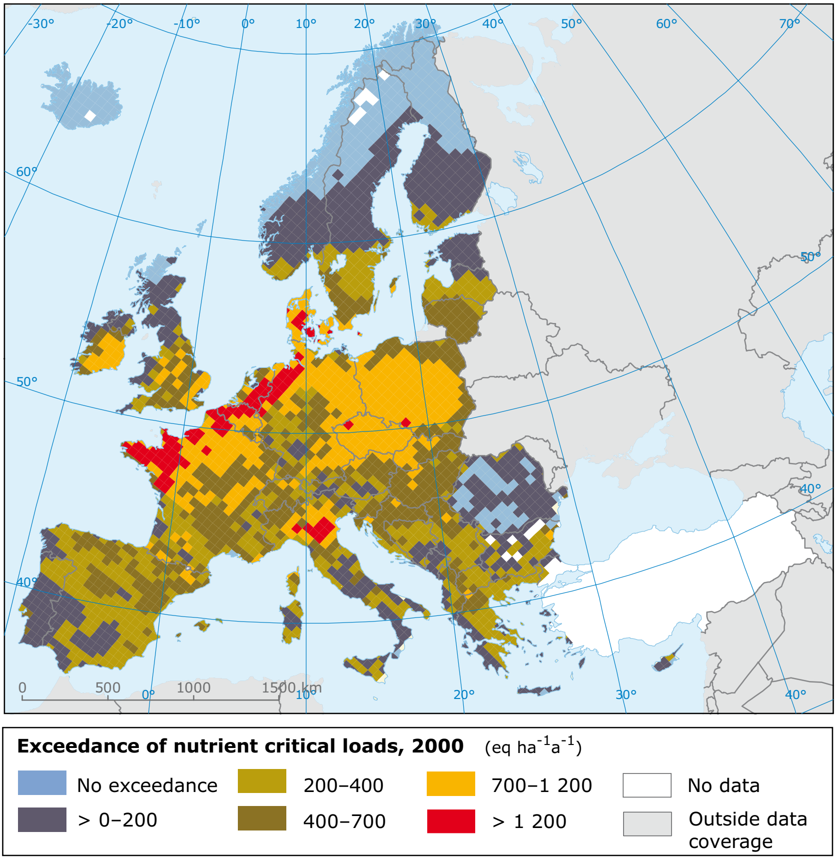
Most European data regarding the effects of pollutants on biodiversity and ecosystems concern acidification and eutrophication ([G]). One of the success stories of Europe's environment policy has been the significant reduction in emissions of the acidifying pollutant SO_2 since the 1970s. The area subject to acidification has decreased further since 1990. In 2010, 10 % of the EEA-32 natural ecosystem area is, however, still subject to acid depositions beyond its critical load. With sulphur emissions declining, nitrogen emitted by agriculture is now the principal acidifying component in our air ([39]).

Agriculture is also a major source of eutrophication through emissions of excess nitrogen and phosphorous, both used as nutrients. The agricultural nutrient balance for many EU Member States has improved in recent years, but more than 40 % of sensitive terrestrial and freshwater ecosystem areas are still subject to atmospheric nitrogen deposition beyond their critical loads. Agricultural nitrogen loads are expected to remain high as nitrogen fertiliser use in the EU is projected to increase by around 4 % by 2020 ([40]).

Phosphorous in freshwater systems stems mainly from run-off from agriculture and discharges from municipal wastewater treatment plants. There has been a significant decline of phosphate concentrations in rivers and lakes, mainly due to progressive implementation of the Urban Wastewater Treatment Directive ([41]) since the early 1990s. Current concentrations, however, often exceed the minimum level for eutrophication. In some water bodies they are such that substantial improvements will be required to achieve good status under the Water Framework Directive (WFD).

Paramount to attainment of good status by 2015 under the WFD ([17]) will be a reduction in the excessive nutrient levels found in a number of water bodies across Europe, as well as the restoration of connectivity and hydro-morphological conditions. River basin

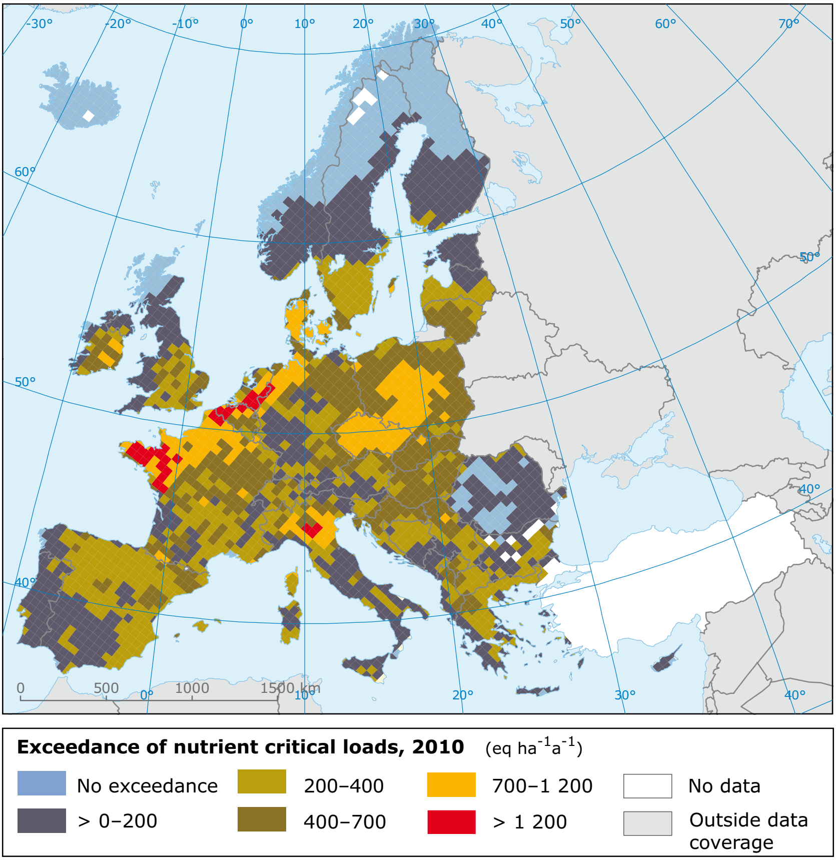
Map 3.3 **Exceedances of critical loads for eutrophication due to the deposition of nutrient nitrogen in 2000**



Note: The results were computed using the 2008 Critical Loads database hosted by the Coordination Centre for Effects (CCE) and Clean Air for Europe scenarios (^{j}) (^{k}). Turkey has not been included in the analyses due to an insufficient data basis for calculating critical loads. For Malta no data were available.

Source: SEBI indicator 09 (^{l}).

Map 3.4 Exceedances of critical loads for eutrophication due to the deposition of nutrient nitrogen in 2010



Note: The results were computed using the 2008 Critical Loads database hosted by the Coordination Centre for Effects (CCE) and Clean Air for Europe scenarios ([j]) ([k]). Turkey has not been included in the analyses due to an insufficient data basis for calculating critical loads. For Malta no data were available.

Source: SEBI indicator 09 ([l]).

management plans set up by Member States under the WFD, due to be operational by 2012, will have to incorporate a suite of cost-effective measures to tackle all sources of nutrient pollution. This will also need particular policy efforts regarding the further integration of environmental aspects into the CAP. Furthermore, full implementation of the Nitrates Directive and compliance with the Birds and Habitats Directives are key flanking policy actions in support of the WFD.

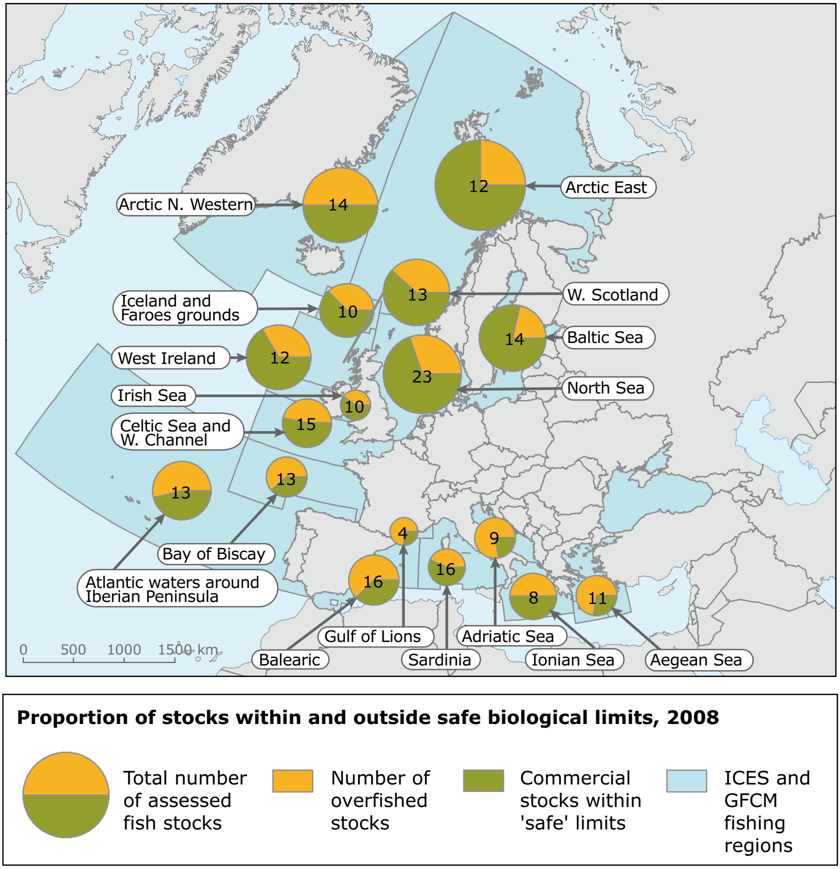
The marine environment is heavily affected by pollution and overfishing

Much of the freshwater pollutant load, described in the previous section, is ultimately discharged to coastal waters, making agriculture also the main source of nitrogen loads in the marine environment. Atmospheric deposition of nitrogen — ammonia (NH_3) originating from agriculture, and NO_X from ship emissions — is increasing and can be 30 % or more of the total nitrogen load to the sea surface.

Nutrient enrichment is a major problem in the marine environment, where it accelerates the growth of phytoplankton. It can change the composition and abundance of marine organisms living in the affected waters and ultimately leads to oxygen depletion, thus killing bottom-dwelling organisms. Oxygen depletion has escalated dramatically over the past 50 years, increasing from about ten documented cases in 1960 to at least 169 in 2007 worldwide ([42]); and it is expected to become more widespread with increasing sea temperatures induced by climate change. In Europe, the problem is particularly evident in the Baltic Sea, where the current ecological status is regarded as predominantly poor to bad ([43]).

The marine environment is also heavily impacted by fisheries. Fish provide the primary source of income for many coastal communities, but overfishing is threatening the viability of both European and global fish stocks ([44]). Of the assessed commercial stocks in the Baltic Sea, 21 % are outside safe biological limits ([H]). For the areas of the North-East Atlantic, the percentages of stocks outside safe biological limits vary between 25 % in the Arctic East and 62 % in the Bay of

Map 3.5 Proportion of fish stocks within and outside safe biological limits



Source: GFCM (^{m}); ICES (^{n}); SEBI indicator 21 (^{o})

Biscay. In the Mediterranean Sea, the percentage of stocks outside safe biological limits is about 60 %, with four out of six areas exceeding 60 % (45).

Overfishing not only reduces the total stock of commercial species, but affects the age and size distribution within fish populations, as well as the species composition of the marine ecosystem. The average size of the fish caught has decreased, and there has also been a serious decrease in the numbers of large predatory fish species, which occupy the higher trophic levels (46). The consequences of this for the marine ecosystem are still poorly understood, but could be substantial.

While the Common Fisheries Policy (CFP) reform in 2002 stated conservation objectives, it is widely acknowledged that these have not been achieved. An EU Green Paper on reforming the CFP in 2009 called for a complete reform of the way fisheries are managed (47). It acknowledges over-fishing, fleet over-capacity, heavy subsidies, low economic resilience and a decline in the biomass of fish caught by European fishermen. This marks an important step towards implementation of an ecosystem-based approach that regulates human exploitation of marine resources from the much wider perspective of ecosystem services.

Maintaining biodiversity, also at global level, is crucial for people

Biodiversity loss has ultimately far-reaching consequences for people through impacts on ecosystem services. Large-scale cultivation and drainage of natural systems has increased carbon emissions to the air and at the same time reduced carbon and water retention capacity. Increased run-off speed, combined with increased precipitation as a result of climate change, is a dangerous cocktail that more and more people have come to experience in the shape of serious flooding.

Biodiversity affects well-being also through providing recreational opportunities and appealing landscapes, a relationship that is increasingly recognised in urban design and spatial planning. Less obvious perhaps, but equally important, is the relationship between the distribution patterns of species and habitats and vector-borne diseases. Invasive alien species may pose a threat in this respect. Their dispersal capacity and potential to become invasive, is enhanced by the globalisation of trade, combined with climate change and the increased vulnerability of agricultural monocultures.

Globalisation also leads to spatially displaced impacts of the use of natural resources. The depletion of European fish stocks, for example, has not resulted in domestic food shortages, but has been compensated by an increasing reliance on imports. Whereas the EU was largely self-sufficient until 1997 (when total catch had grown to 8 million tonnes), domestic supply levels had fallen to over 50 % in 2007 (5.5 million tonnes of 9.5 million tonnes consumed) ([48]).

Large net imports also occur for cereals (around 7.5 million tonnes), fodder (around 26 million tonnes) and wood (around 20 million tonnes) ([49]), again with implications for biodiversity outside Europe (such as deforestation in the tropics). Furthermore, the rapidly growing demand for biofuels may further increase Europe's global footprint (Chapter 6). Trends such as these increase pressure on global resources (Chapter 7).

Overall, the many contributions of biodiversity to human well-being are becoming more explicit. Increasingly we associate the food we eat, our clothes and building materials with 'biodiversity'. It is a vital resource that needs to be managed sustainably and provided with protection, so that in turn it protects us and the planet. At the same time, Europe is currently consuming twice what its land and seas can produce.

Reconciling these realities lies at the core of the proposed EU 2050 vision and 2020 headline target; achieving progress requires the active involvement of all citizens — not just those economic sectors and actors highlighted throughout this assessment.

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4 Natural resources and waste

The overall environmental impact of Europe's resource use continues to grow

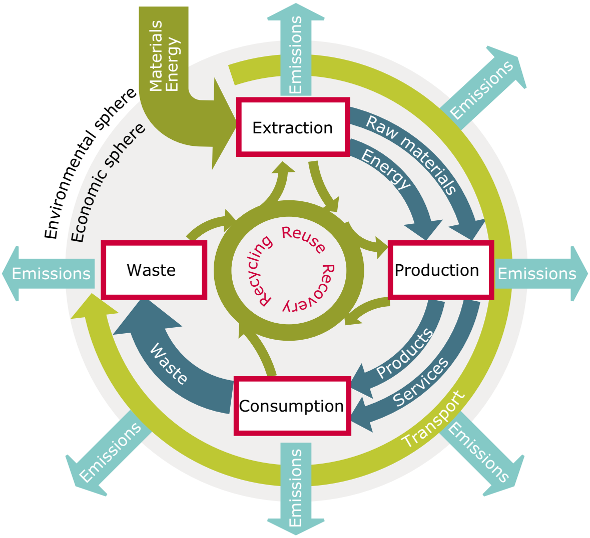
Europe relies heavily on natural resources ([A]) to fuel its economic development. Past and current production and consumption patterns have underpinned substantial growth in wealth across Europe. However, concerns about the sustainability of these patterns are mounting, particularly regarding the implications related to resource use and over-use. The assessment of natural resources and waste in this chapter complements the assessment of biotic natural resources in the previous chapter by focusing on material, and often non-renewable, resources as well as water resources.

A life-cycle perspective on natural resources addresses several environmental concerns related to production and consumption, and ties together the use of resources and the generation of waste. While both resource use and waste generation have distinct environmental impacts, the two issues share many of the same driving forces — largely related to how and where we produce and consume goods, and how we use natural capital to sustain economic development and consumption patterns.

In Europe, resource use and waste generation continue to rise. However, there are considerable national differences in per person resource use and waste generation, driven mainly by varying social and economic conditions as well as different levels of environmental awareness. While resource extraction within Europe has been stable over the past decade, dependence on imports is increasing ([1]).

Environmental problems associated with the extraction and processing of many materials and natural resources are shifting from Europe to the respective exporting countries. Consequently, the impacts of consumption and resource use from Europe on the global environment are increasing. As resource use in Europe exceeds local availability, Europe's dependence on and competition for resources from elsewhere in the world raises questions about security in

Figure 4.1 **Life-cycle chain: extraction — production — consumption — waste**



Source: EEA, ETC Sustainable Consumption and Production.

the supply of resources for Europe in the long term, and carries a potential for future conflicts ([2]).

Europe's ambition is to decouple economic growth from environmental degradation

Waste management has been a focus of EU environmental policies since the 1970s. Such policies, which increasingly require the reduction, reuse and recycling of waste, are contributing to closing the loop of material use throughout the economy by providing waste-derived materials as inputs for production.

More recently, life-cycle thinking has been introduced as a guiding principle of resource management. Environmental impacts are considered across the whole life cycle of products and services to avoid or minimise shifting the environmental burden between different phases of the life cycle and from one country to another — using market-based instruments where possible. Life-cycle thinking affects not only environmental, but also most sectoral policies — by making use of materials and energy from waste, decreasing emissions, and re-using already developed land.

The EU brings together waste and resource use policies through the Thematic Strategy on the prevention and recycling of waste (3) and the Thematic Strategy on the sustainable use of natural resources (4). Furthermore, the EU has set itself a strategic goal of moving towards more sustainable patterns of consumption and production, with a view to decoupling resource use and waste generation from the associated negative environmental impacts and becoming the world's most resource-efficient economy (6th EAP) (5).

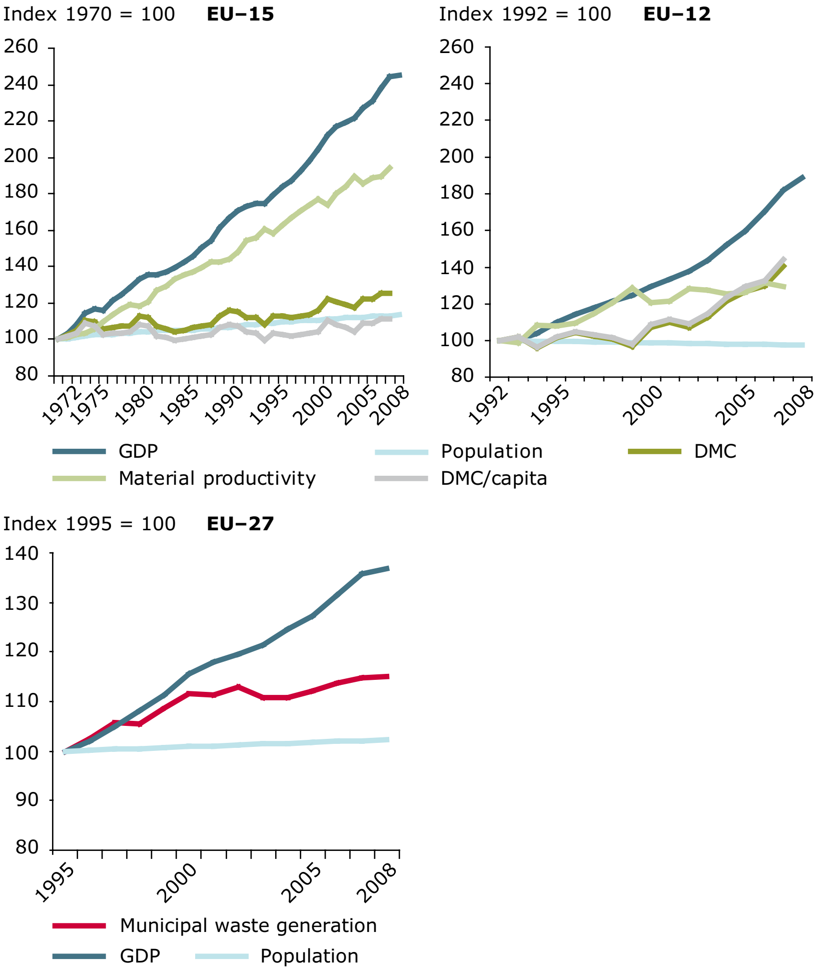
In addition, water as a renewable natural resource is covered by the Water Framework Directive (6) which aims to ensure the provision of sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use. In addition, broader considerations of water scarcity in the context of sustainable consumption and production and climate change, as well as strengthening demand management require a better information base and further policy development.

Waste management continues to shift from disposal to recycling and prevention

Any society with a history of rapid growth of industry and consumption faces the issue of sustainable waste management, and for Europe, this issue continues to raise considerable concerns.

The EU is committed to reducing waste *generation*, but is not succeeding. Trends for those waste streams for which data are available indicate the need to reduce the generation of waste in absolute terms to ensure further reduction of environmental impacts. In 2006, EU-27 Member States produced some 3 billion tonnes of waste — an average of 6 tonnes per person. There are substantial differences in waste generation between countries, up to a factor of 39 between EU Member States, largely due to different industrial and socio-economic structures.

Figure 4.2 Trends in the use of material resources in EU-15 and EU-12 and municipal waste generation in EU-27 compared with GDP and population


Index 1970 = 100 **EU–15**

Index 1992 = 100 **EU–12**

Index 1995 = 100 **EU–27**

Note: Domestic material consumption (DMC) is an aggregate of materials (excluding water and air) which are actually consumed by a national economy: used domestic extraction and physical imports (mass weight of imported goods) minus exports (mass weight of exported goods).

Source: The Conference Board ([a]); Eurostat (domestic material consumption indicator); EEA (municipal waste generation, CSI 16).

Similarly, municipal waste generation per person varies by a factor of 2.6 between countries, amounting to 524 kg per person in 2008 on average in EU-27 Member States. It has increased between 2003 and 2008 in 27 out of 35 countries analysed. However, the growth of municipal waste generation in EU-27 has been slower than that of GDP, thus achieving relative decoupling for this waste stream. The growth in waste volumes were driven mainly by household consumption and increasing number of households.

Waste generation from construction and demolition activities has increased, as has packaging waste. There is no time-series data for waste electric and electronic equipment; however, recent projections show this to be one of the fastest-growing waste streams (7). Volumes of hazardous waste, which amounted to 3 % of total waste generation in EU-27 in 2006 (8), are also increasing in the EU and remain a key challenge.

Sewage sludge generation is increasing as well, mostly linked to implementation of the Urban Waste Water Treatment Directive (9). This raises concerns about its disposal (and the effects on food production where agricultural land is used).

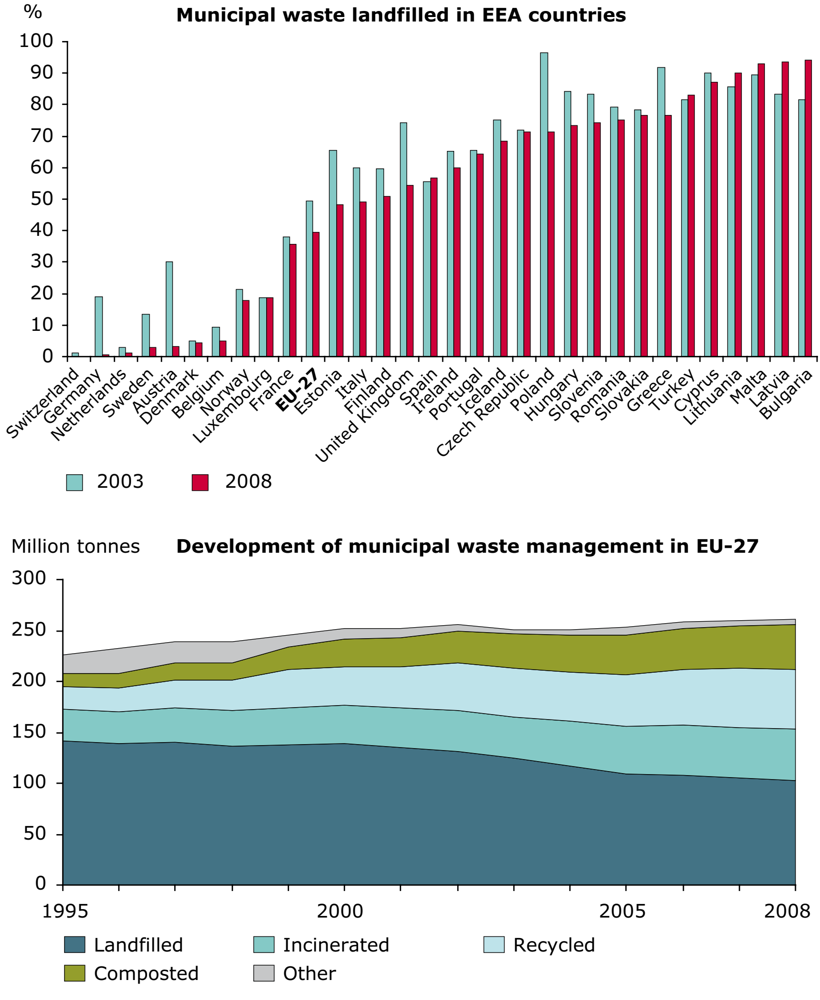
Also, marine litter (B) is an area of increased concern for European seas (10) (11) (12): the management of its impacts has been included in the Marine Strategy Framework Directive (13) and in regional sea conventions.

Furthermore, it is worth noting that there are some specific waste-related challenges in Western Balkan countries related to past practices, such as unmanaged waste from mining, oil processing, chemical and cement industries, and the consequences of conflicts in the early 1990s (14).

Meanwhile, waste *management* has improved in almost all EU Member States, as more waste is being recycled and less landfilled. Nevertheless, still about half of the 3 billion tonnes of total waste generated in the EU-27 in 2006 was landfilled. The rest was recovered, recycled and reused, or incinerated.

Good waste management reduces environmental impacts and offers economic opportunities. It has been estimated that roughly 0.75 %

Figure 4.3 **Percentage of municipal waste landfilled in EEA countries, 2003 and 2008; and development of municipal waste management in EU-27, 1995 to 2008**



Source: EEA, based on Eurostat.

of EU GDP corresponds to waste management and recycling ([15]). The recycling sector has an estimated turnover of EUR 24 billion and employs about half a million persons. Thus, the EU has around 30 % of world share of eco-industries and 50 % of the waste and recycling industries ([16]).

Waste is increasingly traded across borders, much of it for recycling, or material and energy recovery. This development is driven by EU policies requiring minimum recycling rates for selected waste streams as well as by economic forces: for more than a decade the prices of raw materials have been high or increasing, making waste materials an increasingly valuable resource. At the same time, export of used goods (for example, used cars) and their subsequent unsuitable waste treatment (for example, land-filling) in the receiving countries can contribute to a considerable loss of resources ([C]).

Hazardous and other problematic wastes are also increasingly being shipped across borders. Exports increased by almost a factor of four between 1997 and 2005. The vast majority of this waste is transported between EU Member States. Movements are driven by the availability of hazardous waste treatment capacities in countries; by different environmental standards between countries; and by different costs. Meanwhile, the increase in illegal shipments of waste, for example, from electric and electronic equipment, is a trend that needs to be curbed.

Overall, the environmental effects of the growing trade in waste need to be examined more closely from a wide range of angles.

Life-cycle thinking in waste management contributes to reducing environmental impacts and resource use

European waste management builds on the principles of a waste hierarchy: preventing waste; reusing products; recycling; recovering, including energy through incineration; and finally disposal. Waste is therefore increasingly also seen as a production resource and a source of energy. However, depending on regional and local conditions, these different waste management activities may have differing environmental impacts.

Although the impacts of waste treatment on the environment have been considerably reduced, there is still potential for further improvement, first by full implementation of existing regulations, and then through the extension of existing waste policies to encourage sustainable consumption and production practices including more efficient resource use.

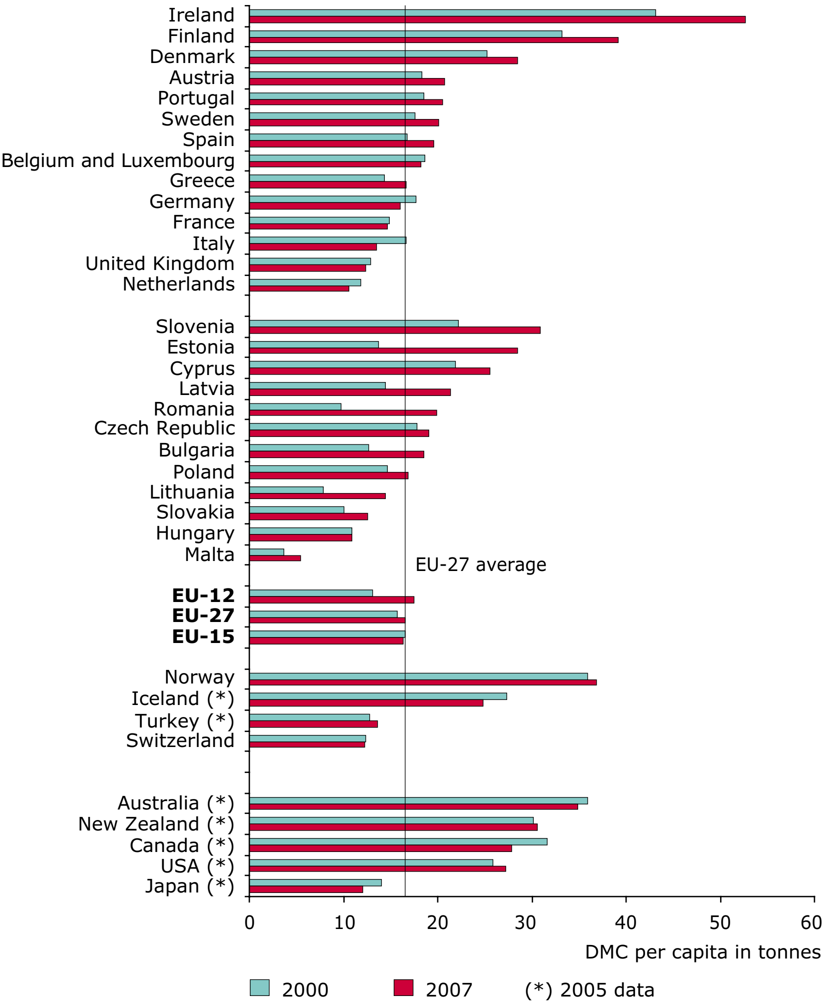
Waste policies can primarily reduce three types of environmental pressures: emissions from waste treatment installations such as methane from landfills; impacts from primary raw materials extraction; and air pollution and greenhouse gas emissions from energy use in production processes. Although recycling processes themselves also have environmental impacts, in most cases the overall impacts avoided by recycling and recovery are greater than those incurred in the recycling processes ([17]).

Waste prevention can help reduce environmental impacts during all stages of the life-cycle of resources. Although prevention has the highest potential to reduce environmental pressures, policies to reduce waste generation have been sparse and often not very effective. For example, there has been an emphasis on diverting biowaste, including food waste ([D]) ([E]) ([18]) from landfills. But more might be achieved by addressing the whole food production and consumption chain to prevent waste, thus also contributing to sustainable resource use, protection of soil and mitigating climate change.

Waste recycling (and waste prevention) is closely linked to material use. On average, 16 tonnes of materials are used annually per person in the EU, much of which is sooner or later turned into waste: of the 6 tonnes of total waste generated annually per person, around 33 % is from construction and demolition activities, about 25 % from mining and quarrying, 13 % from manufacturing and 8 % from households. However, direct links between resource use and waste generation are difficult to quantify with current indicators due to methodological differences in accounting for them and a lack of long-term time-series data.

The increases in overall resource use and waste generation in Europe are closely linked to economic growth and increasing affluence. In absolute terms, Europe is using more and more resources. For example, resource use increased by 34 % between 2000 and 2007 in

Figure 4.4 Resource use per person, by country, 2000 and 2007



Note: Domestic material consumption (DMC) is an aggregate of materials (excluding water and air) which are actually consumed by a national economy. It includes used domestic extraction and physical imports (mass weight of imported goods) minus exports (mass weight of exported goods).

Source: Eurostat and OECD (DMC data); The Conference Board ([a]); Groningen Growth and Development Centre (population data).

the EU-12. This continues to have considerable environmental and economic consequences. Of 8.2 billion tonnes of materials used in the EU-27 in 2007, minerals and including metals accounted for more than half, and fossil fuels and biomass for about a quarter each.

The resource use category which increased most between 1992 and 2005 was that of minerals for construction and industrial use. Differences between individual countries are significant: the use of resources per person varies by a factor of almost ten between the highest and the lowest numbers. Factors that determine resource use per person include climate, population density, infrastructure, availability of resources, level of economic development, and the structure of the economy.

Although the level of extraction of resources within Europe has remained stable, and in some cases has even decreased — some unmanaged burdens from past extraction persist related to mining closures. As Europe uses up reserves that are easy to access, it will have to rely more on less concentrated ores, less accessible resources and fossil fuels with lower energy content, which are expected to cause higher environmental impacts per unit of material or energy produced.

The high use of resources to fuel economic growth increases the problems of ensuring supplies and sustainable yields, and managing the environmental impacts in relation to ecosystems' absorption capacities. A challenge for both policy and science is how best to measure environmental impacts that result from resource use; several current initiatives aim to better quantify the environmental impacts of resource use.

Box 4.1 Quantifying environmental pressures and the environmental impacts of resource use

Several initiatives aim to better quantify the impacts of resource use and progress with decoupling (for example, the decoupling of economic growth from resource use and the decoupling of economic growth from environmental degradation).

Domestic material consumption (DMC) is often used as a proxy for the environmental pressures of resource use. DMC measures resources directly consumed within a national economy, with an understanding that eventually each tonne of material entering an economy will come out as waste or emissions. However, such a mass-based approach does not address the large differences in environmental impacts between different materials.

The environmentally-weighted material consumption (EMC) indicator attempts to combine information on material flows with information on environmental pressures for specific categories including abiotic resource depletion, land use, global warming, ozone layer depletion, human toxicity, terrestrial ecotoxicity, aquatic ecotoxicity, photochemical smog formation, acidification, eutrophication, and radiation. However, the EMC also focuses on environmental pressures and thus only provides a proxy for related impacts.

The national accounts matrix extended by environmental accounts (NAMEA) approach aims to take the assessment of environmental pressures further by also including environmental pressures 'embedded' in traded goods and services. Thus the results of the traditional materials accounting and NAMEA approach may be quite different. This difference can be illustrated by looking at greenhouse gas emissions: while traditional accounting for national emissions is based on a territorial perspective, the NAMEA approach aims to include all emissions induced by a nation's consumption.

In addition to the above, a basket of indicators or accounting approaches has been identified which aim to monitor environmental impacts from resource use. These includes the ecological footprint (EF) which compares human demand with planet Earth's ecological capacity to regenerate, human appropriation of net primary production (HANPP), land and ecosystem accounts (LEAC) ([b]).

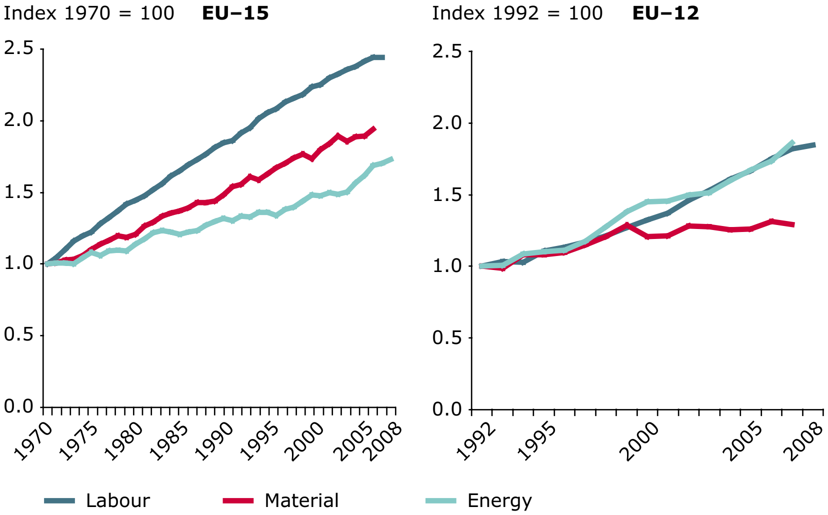
Source: EEA.

Reducing resource use in Europe also reduces environmental impacts globally

European economies are creating more and more wealth from the resources that we use. Resource efficiency in Europe has improved over the past two decades through the use of more eco-efficient technologies, the transition to service-based economies and an increased share of imports in EU economies.

However, differences in resource efficiency across Europe are substantial, with a factor of almost ten between the most and least resource-efficient EU economies. Factors that affect resource efficiency include the technological level of production and consumption; the share of services versus heavy industry; regulatory and tax systems; and the share of imports in total resource use.

Figure 4.5 **Growth in the productivity of labour, energy and materials, EU-15 and EU-12**



Source: The Conference Board ([a]); Groningen Growth and Development Centre (GDP and working hours data); Eurostat; Wuppertal Institute for Climate, Environment and Energy (material data); International Energy Agency (energy data).

The magnitude of the differences between countries points to significant potential for improvement. For example, resource efficiency in EU-12 is only about 45 % of that in the EU-15. The ratio has changed little over the past two decades, and efficiency improvements in the EU-12 were mostly recorded before 2000.

Indeed, the growth in the productivity of resources over the past forty years has been significantly slower than that in the productivity of labour and in some cases of energy. While some of this is a result of the restructuring of economies, with a growing share of services, it also reflects the fact that labour has become relatively more costly compared with energy and materials, partly as a result of prevailing tax regimes.

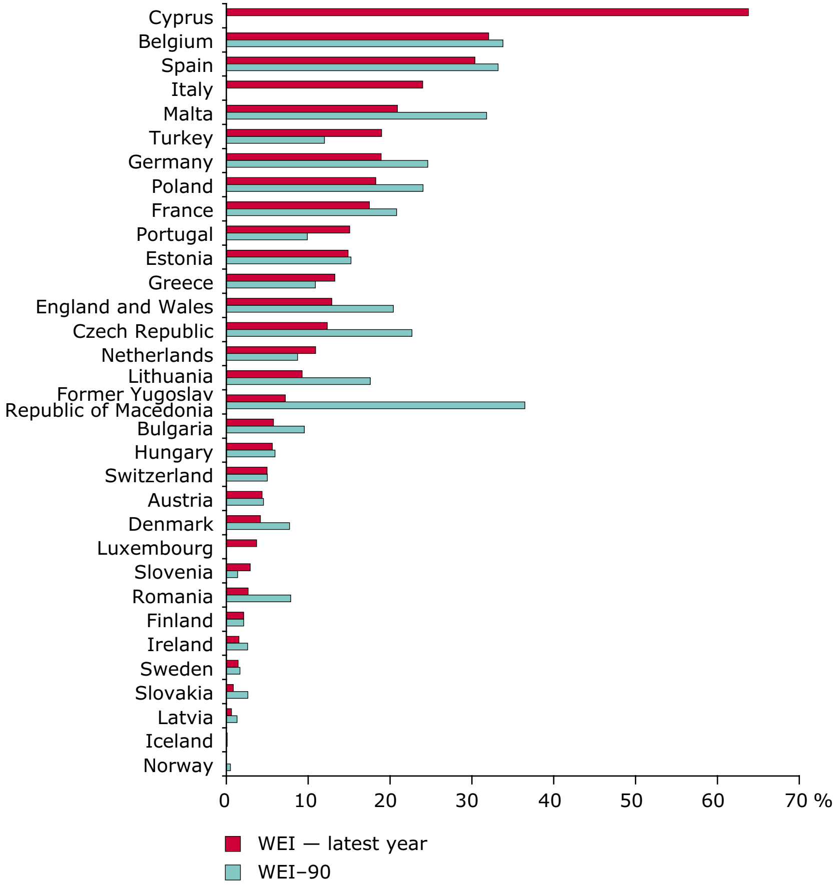
Addressing resource productivity and energy efficiency, substituting non-renewable with renewable resources, and addressing resource efficiency gaps between EU-15 and EU-12 Member States can provide opportunities for increasing European competitiveness.

Water demand management is essential for using water resources within natural limits

Water resource management differs from the management of other resources due to the unique characteristics of water as a resource: water moves through the hydrological cycle, is dependent on climatic influences, and its availability varies in time and space. It also connects different regions and other environmental media. Water is the basis for many ecosystem services — such as transport, energy provision, cleaning — but can also transfer impacts from one environmental medium or one region to another. This poses explicit needs for integration and cross-border cooperation.

Human demand for water is in direct competition with the water needed for maintaining ecological functions. In many locations in Europe, water used by agriculture, industry, public water supply and tourism put considerable stress on Europe's water resources, and demand often exceeds local availability — and this is likely to be further exacerbated by climate change impacts.

Figure 4.6 **Water exploitation index (WEI) — in late 1980s/early 1990s (WEI-90) compared to latest years available (1997 to 2005) (F)**



Note: WEI: annual total water abstraction as a percentage of available long-term freshwater resources.

The warning threshold, which distinguishes a non-stressed from a water scarce region, is around 20 %, with severe scarcity occurring where the WEI exceeds 40 %.

Source: EEA, ETC Water.

Water resources and the demand for water by different economic sectors are unevenly distributed across Europe. Even if water is abundant on a national scale, it may be scarce in individual river basins during different time periods or seasons. In particular river basins in the Mediterranean region, but occasionally also some northern regions, experience over-abstraction.

The main reasons for over-abstraction include increasing demand for irrigation and tourism. In addition, considerable 'loss' of water can occur in public distribution and supply networks prior to it reaching consumers, thus aggravating shortages in already water scarce regions. In some countries this loss in the supply network may be up to 40 % of the total water supply in others it is below 10 % ([19]).

A combination of economic and natural factors results in major regional differences in water use. Water use is stable in southern Europe and, decreasing in western Europe. This decrease is attributed mostly to behavioural changes, technological improvements and the prevention of water losses in distribution systems, supported by water pricing. Eastern Europe has experienced substantial decreases in water use — the average annual water use in the period 1997 to 2005 was around 40 % lower than in the early 1990s — mainly as a result of the introduction of water meters, higher water prices, and the closure of some water-intensive industries ([19]).

In the past, European water management has largely focused on increasing supply by drilling new wells, constructing dams and reservoirs, investing in desalination and large-scale water-transfer infrastructures. Increasing problems of water scarcity and drought clearly indicate the need for a more sustainable management approach. There is a particular need to invest in demand management that increases the efficiency of water use.

Greater water efficiency is possible. For example, there are large but currently unrealised potentials for water metering and the reuse of wastewater ([19]). Reuse of wastewater has been proved internationally, in water-stressed regions, to be a drought-proof source of water and one of the most effective solutions to water scarcity. In Europe, wastewater is reused mainly in southern Europe. Provided that the quality is thoroughly controlled, the benefits can be substantial, including increased availability of water, reduced nutrient discharges, and reduced manufacturing costs for industry.

Not least, land use practices and development planning could have a major impact on water scarcity, through parallel, compatible considerations of the use of groundwater and surface water. Intensive exploitation of aquifers can give rise to over-exploitation, such as that related to excessive abstraction for irrigation. The resulting short-term increase in productivity and change in land use impacts further exacerbates groundwater exploitation and can establish a cycle of unsustainable socio-economic developments — including risk of poverty, social distress, energy and food security (20).

Land-use practices can also cause significant hydro-morphological alterations with potential adverse ecological consequences. For example, many important wetlands, forests and floodplains in Europe have been drained and dammed, regulations and channels have been constructed to support urbanisation, agriculture, energy demand and protection from floods. The issues of water quantity and quality, irrigation water demand, water-use conflicts, environmental and socioeconomic aspects and risk management aspects can be better integrated in the institutional and political systems.

The Water Framework Directive (WFD) provides a framework to integrate high environmental standards for water quality and use into other policies (6). A first look at river basin management plans, which have been set up and reported by Member States during the first round of implementation of the WFD, indicates that a significant number of water bodies face a high risk of not achieving good ecological status by 2015. In many cases, this is due to issues related to water management, particularly linked to water quantity and irrigation, modifications of the structure of river-banks and river-beds, the connectivity of rivers or unsustainable flood protection measures which have not been addressed by earlier, pollution-oriented policies.

The overall challenge which the WFD can help tackle, if implemented fully, is to ensure the sustainable availability of good water quality, as well as managing inevitable trade-offs between competing uses, such as domestic use, industry, agriculture and the environment (see also Chapter 6).

Consumption patterns are key drivers of resource use and waste generation

The use of resources, water, energy and the generation of waste are all driven by our patterns of consumption and production.

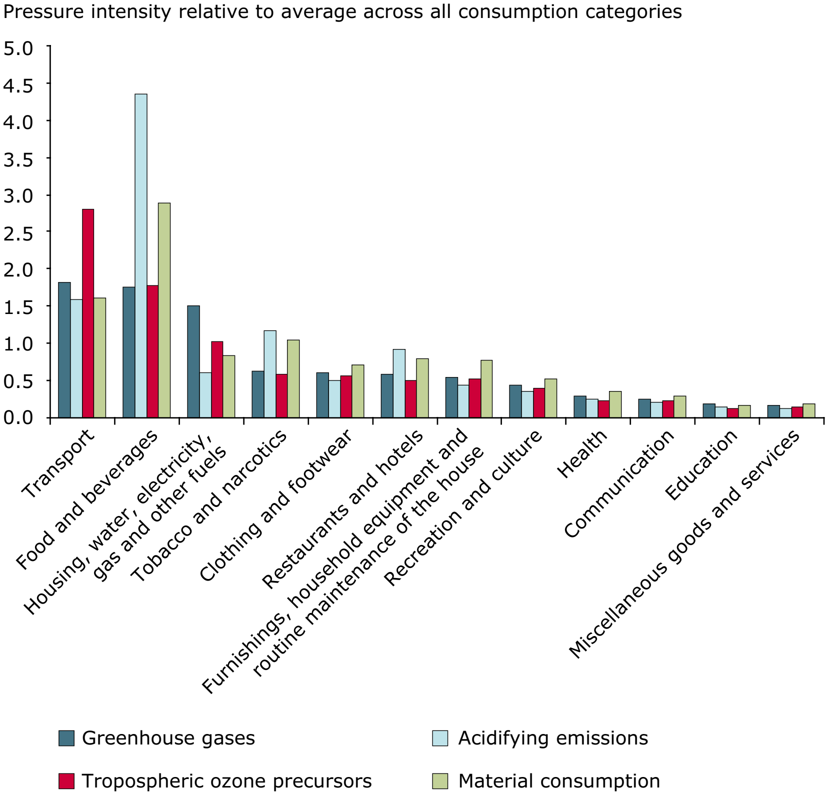
The majority of greenhouse gas emissions, acidifying substances, tropospheric ozone precursor emissions and material input caused by the life-cycles of activities related to consumption can be allocated to the main consumption areas of eating and drinking, housing and infrastructures, and mobility. Within nine countries analysed ([F]), these three consumption areas contributed 68 % of greenhouse gas emissions, 73 % of acidifying emissions, 69 % of tropospheric ozone precursor emissions and 64 % of direct and indirect material input, including use of domestic and imported resources in 2005.

Eating and drinking, mobility, and to a lesser extent housing, are also the areas of household consumption with the highest pressure intensities, which indicates the largest environmental pressures per Euro spent. Reductions in environmental pressures caused by household consumption could be achieved by reducing the pressure intensities within individual consumption categories — for example, through improvements in housing energy efficiency; by switching transport expenditure from private cars to public transport; or by shifting household expenditure from a pressure-intensive category (such as transport) to a low intensity one (such as communication).

European policy has only recently begun to address the challenge of the growing use of resources and unsustainable consumption patterns. European policies, such as the Integrated Product Policy ([21]) and Directive on Eco-design ([22]) focused on reducing the environmental impacts of products, including their energy consumption, throughout their entire life-cycle: it is estimated that over 80 % of all product-related environmental impacts are determined during the design phase of a product. In addition, EU policies also stimulate innovation-friendly markets with the EU Lead Markets initiative ([23]).

The 2008 EU Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policies ([24]) reinforces life-cycle approaches. In addition, it strengthens green public procurement

Figure 4.7 Pressure intensity (unit pressure per Euro spent) of household consumption categories, 2005



Source: EEA NAMEA project.

and initiates some actions to address consumer behaviour. However, current policies do not sufficiently address the underlying causes of unsustainable consumption, tend to focus instead on reducing impacts, and are often based on voluntary instruments.

Trade facilitates European resource imports and shifts some of the environmental impacts abroad

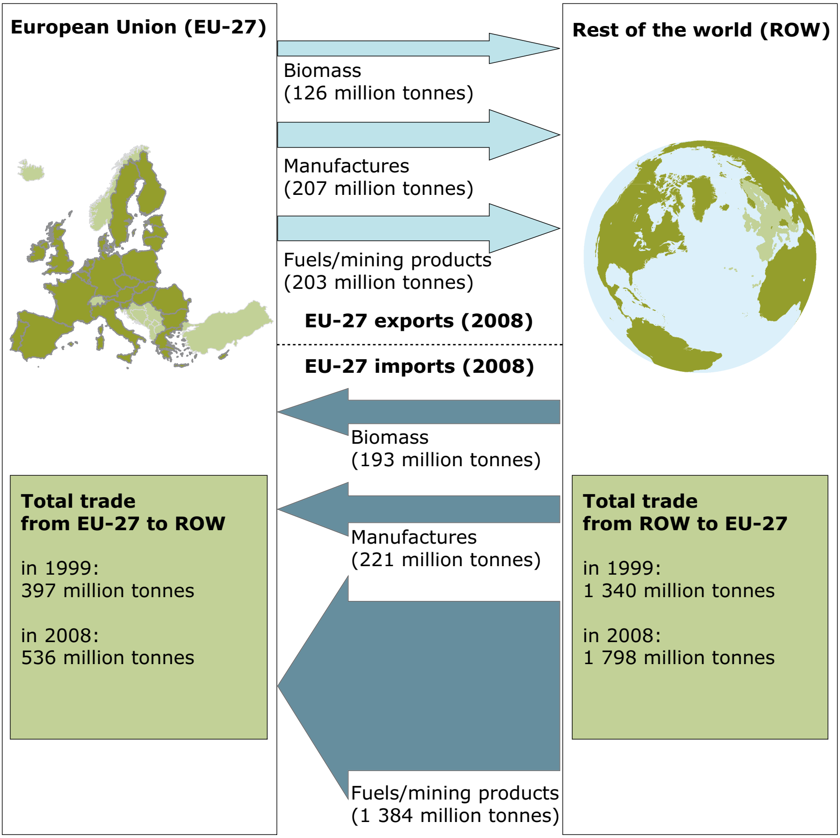
Overall, much of the EU resource base is now located abroad — more than 20 % of resources used in Europe are imported ([25]) ([26]). This import reliance is particular apparent with regard to fuels and mining products. A side-effect of this trade balance is that some of the environmental impacts of European consumption are felt by the exporting countries and regions.

Europe is, for example, a net importer of fodder and cereals for European meat and dairy production. Also, more than half of EU fish supplies are imported: the 4 million tonne gap between fish demand and supply in Europe is being made up through aquaculture and imports ([27]). This increasingly raises concerns about the impacts on fish stocks, as well as other environmental impacts related to food production and consumption (Chapter 3).

For many materials and trade goods, the environmental pressures related to their extraction and/or production — such as the waste generated, or water and energy used — affect the countries of origin. However, even though these pressures can be significant, they are not captured in indicators commonly used today. For some products, for example computers or mobile phones, those pressures may be several orders of magnitude higher than the actual weight of the product itself.

Another example for the use of natural resources embedded in traded products is the water required in growing regions for many food and fibre products. Their production results in an indirect and often implicit export of water resources: for example, 84 % of the EU cotton-related water footprint, which is a measure for the total amount of water used to produce goods and services consumed — lies outside the EU, mostly in water-scarce region with intensive irrigation ([28]).

Figure 4.8 **EU-27 physical trade balance with the rest of the world, 2008**



Source: EEA, ETC Sustainable Consumption and Production (based on Eurostat).

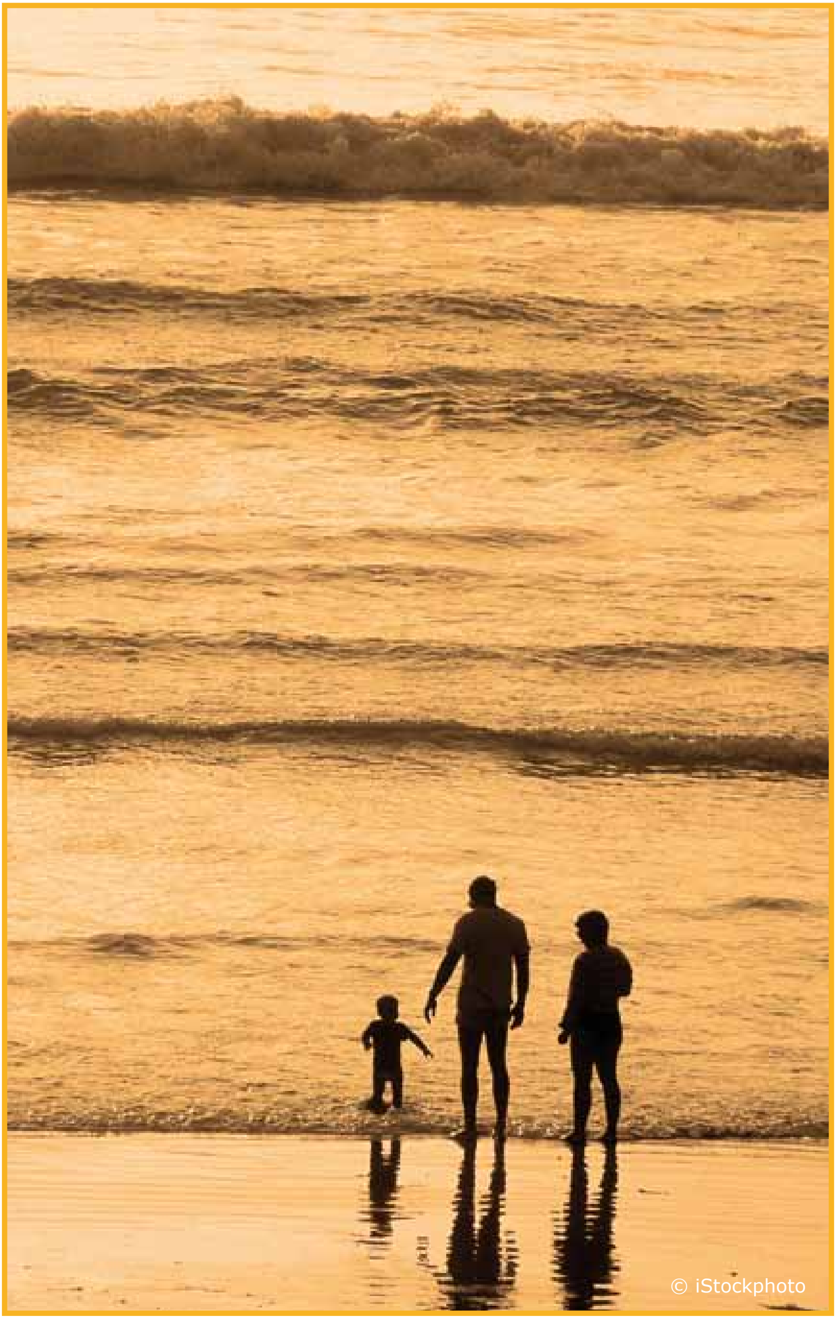
Trade-related environmental impacts may be further aggravated by lower social and environmental standards in some exporting countries, especially compared to those in the EU. However, globalisation and trade also enable resource-rich countries to export resources and raise revenues. If managed properly, for example by offering dedicated incentives, the benefits can increase the environmental efficiency of both exports and imports by enhancing green export competitiveness and reducing embedded environmental pressures in imports.

Natural resource management is linked to other environmental and socio-economic issues

The direct environmental impacts of resource use include the degradation of fertile land, water shortages, waste generation, toxic pollution, and biodiversity loss in terrestrial and freshwater ecosystems. In addition, indirect environmental impacts, for example related to land-cover changes, may have considerable effects on ecosystem services and health.

Climate change is expected to increase environmental pressures related to resource use as changing precipitation patterns in the Mediterranean, for example, put additional pressure on water resources and influence land-cover changes.

Most environmental pressures assessed in this report are driven — directly or indirectly — by the increasing use of natural resources for production and consumption patterns that leave an environmental footprint in Europe and elsewhere in the world. Furthermore, the related depletion of our stocks of natural capital and its links to other forms of capital is putting at risk the sustainability of Europe's economy and social cohesion.



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5 Environment, health and quality of life

Environment, health, life expectancy and social inequalities are linked

The environment plays a crucial role in people's physical, mental and social well-being. Despite significant improvements, major differences in environmental quality and human health remain between and within European countries. The complex relationships between environmental factors and human health, taking into account multiple pathways and interactions, should be seen in a broader spatial, socio-economic and cultural context.

In 2006, life expectancy at birth in the EU-27 was among the highest in the world — almost 76 years for men and 82 years for women ([1]). Most of the gain in life expectancy in recent decades has been due to improved survival of people above the age of 65, while before 1950 it was mostly due to a reduction in premature deaths (i.e. death below the age of 65). On average, men are expected to live almost 81 % of their lives free of disability, and women 75 % ([2]). There are, however, differences between genders, and between Member States.

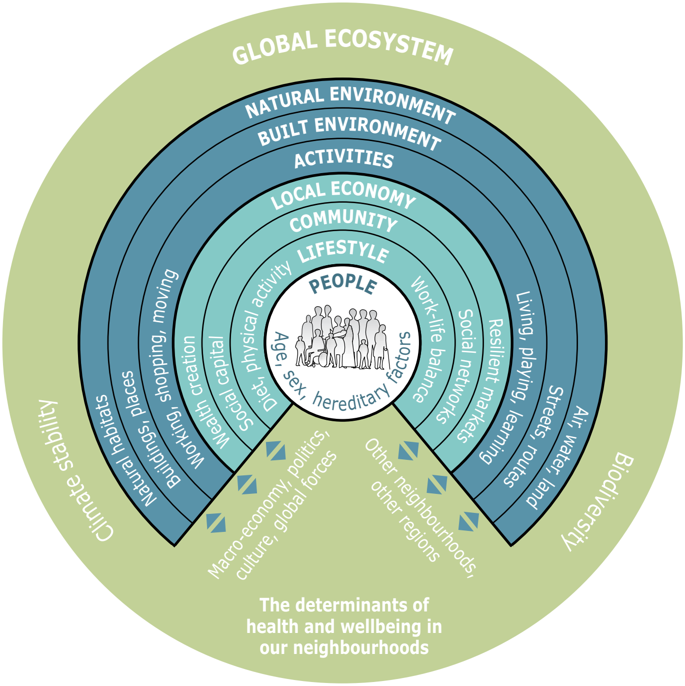
The degradation of the environment, through air pollution, noise, chemicals, poor quality water and loss of natural areas, combined with lifestyle changes, may be contributing to substantial increases in rates of obesity, diabetes, diseases of the cardiovascular and nervous systems and cancer — all of which are major public health problems for Europe's population ([3]). Reproductive and mental health problems are also on the rise. Asthma, allergies ([4]), and some types of cancer related to environmental pressures are of particular concern for children.

The World Health Organization (WHO) estimates the environmental burden of disease in the pan-European region at between 15 and 20 % of total deaths, and 18 to 20 % of disability-adjusted life years (DALYs) ([A]), with a relatively higher burden in the eastern part of the region ([5]). The preliminary results of a study conducted in Belgium, Finland, France, Germany, Italy and the Netherlands, indicate that 6 to

12 % of the total burden of disease could be attributed to nine selected environmental factors, out of which particulate matter, noise, radon, and environmental tobacco smoke were leading. Due to uncertainties, the results need to be interpreted with caution as an indicative ranking of environmental health impacts only (6).

The significant differences in the quality of the environment across Europe depend on the varying pressures related, for example, to urbanisation, pollution and natural resource use. Exposures and associated health risks, as well as the benefits of pollution reduction and of a natural environment, are not uniformly distributed within populations. Studies show that poor environmental conditions affect vulnerable groups especially (7). The evidence is scarce, but shows

Figure 5.1 The health map



Source: Barton and Grant (a).

Box 5.1 Environmental burden of disease — estimating the impacts of environmental factors

The environmental burden of disease (EBD) represents the proportion of ill health attributed to exposure to environmental factors. Use of the EBD approach allows: comparison of health losses due to different risk factors; setting priorities; and evaluating the benefits of specific measures. However, the results are likely to underestimate the overall environmental burden as they focus on single risk factors and health outcomes, rather than taking full account of complex causal pathways. Estimates of similar issues may vary, depending on the underlying assumptions, methods and data used; and, for many risk factors EBD estimates are not yet available (c) (d).

Attribution of the role of the environment in the development of diseases, and the development of novel assessment approaches aimed at taking the inherent complexity and uncertainty of environment and health interactions into account, remain a subject of intense debate (e) (f) (g).

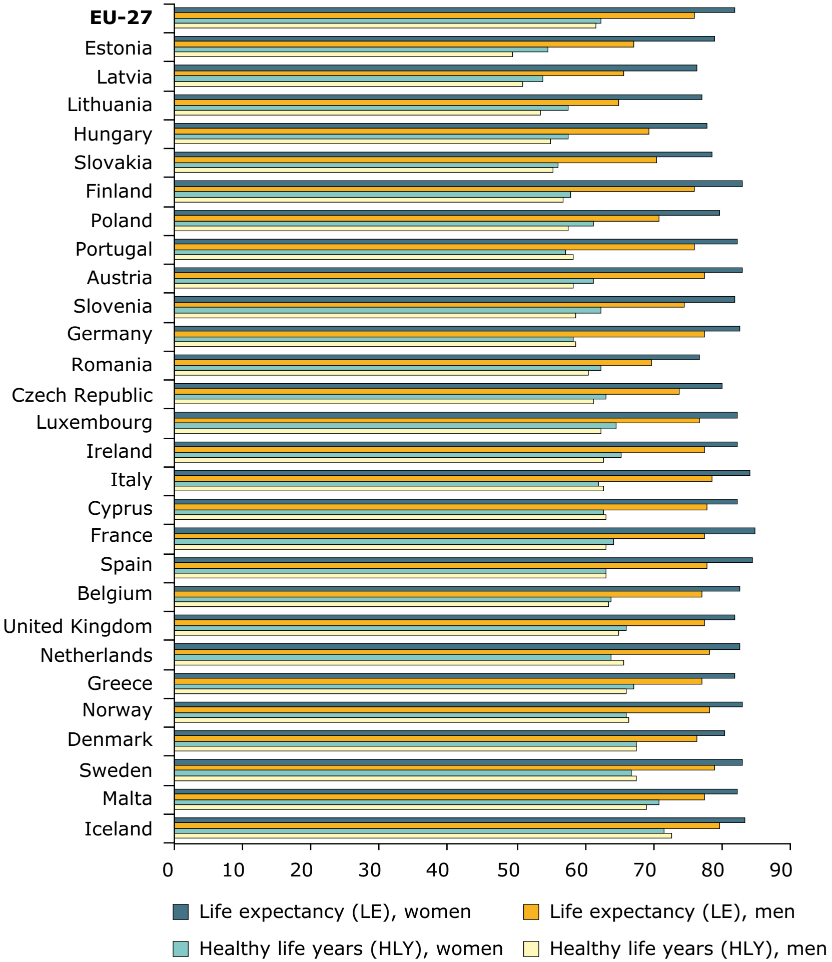
that deprived communities are more likely to be affected; for example, in Scotland, mortality rates in people aged under 75 in the 10 % most deprived areas were three times higher than those in the 10 % least deprived (8).

Better understanding of differences in the social distribution of environmental quality can be helpful for policy, since specific population groups, such as those on low incomes, children, and the elderly, may be more vulnerable — mostly due to their health, economic and educational status, access to health care, and lifestyle factors that affect their adaptation and coping capacities (7) (9) (10).

Europe's ambition is to provide an environment not giving rise to harmful effects on health

The main European policies aim to provide an environment in which the level of pollution does not give rise to harmful effects on human health and the environment, and vulnerable population groups are protected. They are the 6th Environment Action Programme (6th EAP) (11), the EU Environment and Health Strategy (12) and Action Plan 2004–2010 (13), and the pan-European WHO Environment and Health process (14) (15).

Figure 5.2 Life expectancy and healthy life years at birth in EU-27, Iceland and Norway in 2007, by gender



Note: Healthy life years (HLY) at birth — the number of years a person at birth is expected to live in a healthy condition. Life expectancy (LE) at birth — the number of years a newborn child is expected to live, assuming that the age-specific mortality levels remain constant.

Data coverage: no HLY data for Bulgaria, Switzerland, Croatia, Liechtenstein, and the former Yugoslav Republic of Macedonia.

Time coverage: 2006 data used for LE for Italy and EU-27.

Source: European Community Health Indicators (^{b}).

Several areas for action have been identified, related to air and noise pollution; water protection; chemicals, including harmful substances such as pesticides; and improving the quality of life, especially in urban areas. The Environment and Health process aims at achieving a better understanding of the environmental threats to human health; reducing the disease burden caused by environmental factors; strengthening EU capacity for policymaking in this area; and identifying and preventing new environmental health threats ([12]).

While EU policy emphasis is on reducing pollution and the disturbance of crucial services provided by the environment, there is also a growing recognition of the benefits of the natural, biologically diverse environment to human health and well-being ([16]).

Furthermore, it is worth noting that most health-related pollution policies are targeted to the outdoor environment. A somewhat neglected area in this regard is the indoor environment — considering that European citizens spend up to 90 % of their time indoors.

Box 5.2 Indoor environment and health

The quality of indoor environment is affected by ambient air quality; building materials and ventilation; consumer products, including furnishings and electrical appliances, cleaning and household products; occupants' behaviour, including smoking; and building maintenance (for example, energy saving measures). Exposure to particulate matter and chemicals, combustion products, and to dampness, moulds and other biological agents has been linked to asthma and allergic symptoms, lung cancer, and other respiratory and cardiovascular diseases ([h]) ([i]).

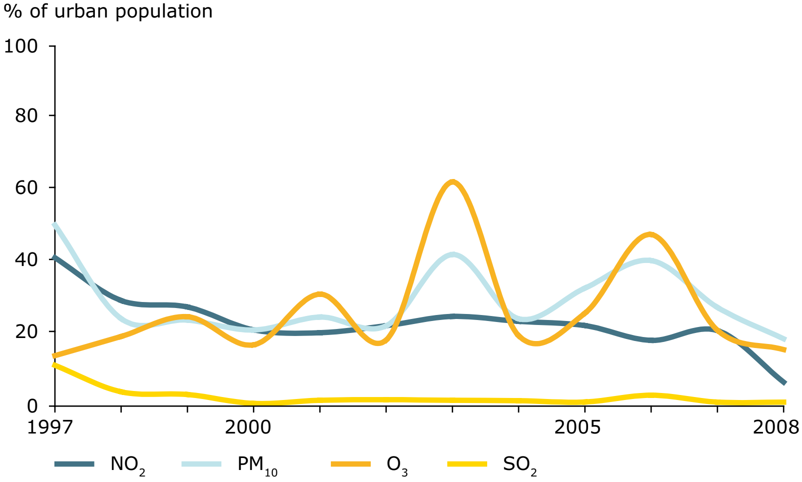
Recent assessments of the sources of, exposure to and policies related to indoor air pollution have analysed the benefits of different measures. The highest health benefits are linked to smoking restrictions. Building and ventilation policies that control indoor exposure to particulate matter, allergens, ozone, radon and noise from outdoors offer high long-term benefits. Better building management, prevention of moisture accumulation and mould growth, and prevention of exposure to exhausts from indoor combustion can bring substantial medium to long-term benefits. Substantial short to medium term benefits result from harmonised testing and labelling of indoor materials and consumer products ([h]).

For some pollutants ambient air quality has improved, but major health threats remain

In Europe, there have been successful reductions in the levels of sulphur dioxide (SO_2) and carbon monoxide (CO) in ambient air, as well as marked reductions in NO_X. Also, lead concentrations have declined considerably with the introduction of unleaded petrol. However, exposure to particulate matter (PM) and ozone (O_3) remain of major environment-related health concern, linked to a loss of life expectancy, acute and chronic respiratory and cardiovascular effects, impaired lung development in children, and reduced birth weight ([17]).

Over the past decade, ozone concentrations have frequently and widely exceeded health- and ecosystem-related target values. The

Figure 5.3 **Percentage of urban population in areas where pollutant concentrations are higher than selected limit/target values, EEA member countries, 1997–2008**



Note: Only urban and sub-urban background monitoring stations are included. Since O_3 and the majority of PM_{10} are formed in the atmosphere, meteorological conditions have a decisive influence on the airborne concentrations. This explains at least partly inter-annual variations and for example the high O_3 levels in 2003, a year with extended heat waves during summer.

Source: EEA AirBase, Urban Audit (CSI 04).

Clean Air for Europe (CAFE) programme estimated that at current levels of ground-level ozone, exposure to concentrations exceeding the health-related target value ([B]) is associated with more than 20 000 premature deaths in EU-25 ([C]) annually ([18]).

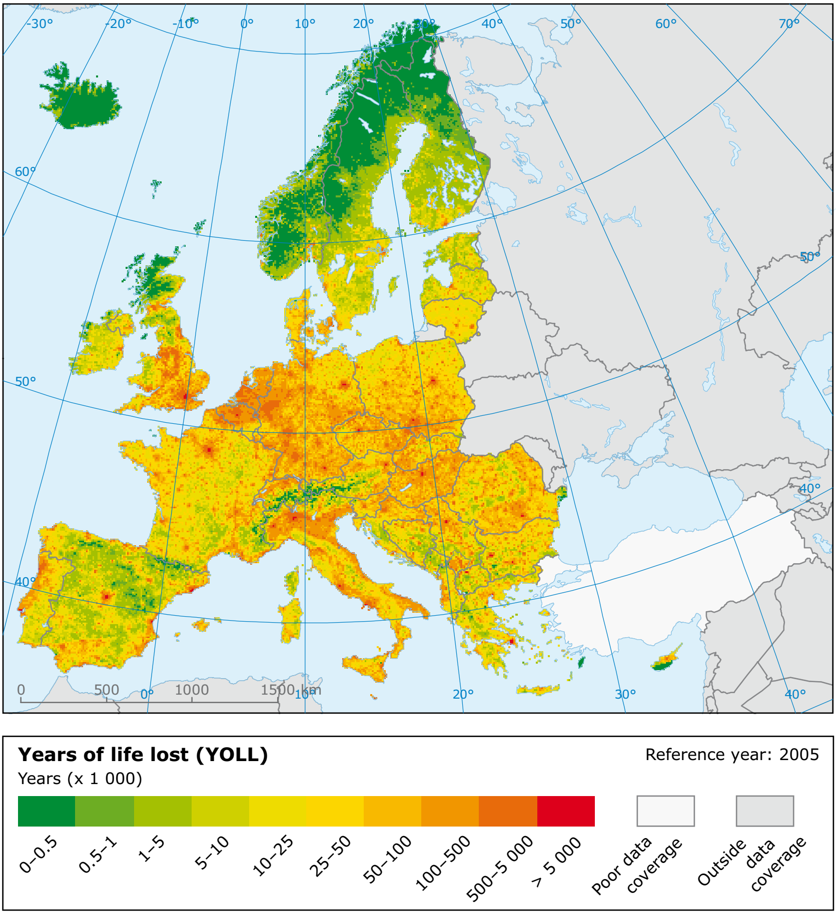
In the period 1997 to 2008, 13 to 62 % of Europe's urban population was potentially exposed to ambient air concentrations of fine and coarse particulate matter (PM_{10}) ([D]) in excess of the EU limit value set for the protection of human health ([E]). However, particulate matter has no threshold concentration, thus adverse health effects can also occur below the limit values.

The fine-particulate fraction ($PM_{2.5}$) ([F]) represents a particular health concern because these can penetrate the respiratory system deeply and be absorbed into the bloodstream. An assessment of the health impacts of exposure to $PM_{2.5}$ in EEA-32 countries in 2005 indicated that almost 5 million lost life years could be attributed to this pollutant ([G]). Reducing such exposure has recently been shown to bring measurable health gains in the United States of America, where life expectancy increased most in the regions with the largest reductions in $PM_{2.5}$ over the past 20 years ([19]).

PM_{10} and $PM_{2.5}$ concentrations are indicators of complex mixtures of pollutants and are used as proxies for the particulate characteristics responsible for the effects. Other indicators, such as black smoke, elemental carbon, and the number of particles, might provide a better link to the sources of pollution which need mitigation in response to specific health effects. This could be beneficial for targeted abatement strategies and setting air quality standards ([20]).

Evidence is increasing that the chemical properties and composition of particles, along with their mass, are important for health impacts ([21]). For example, benzo(a)pyrene (BaP), which is a marker of carcinogenic polycyclic aromatic hydrocarbons, is emitted mainly from the burning of organic material and mobile sources. High levels of BaP occur in some regions, such as the Czech Republic and Poland ([22]). The increasing wood burning in homes in some parts of Europe may become an even more prominent source of such hazardous pollutants. Climate change mitigation strategies may also play a role, by stimulating use of wood and biomass as domestic energy sources.

Map 5.1 Estimated years of life lost (YOLL) in reference year 2005 attributable to long-term $PM_{2.5}$ exposure



Source: EEA, ETC Air and Climate Change (^{j}).

The 6th EAP sets the long-term objective of achieving levels of air quality that do not give rise to unacceptable impacts on, and risks to, human health and the environment. Its subsequent Thematic Strategy on air pollution ([23]) set interim objectives through the improvement of air quality by 2020. The Air Quality Directive ([24]) has set legally binding limits for $PM_{2.5}$ and for organic compounds such as benzene. It has also introduced additional $PM_{2.5}$ objectives, based on the average exposure indicator (AEI) ([H]) to determine a required percentage reduction to be attained in 2020.

Furthermore, several international bodies are discussing the setting of targets for 2050 in relation to the long-term environmental objectives of European policies and international protocols ([25]).

Road traffic is a common source of several health impacts, especially in urban areas

Air quality is worse in urban areas than in rural areas. Yearly average PM_{10} concentrations in the European urban environment have not changed significantly over the past decade. The main sources are road traffic, industrial activities, and the use of fossil fuels for heating and energy production. Motorised traffic is the major source of the PM fractions responsible for adverse health effects, which also come from non-exhaust PM emissions, for example, brake and tyre wear or re-suspended particles from pavement materials.

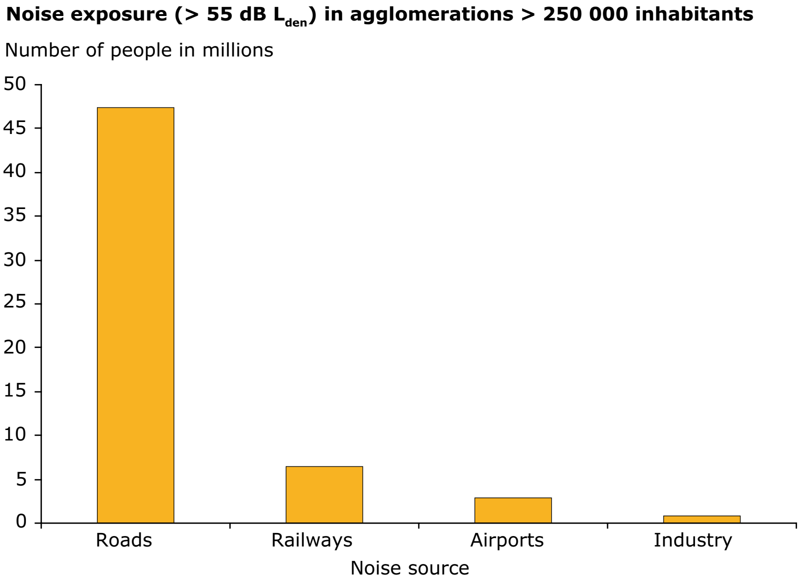
Meanwhile, road traffic injuries, with an estimated more than 4 million incidents in the EU every year, remain an important public health issue. There were 39 000 fatalities in the EU in 2008; 23 % of fatal accidents in built-up areas affected people under the age of 25 ([26]) ([27]). Transport sources also account for a substantial proportion of human exposure to noise, which has negative impacts on human health and well-being ([28]). Data delivered in accordance with the Directive on Environmental Noise ([29]) are available through the Noise Observation and Information Service for Europe ([30]).

Approximately 40 % of the population living in the largest cities in the EU-27 may be exposed to long-term average road traffic noise levels ([I]) exceeding 55 decibels (dB), and at night, almost 34 million people may be exposed to long-term average road noise levels ([I]) exceeding 50 dB.

The WHO night noise guidelines for Europe recommend that people should not be exposed to night noise greater than 40 dB. Night-time noise levels of 55 dB, described as 'increasingly dangerous to public health', should be considered as an interim target in situations where the achievement of the guidelines is not feasible (28).

According to a German Environmental Survey for Children, children from families of low socio-economic status are more heavily exposed to traffic, and annoyed by road traffic noise, during the day, as compared with children with higher socio-economic status (31). Urban air quality and noise often share a common source and may cluster spatially. There are examples, such as Berlin, of successful integrated approaches to reducing both local air pollution and noise levels (32).

Figure 5.4 **The reported long-term (yearly average) exposure to day-evening-night noise (L_{den}) of more than 55 dB in EU-27 agglomerations with more than 250 000 inhabitants**



Source: NOISE (k).

Better wastewater treatment has led to improved water quality, but complementary approaches may be needed for the future

Wastewater treatment, and the quality of both drinking and bathing water have improved significantly in Europe over the past 20 years, but continued efforts are needed to further improve the quality of water resources.

Human health can be affected through a lack of access to safe drinking water, inadequate sanitation, the consumption of contaminated freshwater and seafood, as well as exposure to contaminated bathing water. The bio-accumulation of mercury and some persistent organic pollutants, for example, can be high enough to raise health concerns in vulnerable population groups such as pregnant women (33) (34).

Understanding of the relative contribution of different exposure routes is, however, incomplete. The burden of water-borne diseases in Europe is difficult to estimate and most likely underestimated (35).

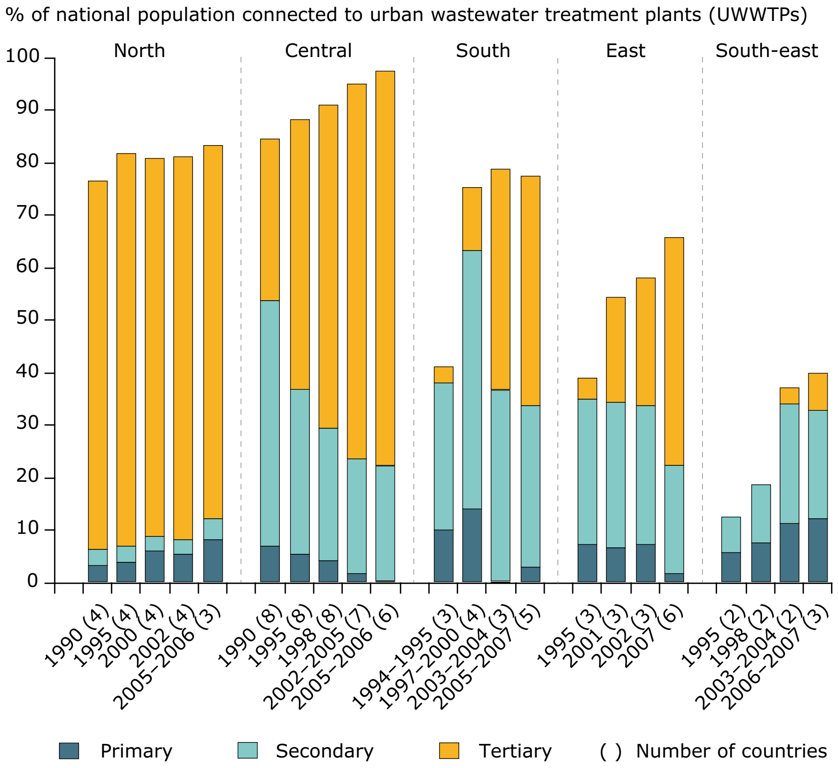
The Drinking Water Directive (DWD) sets quality standards for water 'at the tap' (36). The majority of the European population receives treated drinking water from municipal supply systems. Thus, health threats are infrequent and occur primarily when contamination of the water source coincides with a failure in the treatment process.

While the DWD addresses water supplies serving more than 50 people, a European data exchange and reporting system applies only to supplies for more than 5 000 people.

In a 2009 survey, the compliance rate with drinking water standards in smaller supplies was 65 %, while for larger ones exceeded 95 % (37). In 2008, 10 out of 12 outbreaks of waterborne diseases reported in the EU-27 were linked to the contamination of private wells (38).

Implementation of the Urban Wastewater Treatment Directive (UWWTD) (39) remains incomplete in many countries (40). However, EU-12 Member States have staggered transition periods for full implementation ranging up to 2018. The UWWTD addresses agglomerations with a population of 2 000 or more; thus potential

Figure 5.5 Regional variation in wastewater treatment between 1990 and 2007



Note: Only countries with data for virtually all of each period were included, the numbers of countries are given in parentheses. Regional percentages have been weighted by country population.

North: Norway, Sweden, Finland and Iceland.
Central: Austria, Denmark, England and Wales, Scotland, the Netherlands, Germany, Switzerland, Luxembourg and Ireland. For Denmark no data have been reported to the joint questionnaire since 1998. However, according to the European Commission, Denmark has achieved 100 % compliance with secondary treatment and 88 % compliance with more stringent treatment requirements (with respect to load generated) under the UWWTD. This is not accounted for in the figure.
South: Cyprus, Greece, France, Malta, Spain and Portugal (Greece only up to 1997 and then since 2007).
East: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovakia.
South-east: Bulgaria, Romania and Turkey.

Source: EEA, ETC Water (CSI 24, based on OECD/Eurostat Joint Questionnaire 2008).

public health risks linked to sanitation exist in some rural areas of Europe. For these areas, complementary, 'low-technology' solutions are available.

The implementation of the UWWTD has led to an increasing proportion of Europe's population being connected to a municipal treatment works. The associated improvements in wastewater treatment have resulted in a decline in the discharges of nutrients, microbes and some hazardous chemicals to receiving waters, and substantial improvement in the microbial quality of Europe's inland and coastal bathing waters (41).

Whilst wastewater treatment has improved, both point and diffuse pollutant sources are still significant in parts of Europe and health risks remain. For example, algal blooms linked to excessive nutrient levels, particularly during extended periods of hot weather, are associated with toxin-producing cyanobacteria — which, in turn, can cause allergic reactions, skin and eye irritation and gastroenteritis in exposed people. Large populations of cyanobacteria can occur in European water bodies used for drinking water, aquaculture, recreation and tourism (42).

Looking ahead, major investment will be needed to maintain existing wastewater treatment infrastructures (43). In addition, the discharge of some pollutants in treated effluent can raise environmental concerns, for example, endocrine-disrupting chemicals (44) or pharmaceuticals (45) (46). While wastewater treatment at municipal plants will continue to play a critical role, complementary approaches, such as tackling pollutants at source need to be explored more extensively.

New legislation related to chemicals (such as the Registration, Evaluation, Authorisation and Restriction of Chemical regulation (REACH) (47) and the Environmental Quality Standards (EQS) Directive (48)) are likely to help drive such a source control approach. In combination with the full implementation of the Water Framework Directive (49), this should lead to a reduced emission of pollutants to water, leading to healthier aquatic ecosystems and reducing risks to human health.

Pesticides in the environment have potential for unintended impacts to wildlife and humans

Pesticides disrupt essential biological processes, for example through affecting nerve transmission or mimicking hormones. Thus, human health concerns related to exposure via water, food, or close proximity to spraying have been raised (50) (51). Due to their intrinsic properties, pesticides can also be harmful to organisms in the wider environment, including freshwater organisms (52).

Mixtures of pesticides are common both in the human food supply (53) and in the aquatic environment. Though assessment of mixture toxicity has been a challenge, a single-chemical approach is likely to underestimate ecological risk, including impacts of mixture of pesticides on fish (54) and amphibians (55).

The EU Thematic Strategy on the sustainable use of pesticides (56) sets objectives to minimise the hazards and risks to health and the environment stemming from the use of pesticides, and to improve controls on the use and distribution of pesticides. Full implementation of the associated Pesticides Directive will be required to support the achievement of good chemical status under the Water Framework Directive (49).

Information on pesticides in surface and ground waters in Europe is limited; however, the reported levels, including pesticides classified as priority substances, can exceed environmental quality standards. Some pesticide impacts are not captured by routine monitoring programs — for example fatal exposure of aquatic species to short-term contamination during rainfall events immediately after pesticide application to cropland (57). These limitations combined with growing concerns about potential adverse effects strengthen the case for a more precautionary approach to their use in agriculture, horticulture and to control unwanted plant growth in public spaces close to where people live.

New chemical regulation may help, but the combined effects of chemicals remain an issue

Water, air, food, consumer products, and indoor dust can play a role in human exposure to chemicals through ingestion, inhalation or contact through skin. Of particular concern are persistent and bio-accumulative compounds, endocrine-disrupting chemicals and heavy metals used in plastics, textiles, cosmetics, dyestuffs, pesticides, electronic goods and food packaging ([58]). Exposure to these chemicals has been associated with declining sperm counts, genital malformation, impaired neural development and sexual function, obesity and cancer.

Chemicals in consumer goods may also be of concern when products become waste, as many chemicals migrate easily to the environment and can be found in wildlife, ambient air, indoor dust, wastewater and sludge. A relatively new concern in this context is waste electrical and electronic equipment, which contains heavy metals, flame retardants or other hazardous chemicals. Brominated flame retardants, phthalates, bisphenol A, and perfluorinated chemicals are most often discussed because of their suspected health effects and ubiquitous presence in the environment and in humans.

Possible combined effects of exposure to a mixture of chemicals found at low levels in the environment or in consumer goods, especially in vulnerable young children, are receiving particular attention. Furthermore, some adult diseases are linked to early-life or even prenatal exposures. The scientific understanding of mixture toxicology has recently been advanced significantly, not least as a result of EU-funded research ([J]).

While concerns about chemicals are growing, data for chemical occurrence and their fate in the environment, as well as for exposures and associated risks, remain scarce. There remains a need to establish an information system on concentrations of chemicals in various environmental compartments and in humans. New approaches and use of information technology offer the scope to do this effectively.

Furthermore, there is increasing recognition that cumulative risk assessment is necessary to avoid underestimation of risks that might occur under the current paradigm of considering substances on a chemical-by-chemical basis ([59]). The European Commission has been asked to take account of 'chemical cocktails' and to apply the precautionary principle in considering effects of chemical combinations when drafting new legislation ([60]).

Good management plays a crucial role in preventing and reducing exposures. A combination of legal, market-based and information-based instruments to support consumer choices is critical, given public concerns about the possible health effects of exposure to chemicals in consumer products. For example, Denmark has published guidelines on how to reduce children's exposure to chemical cocktails, focusing on phthalates, parabens, and polychlorinated biphenyls (PCBs) ([61]). In the EU rapid alert system for non-food dangerous products, operating since 2004, chemical risks represented 26 % of almost 2 000 notifications in 2009 ([62]).

The Registration, Evaluation, Authorisation and Restriction of Chemical regulation (REACH) ([47]) aims to improve the protection of human health and the environment from the risks of chemicals. Manufacturers and importers are required to gather information on the properties of chemical substances and propose risk management measures for safe production, use and disposal — and to register the information in a central database. REACH also calls for the progressive substitution of the most dangerous chemicals once suitable alternatives have been identified. However, the regulation does not address simultaneous exposure to multiple chemicals.

The efforts to better protect human health and the environment through safer chemical substitutes need to be complemented by a systemic approach to chemicals assessment. Such assessments should include not only toxicity and eco-toxicity, but also address the starting material, water and energy use, transport, release of CO_2 and other emissions, as well as waste generation through the life cycle of different chemicals. Such a 'sustainable chemistry' approach requires new, resource-efficient production processes and the development of chemicals that use fewer raw materials and are of high quality, with limited impurities to reduce or avoid waste — however, there is no comprehensive legislation on sustainable chemistry in place as yet.

Climate change and health is an emerging challenge for Europe

Nearly all the environmental and social impacts of climate change (Chapter 2) may ultimately affect human health through altering weather patterns, and through changes in water, air and food quality and quantity, ecosystems, agriculture, livelihoods and infrastructure ([63]). Climate change can multiply risks and existing health problems: potential health effects depend largely on populations' vulnerability and their ability to adapt.

The heat wave in Europe in summer 2003, with a death toll exceeding 70 000, highlighted the need for adaptation to a changing climate ([64]) ([65]). The elderly and people with particular diseases are at higher risk, and deprived population groups are more vulnerable ([7]) ([66]). In congested urban areas with high soil sealing and heat absorbing surfaces, the effects of heat waves can be exacerbated due to insufficient nocturnal cooling and poor air exchange ([67]). For populations in the EU, mortality has been estimated to increase by 1 to 4 % for each degree increase of temperature above a (locally-specific) cut-off point ([68]). In the 2020s, the estimated increase in heat-related mortality resulting from projected climate change could exceed 25 000 per year, mainly in central and southern European regions ([69]).

An anticipated impact of climate change on the spread of water-, food-and vector-borne ([K]) diseases in Europe emphasises the need for tools to address such threats to public health ([70]). Transmission patterns of communicable diseases are also influenced by ecological, social and economic factors, such as changing land-use patterns, declining biological diversity, alterations in human mobility and outdoor activity, as well as access to health care and population immunity. This can be exemplified by the shift in the distribution of ticks, vectors of the lyme disease and tick-borne encephalitis. Other examples include the extended range in Europe of the Asian tiger mosquito, a vector of several viruses, with a potential for further transmission and dispersion under the changing climate conditions ([71]) ([72]).

Climate change may also exacerbate existing environmental problems, such as particulate emissions and high ozone concentrations, and pose additional challenges to providing sustainable water and sanitation services. Climate-related changes in air quality and pollen distribution are expected to affect several respiratory diseases. Systematic assessments of the resilience of water supply and sanitation systems to climate change and inclusion of its impacts in water safety plans are needed ([35]).

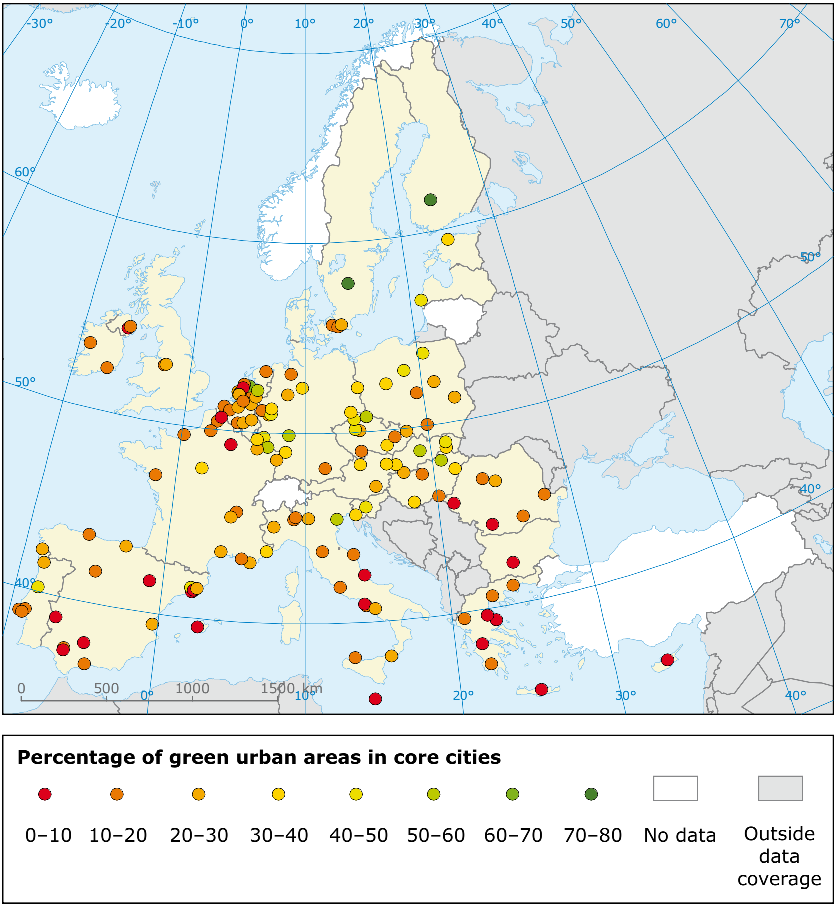
Natural environments provide multiple benefits to health and well-being, especially in urban areas

Nearly 75 % of European citizens live in urban areas, and this is expected to increase to 80 % by 2020. Under the 6th EAP, the Thematic Strategy on the urban environment ([73]) highlights the consequences for human health of the environmental challenges facing cities, the quality of life of urban citizens and the performance of cities. It aims to improve the urban environment, to make it more attractive and healthier to live, work and invest in, while trying to reduce the adverse environmental impacts on the wider environment.

The quality of life and health of urban dwellers depends strongly on the quality of the urban environment, functioning in a complex system of interactions with social, economic, and cultural factors ([74]). Green urban areas play an important role in this context. A multifunctional network of green urban areas is capable of delivering many environmental, social, and economic benefits: jobs, habitat maintenance; improved local air quality and recreation, to name a few.

The benefits of contacts with wildlife and access to safe green spaces for a child's exploratory, mental and social development have been shown both in urban and rural settings ([75]). Health is generally perceived to be better by people living in more natural environments, with agricultural land, forests, grasslands or urban green spaces near the place of residence ([76]) ([77]). Furthermore, the perceived availability of green urban areas has been shown to reduce annoyance due to noise ([78]).

Map 5.2 Percentage of green urban areas in core cities (^{L})



Source: EEA, Urban Atlas.

A broader perspective is needed to address ecosystem and health links and emerging challenges

Much progress has been achieved through dedicated approaches to improving the quality of the environment and reducing particular burdens on human health — but many threats remain. The predominant drive for material well-being has played a major role in the biological and ecological disturbances witnessed today. Preserving and extending the benefits provided by the environment for human health and well-being will require continuous effort to improve the quality of the environment. Furthermore, these efforts need to be complemented by other measures, including significant changes in lifestyle and human behaviour, as well as consumption patterns.

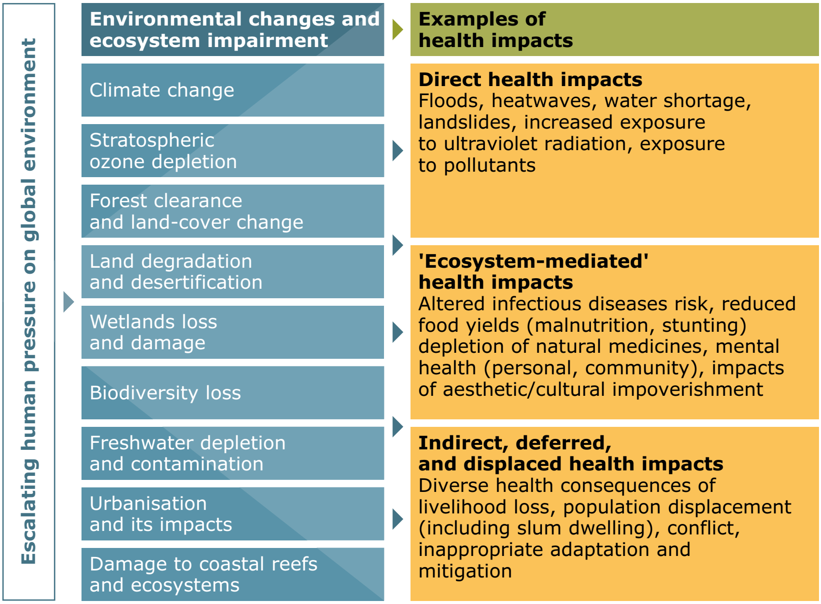
Meanwhile, new challenges are emerging with a wide range of potential, highly uncertain, ecological and human health implications. In this context, technological advancements may provide new benefits — however, history also offers many examples of adverse health impacts from new technologies (79).

Nanotechnology, for example, may allow the development of new products and services which are capable of enhancing human health, conserving natural resources or protecting the environment. However, the unique features of nanomaterials also raise concerns about potential environmental, health, occupational and general safety hazards. The understanding of nanotoxicity is in its infancy, as are methods for assessing and managing the risks inherent in the use of some materials.

Given such knowledge gaps and uncertainties, an approach to responsible development new technologies, such as nanotechnologies, could be achieved through 'inclusive governance' based on broad stakeholder involvement and early public intervention in research and development (80). The European Commission has, for example, consulted experts and the public regarding the benefits, risks, concerns and awareness of nanotechnologies to support the preparation of a new action plan for 2010 to 2015 (81).

The increasing awareness of multi-causality, complexity, and uncertainties also means that the EU Treaty principles of precaution and prevention are even more relevant than before. More recognition of the limits of what we can know, in time to prevent harm, is called for, as is the need to act on sufficient, rather than overwhelming, evidence of the potential harms to health, given the pros and cons of action versus inaction.

Figure 5.6 Harmful effects of ecosystem change on human health



Note: Not all ecosystem changes are included. Some changes can have positive effects (food production, for example).

Source: Millennium Ecosystem Assessment (1).

6 Links between environmental challenges

Links between environmental challenges point towards increasing complexity

From the analyses presented in previous chapters, it is clear that the growing demands for natural resources in recent decades are putting pressures on the environment in increasingly complex and wide-ranging ways.

Generally speaking, specific environmental issues, often with local effects, have in the past been dealt with through targeted policies and single-issue instruments, such as the approaches to waste disposal and species protection. Since the 1990s, however, the recognition of diffuse pressures from different sources has led to an increased focus on the integration of environmental concerns within sectoral policies, for example in transport or agricultural policies.

Today's main environmental challenges are systemic in character and cannot be tackled in isolation. The assessments of four environmental priority areas — climate change, nature and biodiversity, use of natural resources and waste, and environment and health — point to a series of direct and indirect links between environmental challenges.

Climate change, for example, impacts all other environmental issues. Changes in temperature and precipitation patterns affect agricultural production as well as plant and animal distribution and phenology, and thus exert additional pressures on biodiversity (Chapter 3). This may lead to species extinctions, particularly in arctic, alpine and coastal zones (Chapter 2). Similarly, changes in climatic conditions across Europe are projected to alter existing health risks by changing the occurrence of heat waves, cold spells and vector-borne diseases (Chapters 2 and 5).

Nature and biodiversity are the basis for virtually all ecosystem services, including food and fibre provisioning, nutrient circulation and climate regulation — forests, for example, provide carbon sinks that help absorb greenhouse gas emissions (Chapter 3). Thus

Table 6.1 Reflecting on environmental challenges

Characterisation of the type of challenge	**Key features**	**In the spotlight in**	**Policy approach example**
Specific	Linear cause-effect; large (point) sources; often local	1970s/1980s (and continuing today)	Targeted policies and single-issue instruments
Diffuse	Cumulative causes; multiple sources; often regional	1980s/1990s (and continuing today)	Policy integration and raising public awareness
Systemic	Systemic causes; interlinked sources; often global	1990s/2000s (and continuing today)	Policy coherence and other systemic approaches

Source: EEA.

biodiversity loss and ecosystem degradation directly affect climate change and undermines the way we are able to use natural resources. In addition, loss of natural infrastructure has been shown to have various harmful effects on human health (Chapter 5).

The use of natural resources and the resulting pollution of air, water and soil put pressure on nature and biodiversity through, for example, eutrophication and acidification (Chapter 3). Ultimately, the use of non-renewable natural resources, such as fossil fuels, is at the heart of the debate about climate change. In addition, waste management is a key sector with regard to greenhouse gas emissions (Chapter 2). How we use natural resources and dispose of wastes also links directly to several health aspects and contributes to the environmental burden of disease (Chapter 5).

Ultimately, environmental pressures that result from, for example, climate change, biodiversity loss, or the use of natural resources, are linked with people's well-being (Chapters 2 to 5). Access to clean water and air are paramount to our health, but is often undermined by pollution and waste that result from human activities (Chapters 4 and 5). Climate change puts additional pressure on air and water quality (Chapter 2), while biodiversity loss may undermine the ability of ecosystems to provide, for example, water purification and other health-related services (Chapter 3).

Table 6.2 Links between environmental challenges

How what is below affects what is across …	Climate change	Nature and biodiversity	Use of natural resources and waste	Environment and health
Climate change		**Direct links:** change in phenology, invasive species, changing run-off **Indirect links:** via land-cover change; via floods and droughts	**Direct links:** change in growing conditions for biomass **Indirect links:** via land-cover change; via floods and droughts	**Direct links:** increase in heat waves, change in diseases, air quality **Indirect links:** via land-cover change; via floods and droughts
Nature and biodiversity	**Direct links:** greenhouse gas emissions (agriculture, forestry carbon sinks) **Indirect links:** via land-cover change		**Direct links:** ecosystem services, food and water security **Indirect links:** via land-cover change, via floods and droughts	**Direct links:** recreation landscapes, air quality regulation, medicines **Indirect links:** via land-cover change, via floods and droughts
Use of natural resources and waste	**Direct links:** greenhouse gas emissions (production, extraction, waste management) **Indirect links:** via consumption; via land-cover change	**Direct links:** depletion of stocks, water pollution, air pollution and quality **Indirect links:** via land-cover change; via floods and droughts; via consumption		**Direct links:** hazardous waste and emissions; air, water pollution **Indirect links:** via land-cover change; via floods and droughts; via consumption

Source: EEA.

Many of the links described above and in the previous chapters are direct, i.e. changes in the state of one environmental issue can translate directly into pressures of another. In addition, a number of indirect links occur with changes in one environmental issue resulting in feedbacks on another and vice versa.

Land use and land-cover changes exemplify such indirect links. They can be seen to be both a driver and an impact, not only of climate change, but also of biodiversity loss and the use of natural resources. Thus, any change in land use and land cover resulting, for example, from urbanisation or converting forests to agriculture, affects climate conditions by changing an area's carbon balance, as well as biodiversity by altering ecosystems.

Most of the changes in the state of the environment described here are ultimately driven by unsustainable consumption and production patterns. These have resulted in unprecedented levels of greenhouse gas emissions and the depletion of renewable

Box 6.1 Natural capital and ecosystem services

Natural capital and ecosystem services embrace many components. Natural capital is the stock of natural resources from which goods can be extracted and the flows of ecosystem services maintained. The stocks and flows rely on ecosystem structures and functions such as landscapes, soil, and biodiversity.

There are three main types of natural capital which require different approaches to managing them:

- non-renewable and exhaustable resources — fossil fuels, metals, etc.;
- renewable but exhaustable resources — fish stocks, water, soil, etc.;
- renewable and non-exhaustable resources — wind, waves, etc.

Natural capital provides several functions and services — it provides the sources of energy, food and materials; the sinks for wastes and pollution; the services of climate and water regulation, pollination; and the space for living and leisure.

Using natural capital often involves trade-offs between these functions and services. For example, if it is too intensively used for emissions and waste it can lose its capacity to provide flows of goods and services: coastal waters that receive pollution and excess nutrients will not be able to support previous levels of fish stocks.

Source: EEA.

environmental resources, such as clean water and fish stocks, as well as non-renewable ones, such as fossil fuels and raw materials. This depletion of natural capital eventually affects human health and well-being, closing another environmental feedback loop.

The various links between environmental issues, coupled with global developments (Chapter 7), also point towards the existence of environmental systemic risks — that is the potential loss or damage to an entire system, rather than a single element. This dimension of emerging systemic risks can become particularly apparent when looking at how we choose to use the natural capital embodied in land, soil, water and biodiversity resources, and how we manage some of the trade-offs that are implicit in the choices we make (Chapters 1 and 8).

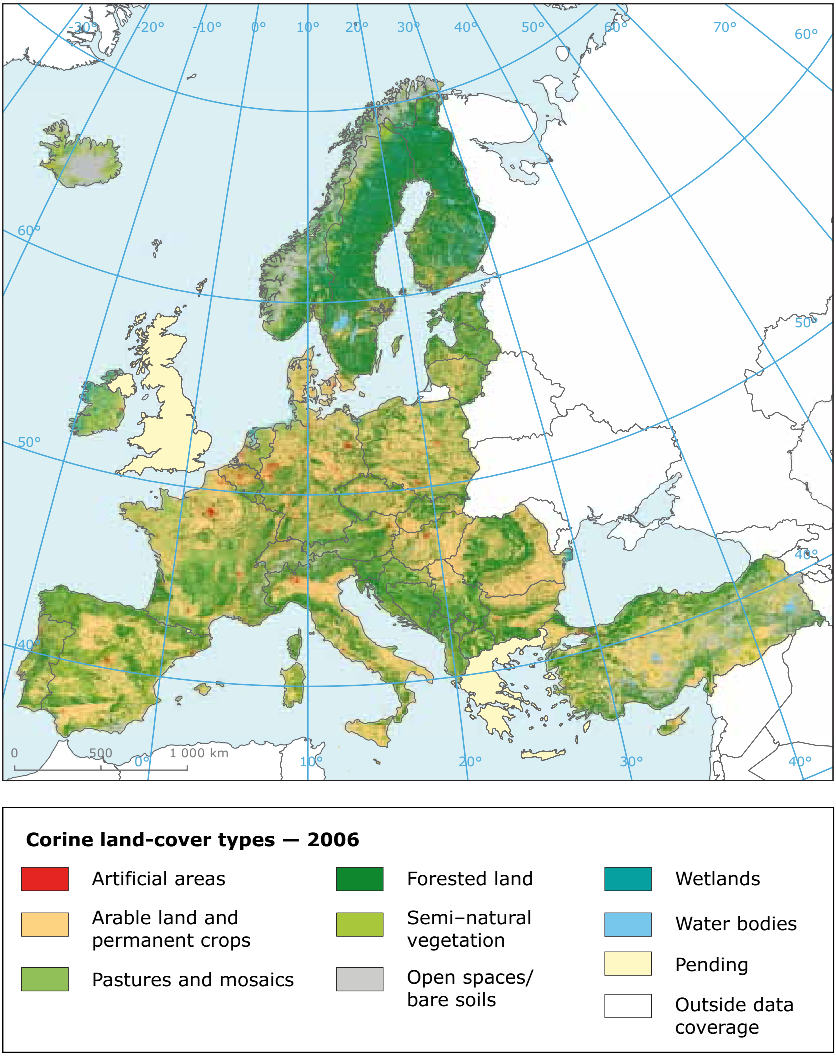
Land-use patterns reflect trade-offs in how we use natural capital and ecosystem services

The way land is used is one of the principal drivers of environmental change. Its influence on landscapes is a major factor in the distribution and functioning of ecosystems, and thus in the delivery of ecosystem services. There are important links between land use and land cover and the priority environmental challenges analysed here. As already discussed in Chapter 3, our demands for food, forest products and renewable energy all compete for land as a resource. The landscape to a large extent reflects the choices that we make in this regard.

The latest Corine land-cover inventory for 2006 ([A]) shows a continued expansion of artificial surfaces, such as urban sprawl and infrastructure development, at the expense of agricultural land, grasslands and wetlands across Europe. The loss of wetlands has slowed down somewhat, but Europe had already lost more than half of its wetlands before 1990. Extensive agricultural land is being converted to more intensive agriculture and in parts into forests.

Meeting our demands for land resources and ecosystem provisioning services is already a difficult 'spatial puzzle', but the real challenge lies in balancing them with the equally vital, yet less obvious, supporting, regulating and cultural services that ecosystems provide. Land-use changes in response to consumer demands and policy choices have

Map 6.1 European land cover in 2006, main land-cover categories of Europe



Note: Based on Corine land cover 2006; data coverage includes all 32 EEA member countries — with the exception of Greece and the United Kingdom — and 6 EEA cooperating countries.

Source: EEA, ETC Land Use and Spatial Information.

implications, for example, for soil carbon storage and greenhouse gas emissions. They also affect biodiversity conservation and water management — including effects of droughts and floods as well as water quality.

The case of bioenergy illustrates the issue of trade-offs. Modern approaches to gain energy from biomass, in particular linked to ambitious renewable energy policy targets, have gained significance over the past two decades and will continue to grow, driven mainly by energy security concerns and their greenhouse gas saving potential. Sugar cane and standard arable crops, such as maize or wheat, are currently the main inputs to biofuel production but the range of potential sources is wide including straw, energy grasses and willow plantations for cellulosic ethanol, wood waste and pellets for heat generation, and algae grown in tanks.

Individual energy crops have very different environmental profiles (1), while different bioenergy pathways — fuels, heating or electricity — show widely ranging efficiency ratios per volume of biomass used (2). Depending on the production pathway, the net benefits in terms of greenhouse emissions also vary greatly (3) (4) (5). Carbon emissions from the conversion of forests or grasslands to energy crops, or due to the replacement of food production areas, can lead to higher greenhouse emissions than using fossil fuels (when considering a period of 50 years or longer) (6) (7).

Where energy crops replace more extensive farming systems, negative impacts on biodiversity and landscape amenity value can be expected. Furthermore, energy crops are a potential competitor for water resources in water-poor regions of the world (8). Various recent studies have looked at the potential environmental gains and losses from a holistic perspective and recommend a cautious approach to the future development of bioenergy production (9) (10).

Soil is a vital resource degraded by many pressures

Soil underpins the delivery of a range of vital land-based ecosystem goods and services. This complex biogeochemical system is best known as a medium that supports agricultural production. However, soil also is a critical component of a diverse set of processes from

Box 6.2 Soil degradation across Europe

Soil degradation is a major environmental concern with many dimensions, including:

- *Soil erosion* is the wearing away of the land surface by water and wind. The main causes of soil erosion are inappropriate land management practices, deforestation, overgrazing, forest fires and construction activities. Erosion rates are very sensitive to both climate and land use, as well as to detailed conservation practice at the field level. Given the very slow rate of soil formation, any soil loss of more than 1 tonne per hectare per year can be considered as irreversible over a time span of 50–100 years. Water erosion affects 115 million hectares (ha) of soil or 12 % of Europe's total land area, and wind erosion 42 million ha. The Mediterranean region is the most affected.
- *Soil sealing* occurs when agricultural or other rural land is built on and all soil functions are lost. On average, built-up areas take up around 4 % of the total area of Member States, but not all of this is actually sealed. In the decade 1990–2000, the sealed area in the EU-15 increased by 6 %, and the demand for new construction sites for urban sprawl and for transport infrastructures is continuing to rise.
- *Salinisation of soils* results from human interventions such as inappropriate irrigation practices, use of salt-rich irrigation water and/or poor drainage conditions. Elevated salt levels in soil limit its agro-ecological potential and represent a considerable ecological and socio-economic threat to sustainable development. Salinisation affects around 3.8 million ha in Europe. The most affected areas are Campania in Italy and the Ebro Valley in Spain, but areas in Greece, Portugal, France and Slovakia are also affected.
- *Desertification* means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Droughts are also associated with or lead to an increased soil erosion risk. Desertification is a problem in parts of the Mediterranean and central and eastern Europe.
- *Soil contamination* is a wide-spread problem in Europe. The most frequent contaminants are heavy metals and mineral oil. The number of sites where potentially polluting activities have taken place now stands at approximately 3 million ([a]).

Source: Based on SOER 2010 *Thematic assessment — Soil*.

water management, terrestrial carbon fluxes, land-based natural greenhouse gas production and adsorption to nutrient cycles. Thus, we and our economy depend on a multitude of soil functions.

For example, soil resources play a major role as a terrestrial sink of carbon and can contribute to climate change mitigation and adaptation. However, around 45 % of the mineral soils in Europe have low or very low organic matter content (0 to 2 % organic carbon) and 45 % have a medium content (2 to 6 % organic carbon) and soil organic matter in Europe is currently diminishing. Several factors are responsible for the decline in soil organic matter and many of them relate to human activity. These factors include conversion of grassland, forests and natural vegetation to arable land; deep ploughing of arable soils; drainage, liming, nitrogen fertiliser use; tillage of peat soils; crop rotations with reduced proportion of grasses.

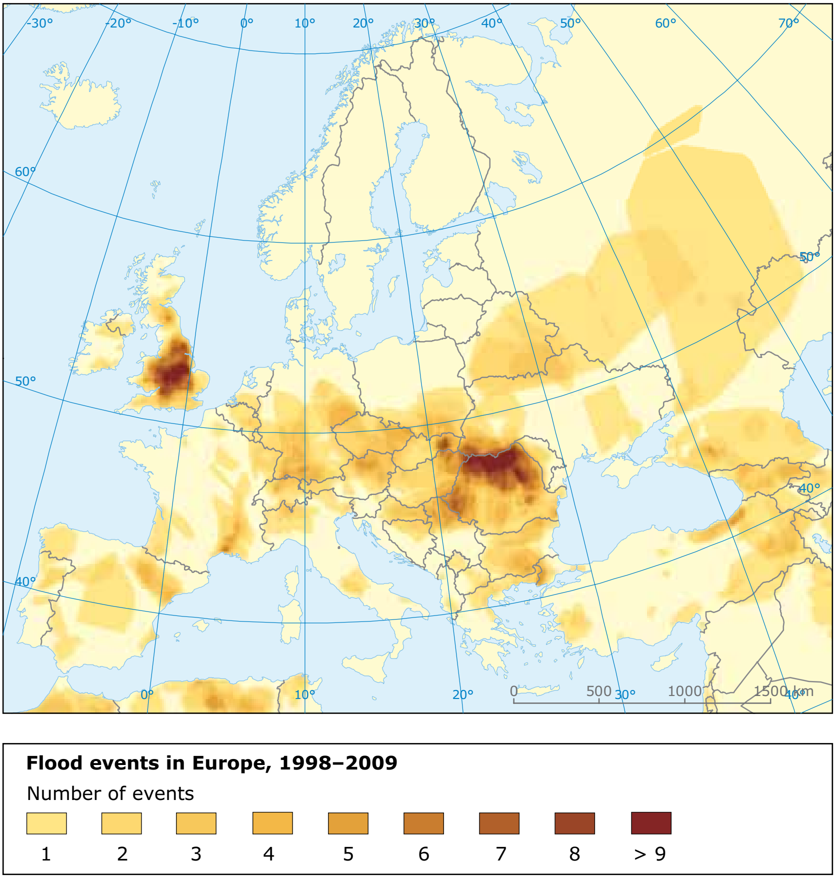
Sustainable water management requires striking a balance between different uses

Water is an ecological and economic resource, renewable but finite. It is vital to support healthy ecosystems (Chapter 3), while access to clean water is essential for human health (Chapter 5). Furthermore, water is a key natural resource linked with agricultural, forestry and industrial production, household consumption, and energy production (Chapter 4).

Environmental pressures on European water systems are closely related to land-use patterns and related human activities in the river basins. The main pressures are diffuse pollution, water abstraction, and hydro-morphological changes in connection with hydropower generation, drainage and canalisation. Soil issues highlighted in the previous section, notably erosion and loss of water retention capacity, are also relevant to how we manage water resources.

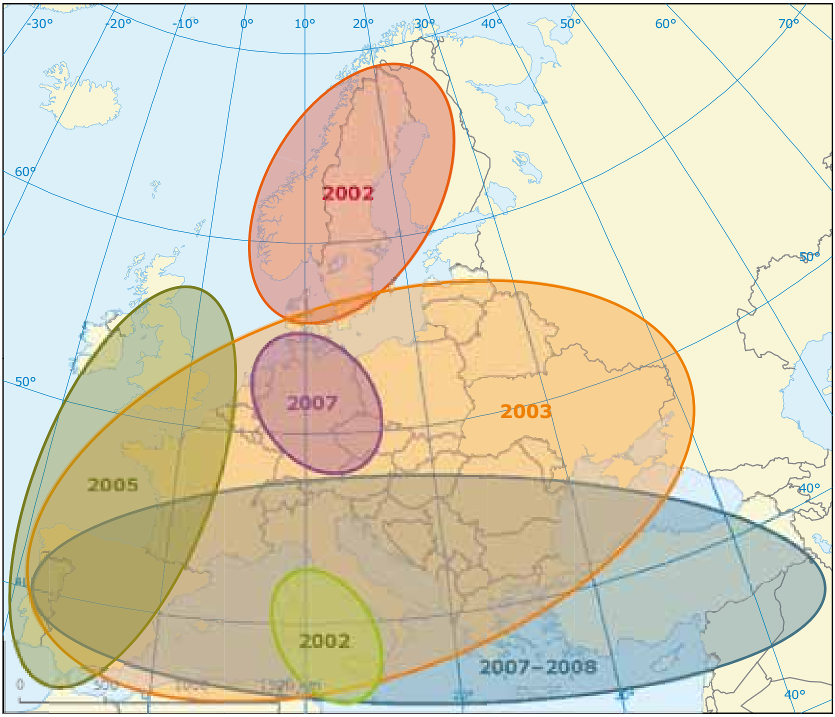
Large areas of Europe are affected by water scarcity and droughts, while other regions are increasingly exposed to serious floods. Over the past ten years, Europe has experienced more than 165 major floods, causing deaths, displacement of people and large economic losses. Future climate change is expected to make matters worse.

Map 6.2 Occurrence of floods in Europe, 1998–2009



Source: EEA.

Map 6.3 Main drought events in Europe, 2000–2009



Main drought events in Europe, 2000–2009

Source: EEA, ETC Land Use and Spatial Information.

The Water Framework Directive (WFD) (11) is the key policy approach aimed at tackling these challenges. It sets ecological limits to human water use and management. Furthermore, it obliges EU Member States and regional authorities to take coordinated measures regarding, for example, agriculture, energy, transport and housing, within the context of rural and urban spatial planning, while also taking biodiversity conservation concerns into account. As noted already (Chapters 3 and 4), a first look at river basin management plans, shows that strong efforts are needed in the coming years to achieve good ecological status by 2015.

For the WFD to be successful, integrated management of river basins is crucial, involving relevant stakeholders in identifying and implementing spatially-differentiated measures that often involve trade-offs between different interests. The management of flood risks, in particular the relocation of dykes and reestablishment of flood plains, requires integrated urban and land-use planning.

Box 6.3 Linked yet competing issues: water-energy-food-climate

Water makes vital contributions to economic activities including agriculture and energy production, and as a key transport route. As a connecting system it is also exposed to many different pressures and links the effects of some economic activities to others, for example agriculture via nutrient run-off to fishing. Climate affects both the supply and demand for energy and water, and energy conversion and water extraction processes have the potential to contribute to climate change.

At the EU and national levels, there are different sectoral and environmental policies and measures that may conflict with water management and the objective of achieving a good ecological status of water bodies. Examples are policies for bioenergy crops and hydro-energy, the promotion of irrigated agriculture, the development of tourism, and expanding inland waterway transport.

The Water Framework Directive provides options to develop integrated resource management at water basin level. This could help strike a balance between wider policy objectives — for examples related to energy and agricultural production, or reducing greenhouse gas emissions — as well as the benefits and impacts on the ecological status of water bodies, adjacent land ecosystems and wetlands.

Source: EEA.

Furthermore, the water-energy link illustrates that coordinated water management in the context of energy generation is needed — to make use of hydropower, cooling, and bioenergy crops without impairing water ecosystems. The sustainability of energy use for desalination and wastewater treatment also needs to be evaluated.

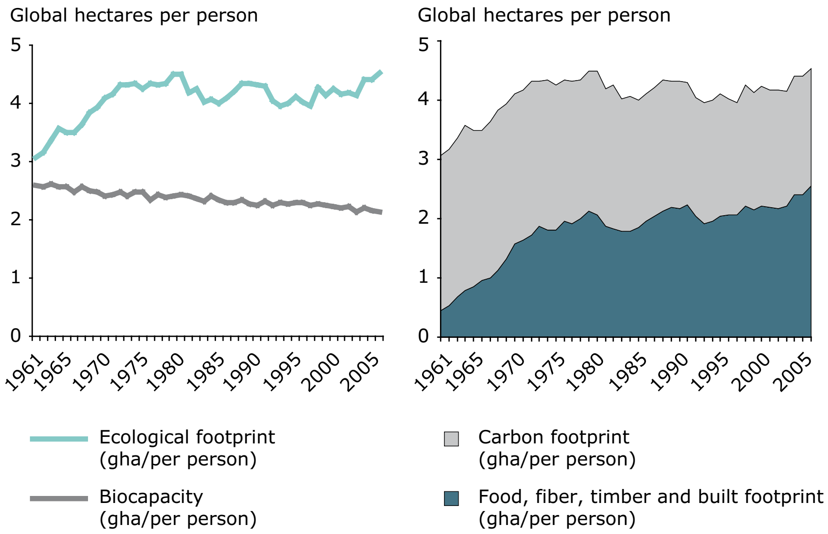
(Not) Keeping our environmental footprint within limits

Common to most of the examples given so far is the fact that environmental problems in Europe cannot be studied or solved in isolation: European and global natural resource use are connected. The key question is to what extent Europeans will be able to rely on natural resources from outside Europe in the light of increasing worldwide demand. Europe's consumption, however, already exceeds its own renewable natural resource production by approximately a factor of two ([12]).

There is little doubt that increasing global food demand, the result of population increases and development, is likely to necessitate further land conversion and increased efficiency of food production ([13]), at least at the global scale. Europe is an importer and exporter of agricultural products. The total volume and intensity of European agricultural production thus matters for the preservation of environmental resources and ecosystems in Europe and around the globe.

Market pressures, technological development and policy interventions have resulted in a long-term tendency to concentrate agricultural production on the more fertile farmland areas in Europe, while marginal or remote farmland is being given up. The associated intensification leads to increased environmental pressure on water and soil resources in intensive farmland areas. In addition, abandonment of extensive farmland leads to a loss of biodiversity in the areas affected. Meanwhile, more natural vegetation cover can provide other ecosystem services — such as the carbon storage provided by forests.

Figure 6.1 **Ecological footprint compared with biocapacity (left), and different components of the footprint (right) in EEA countries, 1961–2006**



Note: The ecological footprint is a measure of the area needed to support a population's lifestyle. This includes the consumption of food, fuel, wood, and fibres. Pollution, such as carbon dioxide emissions, is also counted as part of the footprint. Biocapacity measures how biologically productive land is. It is measured in 'global hectares': a hectare with the world average biocapacity. Biologically productive land includes cropland, pasture, forests and fisheries (b).

Source: Global Footprint Network (c).

Conversely — and in a global perspective — the conversion of forests and grasslands to agricultural land is one of the most important drivers for habitat loss and greenhouse gas emissions worldwide.

There are clear links between the use of farmland in Europe and global agricultural trends, and both relate to environmental trends. Trade-offs associated with intensifying farming and environmental protection in Europe, and their implications for ecosystems around the world need further evaluation. An important consideration in this regard is the preservation of critical natural capital — such as fertile soils, adequate and clean water resources, and natural ecosystems that serve as carbon sinks, harbour genetic diversity and support food provisioning.

How and where we use natural capital and ecosystem services matters

All of this brings us back to the 'spatial puzzle': natural capital, including land, water, soil and biodiversity resources, provides a foundation for ecosystem services and other forms of capital that human society relies on (human, social, manufactured and financial capital). This dependency lifts the debate to yet another level of complexity: the need to balance different uses of natural resources within environmental limits becomes a truly systemic challenge.

In order to maintain natural capital and ensure a sustainable flow of ecosystem services, further increases in the efficiency with which we use natural resources will be necessary — combined with changes in the underlying consumption and production patterns.

Furthermore, integrated management approaches for natural capital need to take into account territorial concerns. In this context, spatial planning and landscape management can help balance the environmental impacts of economic activities, especially those related to transport, energy, agriculture and manufacturing, across communities, regions and countries.

Dedicated management of natural capital and ecosystem services more than ever offers an integrating concept for dealing with a range of environmental priorities, and for linking to the many economic activities that bear upon them. Increasing resource efficiency and security, especially for energy, water, food, pharmaceuticals, key metals and materials, are essential elements in this regard (see Chapter 8).

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7 Environmental challenges in a global context

Environmental challenges in Europe and in the rest of the world are intertwined

There is a two-way relationship between Europe and the rest of the world. Europe is contributing to environmental pressures and accelerating feedbacks in other parts of the world through its dependence on fossil fuels, mining products and other imports. Conversely, in a highly interdependent world, changes in other parts of the world are increasingly felt closer to home, both directly through the impacts of global environmental changes, or indirectly through intensified socio-economic pressures ([1]) ([2]).

Climate change is an obvious example. Most of the growth in global greenhouse gas emissions is projected to occur outside Europe, as a result of increasing wealth in populous emerging economies. In spite of successful efforts to reduce emissions and a decreasing share in the global total, European societies continue to be major emitters of greenhouse gases (Chapter 2).

Many of the countries that are most vulnerable to climate change are outside the European continent, others are our direct neighbours ([3]). Often these countries are highly dependent on climate-sensitive sectors such as farming and fishing. Their adaptive capacity varies, but is often rather low, in particular due to persistent poverty ([4]) ([5]). The links between climate change, poverty and political and security risks and their relevance for Europe have been extensively analysed ([6]) ([7]) ([8]).

Biodiversity has continued to decline globally despite a few encouraging achievements and increased policy action ([9]) ([10]). The global rate of species extinction is escalating and is now estimated to be up to 1 000 times the natural rate ([11]). Evidence is growing that critical ecosystem services are under great pressure globally ([12]). According to one estimate, approximately one quarter of the potential net primary production has been converted by humans, either through direct cropping (53 %), land-use-induced productivity

Box 7.1 Global sea-level rise and ocean acidification

During the 20th century, global sea level rose by an average of 1.7 mm/year. This was due to an increase in the volume of ocean water as a consequence of temperature rise, although inflow of water from melting glaciers and ice sheets is playing an increasing role. In the past 15 years, sea-level rise has been accelerating and averaged about 3.1 mm/year, based on data from satellites and tide gauges, with a significantly increasing contribution from the ice sheets of Greenland and Antarctica. Sea level is projected to rise considerably during this century and beyond.

In 2007, the IPCC presented a projected rise of 0.18 to 0.59 m above the 1990 level by the end of the century ([a]). However, since 2007, reports comparing the IPCC projections with observations show that sea level is currently increasing at an even greater rate than indicated by these projections ([b]) ([c]). Recent estimates suggest, in case of unabated greenhouse gas emissions, a projected global average sea-level rise of about 1.0 m or possibly (although unlikely) even up to 2.0 m, by 2100 ([d]).

Ocean acidification is a direct consequence of CO_2 emissions to the atmosphere. The oceans have already taken up around a third of the CO_2 produced by humankind since the industrial revolution. While this has limited the amount of CO_2 in the atmosphere somewhat, it has come at the price of a significant change to ocean chemistry. Evidence indicates that ocean acidification is likely to become a serious threat to many organisms and will have implications for food webs and ecosystems, for example, tropical coral reefs.

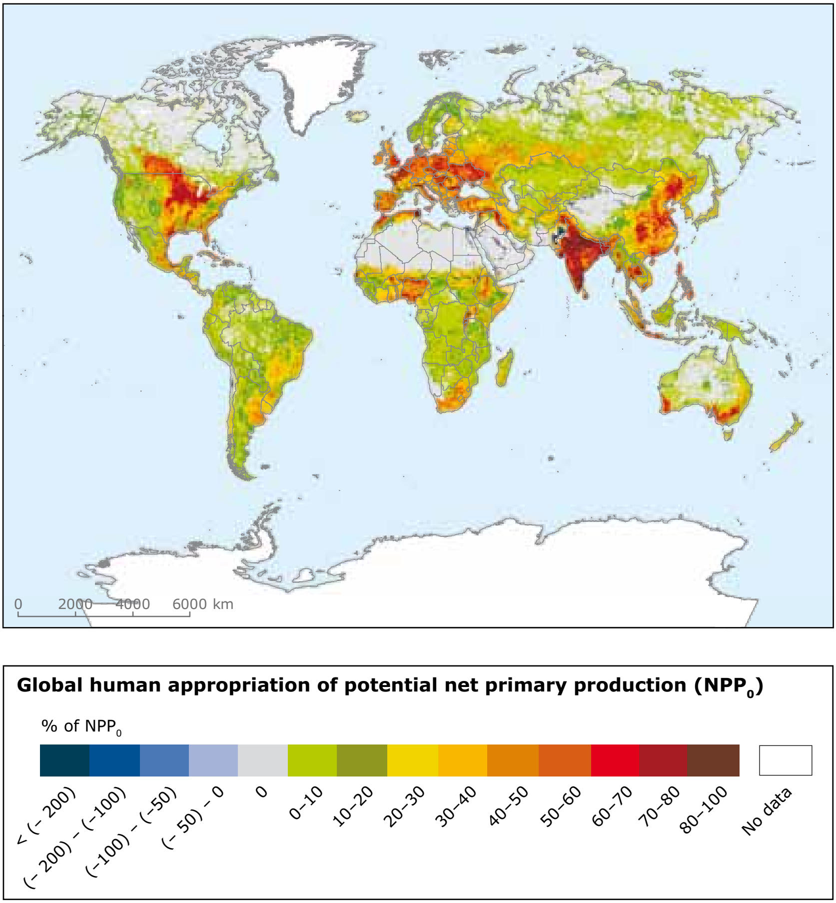
It is expected that, at atmospheric carbon dioxide concentrations above 450 ppm, large areas of the polar oceans will probably become corrosive to shells of key marine calcifiers, an effect that will be strongest in the Arctic. Already, loss of shell weight in planktonic Antarctic calcifiers has been observed. The rate of change in ocean chemistry is high, and faster than previous ocean acidification-driven extinctions in the Earth's history ([e]) ([f]).

Source: EEA.

changes (40 %) or human-induced fires (7 %) ([A]) ([13]). While such figures should be treated with caution, they do give an indication of the substantial impact of humans on natural ecosystems.

Loss of biodiversity in other regions of the world affects European interests in several ways. It is the world's poor that bear the brunt of biodiversity loss, as they are usually most directly reliant on functioning ecosystem services ([14]). Increases in poverty and inequality are likely to further fuel conflict and instability in regions that

Map 7.1 **Global human appropriation of net primary production**



Note: This map shows human-appropriated net primary production (HANPP) as a percentage of potential net primary production (NPP) (A).

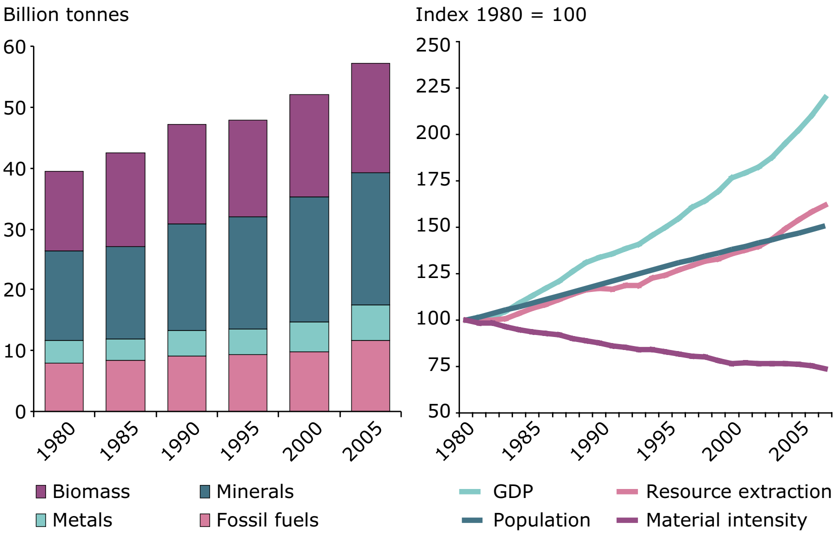
Source: Haberl et al. (9).

are already characterised by often fragile governance structures. Moreover, reduced genetic variety in crops and cultivars implies future losses of economic and social benefits for Europe in such critical areas as food production and modern healthcare (15).

Global extraction of **natural resources** from ecosystems and mines grew more or less steadily over the past 25 years, from 40 billion tonnes in 1980 to 58 billion tonnes in 2005. Resource extraction is unevenly distributed across the world, with Asia accounting for the largest share in 2005 (48 % of total tonnage, compared with Europe's 13 %). Over this period, a relative decoupling of global resource extraction and economic growth took place: resource extraction increased by roughly 50 % and world economic output (GDP) by about 110 % (16).

Nonetheless, resource use and extraction is still increasing in absolute terms, outweighing gains in resource efficiency. Such a composite

Figure 7.1 Global extraction of natural resources from ecosystems and mines, 1980 to 2005/2007



Source: SERI Global Material Flow Database, 2010 edition (h) (i).

indicator does not, however, reveal information on specific resource developments. Global food, energy and water systems appear to be more vulnerable and fragile than thought a few years ago, the factors responsible being increased demand, decreased supply, and supply instabilities. Over-exploitation, degradation and loss of soils are relevant concerns in this regard ([17]) ([18]) ([19]). With global competition and increased geographic and corporate concentration of supplies for some resources, Europe faces increasing supply risks ([20]).

In spite of general progress in the area of **environment and health** in Europe, the global human toll of environmental health impacts remains deeply worrying. Unsafe water, poor sanitation and hygiene conditions, urban outdoor air pollution, indoor smoke from solid fuels and lead exposure and global climate change account for nearly a tenth of deaths and disease burden globally, and around one quarter of deaths and disease burden in children under 5 years of age ([21]). It is again poor populations in low latitudes that are affected most heavily.

Table 7.1 **Death and DALYs (disability-adjusted life years) ([B]) attributable to five environmental risks, by region, 2004**

Risk	World	Low and middle income	High income
Percentage of deaths			
Indoor smoke from solid fuels	3.3	3.9	0.0
Unsafe water, sanitation, hygiene	3.2	3.8	0.1
Urban outdoor air pollution	2.0	1.9	2.5
Global climate change	0.2	0.3	0.0
Lead exposure	0.2	0.3	0.0
All five risks	***8.7***	***9.6***	***2.6***
Percentage of DALYs			
Indoor smoke from solid fuels	2.7	2.9	0.0
Unsafe water, sanitation, hygiene	4.2	4.6	0.3
Urban outdoor air pollution	0.6	0.6	0.8
Global climate change	0.4	0.4	0.0
Lead exposure	0.6	0.6	0.1
All five risks	***8.0***	***8.6***	***1.2***

Source: World Health Organization ([j]).

Many low- and middle-income countries now face a growing burden from new risks to health, while still fighting an unfinished battle with the traditional risks to health. The World Health Organization (WHO) forecasts that between 2006 and 2015, deaths from non-communicable diseases could increase worldwide by 17 %. The greatest increase is projected for the African region (24 %) followed by the eastern Mediterranean region (23 %) ([22]). Europe is likely to be faced with the increased problem of emerging or re-emerging infectious diseases that are critically influenced by changes in temperature or precipitation, habitat loss and ecological destruction ([23]) ([24]). In an increasingly urbanised world, which is tightly linked by long-distance transport, the incidence and distribution of infectious diseases affecting humans is likely to increase ([25]).

Links between environmental challenges are particularly apparent in Europe's direct neighbourhood

Europe's direct neighbourhood — the Arctic, the Mediterranean and the eastern neighbours — is worth particular attention here due to the strong socio-economic and environmental links and the importance of these regions in EU external policy. Furthermore, some of the world's largest reservoirs of natural resources are in these regions, which is of immediate relevance to a resource-scarce Europe.

These regions are also home to some of the world's richest and yet most fragile natural environments which are facing multiple threats. At the same time, concerns remain related to many transboundary issues like water management and air pollution deposition shared between Europe and its neighbours. Some of the main environmental challenges in these regions include:

- **The Arctic** — European activities, such as those resulting in long-range emission of air pollution, black carbon and greenhouse gas emissions, leave a considerable footprint in the Arctic. At the same time what happens in the Arctic also influences Europe's environment because the Arctic plays a key role, for example, in the context of climate change and related sea-level rise projections. Furthermore, multiple pressures on Arctic ecosystems have resulted in biodiversity loss across the region. Such changes have global repercussions because of the loss of key ecosystem functions and are creating additional challenges for the people living in the Arctic as changing seasonal patterns affect hunting and food provision ([26]).

- **Eastern neighbours** — EU neighbours to the east face many environmental challenges affecting human health and ecosystems. The EEA's fourth assessment report of Europe's environment ([27]) summarises key environmental issues across the pan-European region, including countries in Eastern Europe, the Caucasus and

Box 7.2 The European Neighbourhood Policy

The European Neighbourhood Policy (ENP) aims to strengthen cooperation between the EU and its neighbours. It is a dynamic and evolving platform for dialogue and action based on joint responsibility and ownership. In recent years, the ENP has been further strengthened through initiatives such as the Eastern Partnership, Black Sea Synergy and Union for the Mediterranean.

Within the ENP, relevant EU instruments — the EU maritime policy, the Water Framework Directive and the development of a Shared Environmental Information System (SEIS) — are gradually being implemented beyond EU borders to help streamline environmental efforts. International legal instruments have also been developed and gradually implemented to address common transboundary issues — such as the UN LRTAP Convention or transboundary water convention, covering also the eastern neighbours.

For the Mediterranean, the Horizon 2020 initiative ([k]) supports the riparian countries in addressing the priority issues of dealing with industrial emissions, municipal waste and wastewater treatment to reduce pollution of the Mediterranean.

Within the Arctic, a number of environmental treaties and conventions, as well as shipping and industrial regulations, provide a backdrop for policy deliberations in the context of the EU's Arctic policy: while the EU has taken the first steps towards an Arctic Policy, no comprehensive policy approach exists at present, several EU policies — such as the EU's agricultural policy, fisheries policy, maritime policy, environmental and climate policy or energy policy — affect the Arctic environment both directly and indirectly.

However, it is worth noting here that environmental trend analyses covering Europe's neighbouring regions often lack reliable data and indicators that are comparable over time and space. Better and more targeted information to underpin environmental analysis and assessment is needed.

The EEA — within the framework of the European Neighbourhood Policy, and in cooperation with the countries and main partners in the regions — is implementing a series of activities that aim to strengthen existing environmental monitoring, data and information management.

Source: EEA.

Central Asia. It focuses on the challenges posed by air and water pollution, climate change, biodiversity loss, pressures on the marine and coastal environment, consumption and production patterns, and assesses sectoral developments that drive environmental change across the region.

- **The Mediterranean** — Located at the crossroad of three continents this is one of the richest 'eco-regions' and yet one of the most vulnerable natural environments in the world. The recent report on the *State of the Environment and Development in the Mediterranean* ([28]) presents the major impacts of climate change, the characteristics of the natural resources and environment in the region, and the challenges linked to their conservation. In particular, some of the main pressures from human activities are identified (such as tourism, transport, and industry) and their impacts on coastal and marine ecosystems are assessed, together with considerations about their environmental sustainability.

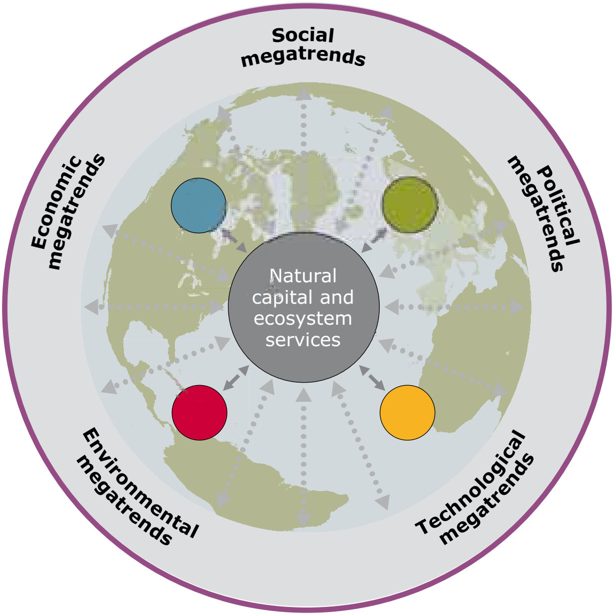
While Europe is contributing directly and indirectly to some of the environmental pressures in these regions, it is also in an unique position to cooperate to improve their environmental conditions, particularly through fostering technology transfer and helping to build institutional capacity. These dimensions are increasingly reflected in European neighbourhood policy priorities ([29]).

Environmental challenges are closely connected with global drivers of change

A range of unfolding trends are shaping the future European and global context, and many of these are outside the realm of Europe's direct influence. Related global megatrends cut across social, technological, economic, political and even environment dimensions. Key developments include changing demographic patterns or accelerating rates of urbanisation, ever faster technological changes, deepening market integration, evolving economic power shifts or the changing climate.

In 1960, the world's population was 3 billion. Today, it is about 6.8 billion. The United Nations Population Division expects this growth to continue and that the global population will exceed

Figure 7.2 **A selection of global drivers of change relevant for the European environment**



Environment policy priority areas

● Climate change
● Nature and biodiversity
● Natural resources and waste
● Environment, health and quality of life

A selection of global megatrends

- Increasing global divergence in population trends: populations ageing, growing and migrating
- Living in an urban world: spreading cities and spiralling consumption
- Changing patterns of global disease burdens and the risk of new pandemics
- Accelerating technologies: racing into the unknown
- Continued economic growth
- Global power shifts: from a uni-polar to a multi-polar world
- Intensified global competition for resources
- Decreasing stocks of natural resources
- Increasing severity of the consequences of climate change
- Increasingly unsustainable environmental pollution load
- Global regulation and governance: increasing fragmentation, but converging outcomes

Source: EEA.

Table 7.2 Population of the world and different regions, 1950, 1975, 2005 and 2050 according to different growth variants

Region	Population in millions			Population in 2050			
	1950	1975	2005	Low	Medium	High	Constant
World	2 529	4 061	6 512	7 959	9 150	10 461	11 030
More developed regions	812	1 047	1 217	1 126	1 275	1 439	1 256
Less developed regions	1 717	3 014	5 296	6 833	7 875	9 022	9 774
Africa	227	419	921	1 748	1 998	2 267	2 999
Asia	1 403	2 379	3 937	4 533	5 231	6 003	6 010
Europe *	547	676	729	609	691	782	657
Latin America and Caribbean	167	323	557	626	729	845	839
Northern America	172	242	335	397	448	505	468
Oceania	13	21	33	45	51	58	58
Europe (EEA-38)	419	521	597	554	628	709	616

Note: * Europe (in UN terminology) includes all EEA member countries (except Turkey) and EEA cooperating countries, as well as Belarus, Republic of Moldova, Russian Federation, Ukraine.

Source: United Nations Population Division (').

9 billion by 2050, according to the 'medium growth variant' of their population estimate (30). However, uncertainties are apparent, and forecasts depend on several assumptions, including for fertility rates. As such, by 2050, the world population could thus exceed 11 billion or be limited to 8 billion (30). The implications of this uncertainty for global resource demands are huge.

In contrast to the global trend, European populations are expected to decline and age significantly. In its neighbourhood, population decline is particularly dramatic in Russia and large parts of Europe. At the same time, northern African countries along the southern Mediterranean are witnessing strong population growth. In general, the wider region of Northern Africa and the Middle East has experienced the highest rate of population growth of any region in the world over the past century (30).

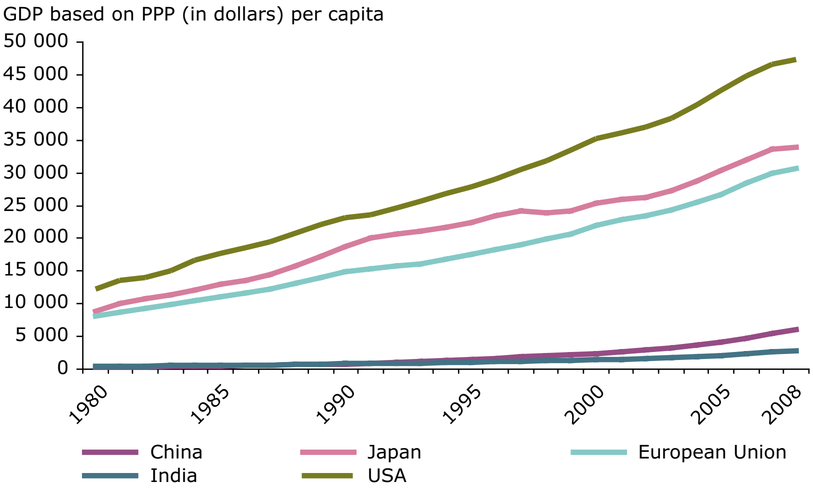
The regional distribution of population growth, the age structure, and migration between regions are also important. Ninety percent of the population growth since 1960 has been in countries classified as 'less developed' by the United Nations ([30]). Meanwhile, the world is urbanising at an unprecedented rate. By 2050, about 70 % of the global population is likely to live in cities, compared with less than 30 % in 1950. Population growth is now largely an urban phenomenon concentrated in the developing world, particular Asia, which is estimated to be home to more than 50 % of the global urban population by 2050 ([31]).

Global integration of markets, shifts in global competitiveness and changing global spending patterns comprise another complex set of drivers. As a result of liberalisation and due to the lowering of transport and communication costs, international trade over the past half-century has grown rapidly: global exports grew in value from USD 296 billion in 1950 to more than USD 8 trillion (measured in relation to 'purchasing power parity') in 2005, and their share of global GDP rose from around 5 % to close to 20 % ([32]) ([33]). Similarly, remittances sent home from emigrant workers often represent a large source of income for developing countries. For some countries remittances exceeded a quarter of the respective GDP in 2008 (for example, 50 % in Tajikistan, 31 % in Moldova, 28 % in the Krygyz Republic, and 25 % in Lebanon) ([34]).

Aided by globalisation, many countries have been able to lift larger proportions of their populations out of poverty ([35]). Global economic growth and trade integration have fuelled long-term shifts in international competitiveness, characterised by a high growth of productivity in emerging economies. The number of middle-income consumers world-wide is growing rapidly, particularly in Asia ([36]). The World Bank has estimated that, by 2030, there could be 1.2 billion middle-income consumers ([C]) in the emerging and developing economies of today ([37]). Already in 2010, the economies of the BRIC countries — Brazil, Russia, India and China — are expected to contribute almost half of global consumption growth ([38]).

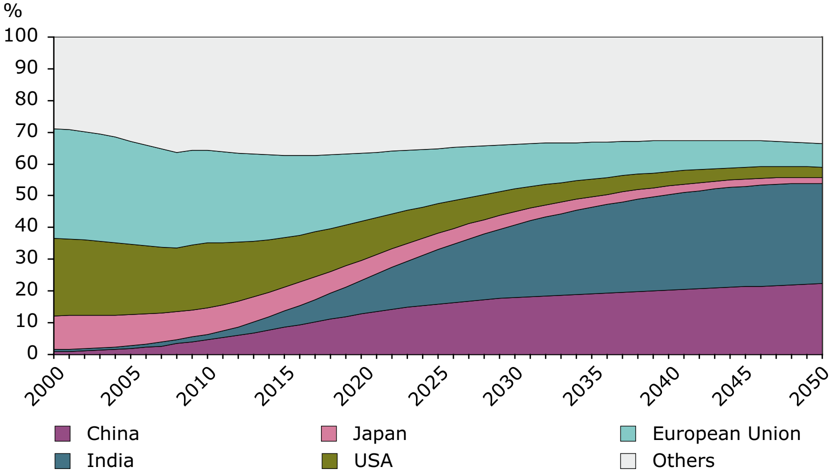
Large differences in individual wealth accumulation are expected to persist between developed economies and key emerging economies. Yet the world's economic balance of power is changing. Large shifts in purchasing power towards middle-income economies

Figure 7.3 Growth of GDP per capita in the EU-27, USA, China, India and Japan, 1980 to 2008



Source: International Monetary Fund (m).

Figure 7.4 Projected shares of global middle-income class consumption, 2000 to 2050



Source: Kharas (n).

and middle-income consumers are underway, creating significant consumer markets in emerging markets that are likely to fuel future global resource demands, again particularly in Asia (39) (40). According to one estimate, the BRIC countries together could match the G7 share of global GDP by the 2040s (41).

A number of critical uncertainties are, however, embedded in those projections. Examples include uncertainties about the degree to which Asia might integrate economically, the impact of population ageing and the capacity to strengthen private investment and education. In the context of greater interconnectedness of markets and a higher susceptibility to risks of market failures, global regulatory regimes are likely to expand in the future, yet their contours and thus their role are unpredictable.

Furthermore, the speed and scope of scientific and technological progress influences key socio-economic trends and drivers. Eco-innovation and eco-friendly technologies are of key relevance in this regard; European companies are already relatively well-positioned in global markets. Supporting policies are relevant both in terms of facilitating market entry of new eco-innovations and technologies as well as increasing global demand (Chapter 8).

In the longer-term perspective, developments and technology convergence in nanoscience and nanotechnologies, biotechnologies and life-sciences, information and communication technologies, cognitive sciences and neuro-technologies are expected to have profound effects on economies, societies and the environment. They are likely to open up completely new options for mitigating and remedying environmental problems including, for example, new pollution sensors, new types of batteries and other technologies for energy storage, and lighter and more durable materials for cars, buildings or aircrafts (42) (43) (44).

However, these technologies also give rise to concerns about detrimental effects on the environment, given the scale and level of complexity of their interactions. The existence of unknown, even unknowable, impacts poses a great challenge to risk governance (45) (46). Rebound effects might also jeopardize environmental and resource-efficiency achievements (47).

As a result of demographic and economic power shifts, the contours of the global governance landscape are changing. A diffusion of political power towards multiple poles of influence is on-going, and changing the geo-political landscape ([48]) ([49]). Private actors such as multi-national enterprises are playing an increasing role in world politics, and are becoming more directly involved in the formulation and implementation of policies. Fostered by advances in communications and information technology, civil society is also increasingly taking part in global negotiation processes of all kind. The interdependence and complexity of decision-making is growing as a result, giving rise to new modes of governance and posing new questions about responsibility, legitimacy and accountability ([50]).

Environmental challenges may increase risks to food, energy and water security on a global scale

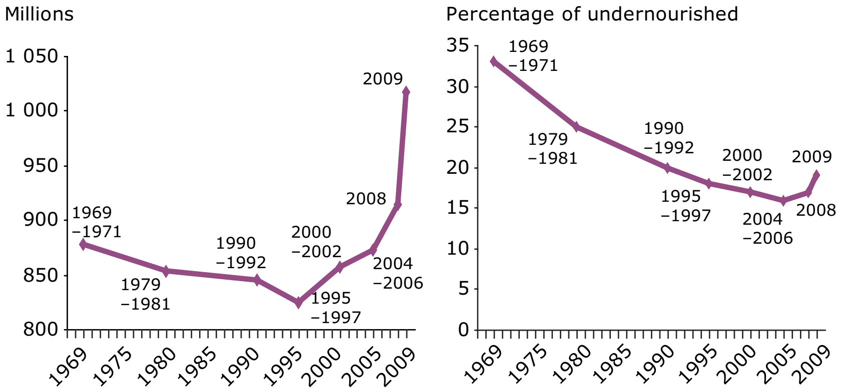
Global environmental challenges, such as impacts of climate change, loss of biodiversity, over-use of natural resources and environmental and health issues, are critically linked to issues of poverty and the sustainability of ecosystems, and consequently, issues of resource security and political stability. This adds pressure and uncertainty to the overall competition for natural resources, which might intensify as a consequence of increased demands, decreased supplies and decreased stability of supplies. Ultimately, this further increases pressure on ecosystems globally, and especially their capacity to ensure continued food, energy and water security.

According to the Food and Agriculture Organization of the United Nations (FAO), demand for food, feed and fibres could grow by 70 % by 2050 ([51]). The fragility of global food, water and energy systems has become apparent over recent years. For example, arable land per person declined globally from 0.43 ha in 1962 to 0.26 ha in 1998. The FAO expects this value to fall further by 1.5 % per year between now and 2030, if no major policy changes are initiated ([52]).

Similarly, the International Energy Agency (IEA) expects global demand for energy to rise by 40 % over the next 20 years if no major policy changes are implemented ([53]). The IEA has repeatedly warned about an impeding global energy crisis due to rising long-term demand. Massive and continuous investments are needed in energy efficiency, renewable energies and new infrastructures to achieve the transition to a low-carbon, resource efficient energy system that is compliant with long-term environmental objectives (53) (54).

But it could be water shortages that will hit hardest over the coming decades. One estimate suggests that in just 20 years, global demand for water could be 40 % higher than today, and more than 50 % higher in the most rapidly developing countries (55). Furthermore, according to a recent estimate prepared by the Secretariat of the Convention of Biological Diversity, the flow in more than 60 per cent of the large river systems in the world has been heavily altered. Limits of ecological sustainability of water availability for abstraction have thus been reached, and up to 50 % of the world could be living in areas with high water stress by 2030, while more than 60% could still lack improved access to sanitation (56).

Figure 7.5 **Number of undernourished in the world; percentage of undernourished in developing countries, 1969 to 2009**



Source: Food and Agriculture Organization of the United Nations (°).

Water infrastructure systems are often old and there is a lack of information about actual performance and losses (57). One estimate foresees an average annual investment need of USD 772 billion for maintaining water and wastewater services around the world by 2015 (58). Here, potential for ripple effects for food and energy supply exist, for example, cutting agricultural output which could result in decreasing overall social resilience.

Already today, in many parts of the world, non-renewable resource use is close to its limit and potentially renewable resources are being used beyond their reproductive capacity. This kind of dynamics can also be recognised in Europe's neighbouring regions with their comparatively rich natural capital. Water resource over-exploitation, combined with insufficient access to safe drinking water and sanitation, for example, are critical challenges both in Eastern Europe and the Mediterranean (35).

At the global level, poverty and social exclusion are further exacerbated by ecosystem degradation and changes in the climate. Globally, efforts to alleviate extreme poverty were reasonably effective until the 1990s (51). However, the recurring food and economic crises throughout 2006 to 2009 have magnified the trend of increasing under-nourishment rates around the world. The number of undernourished rose, for the first time, to more than 1 billion in 2009 and the proportion of undernourished in developing countries, which was declining quite rapidly, has risen in the past few years.

Resource over-exploitation and changes in the climate aggravate threats to natural capital. They also affect quality of life, potentially undermining social and political stability (2) (8). Furthermore, the livelihoods of billions of people are inevitably linked with the sustainability of local ecosystem services. Combined with demographic pressures, decreasing socio-ecological resilience can add a new dimension to the environment and security debate, as conflict around scarcer resources is likely to intensify and add to migration pressures (2) (59).

Box 7.3 Towards identifying environmental thresholds and planetary boundaries

Earth system scientists are trying to understand the complexity of the interactions in bio-geophysical processes that determine the Earth's capacity for self-regulation. In this regard ecologists have observed thresholds in a range of essential ecosystem processes, that when crossed cause the functioning of an ecosystem to fundamentally change.

More recently, a group of scientists have proposed a number of planetary boundaries within which humanity must stay to avoid catastrophic environmental change (p). They suggest that three critical boundaries have already been exceeded; the rate of biodiversity loss, climate change and human interference with the nitrogen cycle, but acknowledge that there are serious knowledge gaps and uncertainties.

The attempt to identify and quantify such planetary boundaries has started a broader debate about the feasibility of such an undertaking, and whether it is meaningful to calculate a global rate for processes some of which are inherently localised, for example nitrate levels and the loss of biodiversity (q). While the general value of such a scientific exercise can be acknowledged, concerns have been raised about the scientific justification, the possibility of choosing exact values that are non-arbitrary and the problems of reducing the complexity of interactions into single boundary values (r) (s).

Problems might arise with regard to balancing limits with ethical and economic issues and confusing values with targets. Some argue that the setting of quantitative boundaries might delay effective action and contribute to the degradation of the environment up to the point of no return (t) (u).

Source: EEA.

Global developments may increase Europe's vulnerabilities to systemic risks

Since many of the global drivers of change operate beyond Europe's direct influence, Europe's vulnerability to external change could increase markedly, particularly accentuated by developments in its direct neighbourhood. Being a resource-scarce continent and neighbour to some of the world's regions most prone to global environmental change, active engagement and cooperation with these regions can help address the range of problems that Europe is facing.

Many key drivers operate on a global scale and are likely to unfold over decades rather than years. In a recent assessment, the World Economic Forum warned about a higher level of *systemic risk* due to the increase in interconnections among various risks (60). Furthermore, the assessment emphasised that unexpected, sudden changes in external conditions are inevitable in a highly inter-linked world. While sudden changes can have huge impacts, the biggest risks may be from slow failures which unfold their full damage potential over decades and may be seriously underestimated in their potential economic impact and societal cost (60). The continued over-exploitation of natural capital is an example for a slow failure.

Such systemic risks — whether they manifest themselves as sudden changes or slow failures — include the potential damage to, or even full failure of, an entire system, for example a market or an ecosystem, as opposed to effects on individual elements only. The interconnectedness between drivers and risks highlighted here are relevant in this regard: while these links can lead to higher robustness when risk sharing is distributed across a greater number of elements in the system, they can also lead to greater fragility. Failure in one critical link can have cascading effects, often as a consequence of decreased system diversity and governance gaps (60) (61).

A key related risk is that of accelerating global environmental feedback mechanisms and their direct and indirect impacts on Europe. Since the *Millennium Ecosystem Assessment* (12) and the *IPCC Fourth Assessment Report* (62), scientific assessments have warned that environmental feedback mechanisms are increasing the likelihood of large scale non-linear changes in key Earth system components. With increasing global temperatures, for example, there is an increasing risk of passing tipping points that may trigger large-scale, non-linear changes (63).

Systemic risks have the potential, if they are not properly addressed, to inflict devastating damage on the vital systems, natural capital and infrastructures on which our well-being depends both at a local and at a global scale. Thus, joint efforts are required to tackle some of the causes of systemic risks, develop adaptive management practices and strengthen resilience in view of increasingly pressing environmental challenges.

Box 7.4 Tipping points: risks of large scale (non-linear) climate change

What are tipping points? If a system has more than one equilibrium state, transitions to structurally different states are possible. If and when a tipping point is passed, the development of the system is no longer determined by the time-scale of the pressure, but rather its internal dynamics, which can be much more rapid than the original pressure.

A variety of tipping points have been identified, some of which have potentially significant consequences for Europe — however, it is worth noting that these may unfold on very different, and sometimes very long, time-scales.

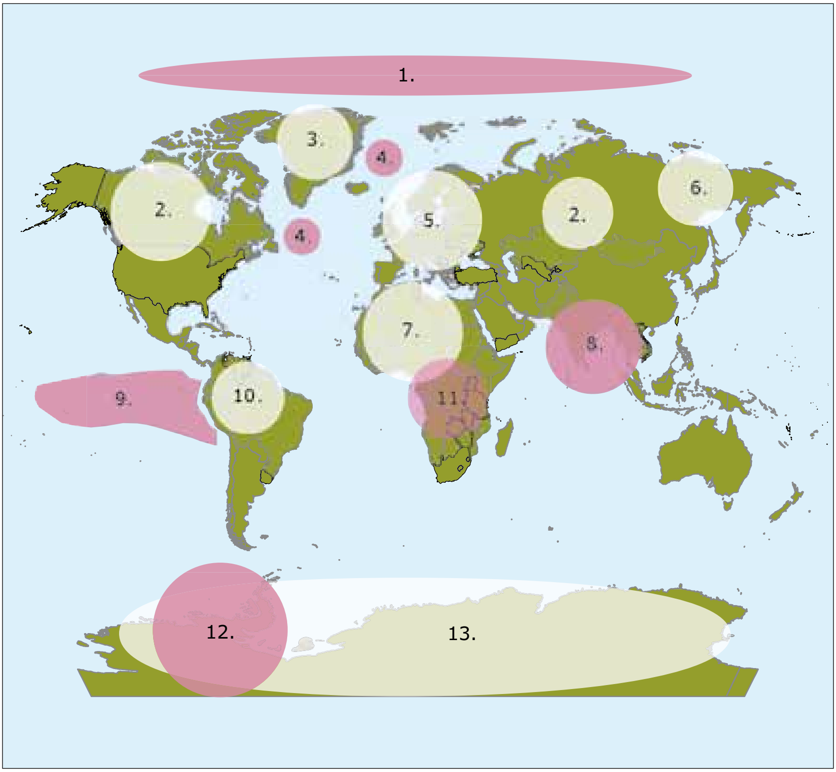
One of the potential large-scale changes likely to affect Europe is the deglaciation of the West Antarctic ice sheet (WAIS) and Greenland ice sheet (GIS) — there is already evidence of accelerated melting of the GIS. Sustained 1–2 °C, respectively 3–5 °C, global warming above 1990 temperatures could be tipping points beyond which at least partial deglaciation of respectively GIS and WAIS and a significant rise in sea level will follow (v) (w).

There is less confidence about other non-linear effects, for example, what may happen with ocean circulation. Parts of the Atlantic meridianal overturning circulation exhibits considerable seasonal and decadal variability, but data do not support a coherent trend in the overturning circulation. A slow-down of the meridianal overturning circulation may temporarily counteract global warming trends in Europe, but may have unexpected and serious consequences elsewhere.

Other examples of possible tipping points are the accelerated emission of methane (CH_4) from permafrost melting, destabilisation of hydrates on the ocean floor, and rapid climate-driven transitions from one ecosystem type to another. The understanding of these processes is as yet limited and the chance of major implications in the current century is generally considered to be low.

Source: EEA.

Map 7.2 Potential climatic tipping elements

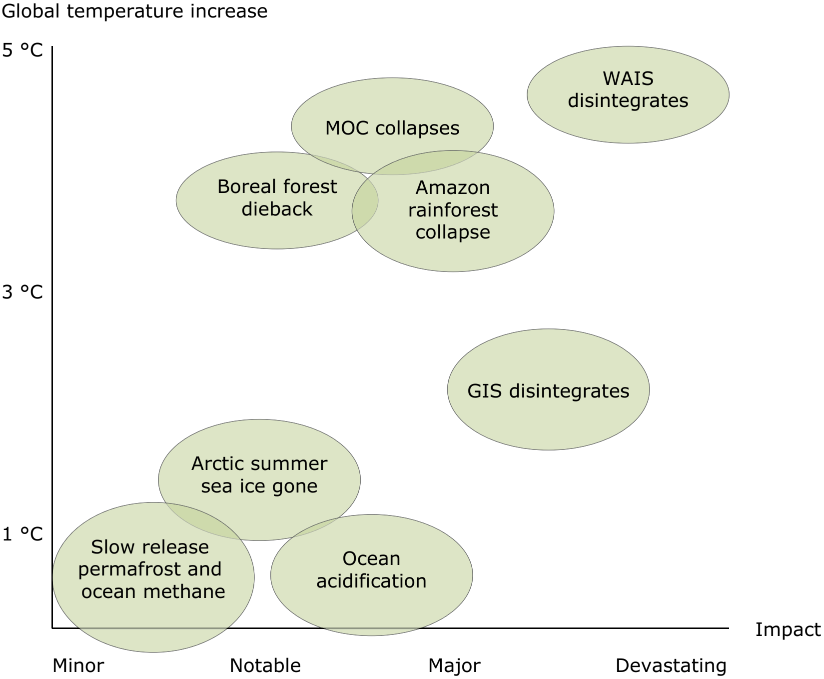


Potential climatic tipping elements
1. Arctic sea-ice loss
2. Boreal forest dieback
3. Melt of Greenland ice sheet
4. Atlantic deep water formation
5. Climatic change-induced ozone-hole(?)
6. Permafrost and tundra loss(?)
7. Sahara greening
8. Indian Monsoon chaotic multi-stability
9. Changes in ENSO amplitude or frequency
10. Dieback of Amazon rain forest
11. West African Monsoon shift
12. Instability of West Antarctic ice sheet
13. Changes in Antarctic bottom water formation(?)

Note: Question marks (?) indicate systems whose status as tipping elements is particularly uncertain. There are other potential tipping elements not depicted here; for example, shallow-water coral reefs threatened in part by ocean acidification.

Source: Schellnhuber (^{x}).

Figure 7.6 **Estimated global warming at which the onset of the events could occur versus their impact**



GIS: Greenland ice sheet

WAIS: West Antartic ice sheet

MOC: North Atlantic Meridional overturning circulation

Note: The shapes and sizes of the ovals do *not* represent uncertainties in the impact and temperature onset of eventualities. These uncertainties may be significant.

Source: PBL ([y]); Lenton ([z]).

8 Future environmental priorities: some reflections

Unprecedented change, interconnected risks and increased vulnerabilities pose new challenges

The previous chapters highlight the fact that the world is experiencing environmental change and hence new challenges on a scale, speed and interconnectedness that are unprecedented.

Decades of intensive use of stocks of natural capital and ecosystem degradation by developed countries to fuel economic development have resulted in global warming, loss of biodiversity and various negative impacts on our health. Even though many of the immediate impacts lie outside Europe's direct influence, they have significant consequences and will create potential risks for the resilience and sustainable development of the European economy and society.

Emerging and developing economies have in recent years replicated this trend but at a much faster speed driven by increasing populations, growing numbers of middle class consumers, and rapidly changing consumption patterns towards levels in developed countries; unprecedented financial flows chasing scarcer energy and raw materials; unparalleled shifts in economic power, growth, and trade patterns from advanced to emerging and developing economies; and, delocalisation of production driven by price competition.

Climate change is one of the most obvious effects of these past developments: breaching the 2 °C target is probably the most tangible example of the risk of going beyond planetary boundaries. The long-term ambition of achieving 80 to 95 % reductions in CO_2 emissions by 2050 in Europe to stay in line with the above target, strongly argues for a fundamental transformation of Europe's current economy, with low-carbon energy and transport systems as central planks of the new economy — but not the only ones.

As in the past, future climate change impacts are expected to affect disproportionately the most vulnerable in society: children, the elderly, and the poor. On the positive side, greater access to green spaces, biodiversity, clean water and air benefit people's health. However, this too raises the question about the sharing of access and benefits, since often spatial planning and investment decisions favour the rich at the expense of the poor.

Well-maintained ecosystems and ecosystem services are essential to support climate change mitigation and adaptation objectives, and preserving biodiversity is a prerequisite for ensuring this. Balancing the role that ecosystems can play as a buffer against expected impacts with possible increased demands for new settlements on water and land, brings new challenges, for example, to spatial planners, architects and conservationists.

The ongoing race for substitution from carbon-intensive to low-carbon energy and materials is expected to further intensify demands on the terrestrial, aquatic and marine ecosystems and services (first and second generation biofuels provide an example here). As these demands increase, for example for chemical substitutes, there are likely to be increasing conflicts with existing uses for food, transport and leisure.

Many of the environmental challenges assessed in this report have been highlighted in previous EEA reports ([1]) ([2]). What is different today is the speed at which interconnectedness spreads risks and increases uncertainties across the world. Sudden breakdowns in one area or geographical region can transmit large-scale failures through a whole network of economies, via contagion, feedbacks and other amplifications. The recent global financial crash or the Icelandic volcano episodes have demonstrated this ([3]) ([4]).

Crises such as these have also shown how difficult it is for society to deal with risks. Well signposted and numerous early warnings are often widely ignored ([5]) ([6]). At the same time, recent times offer many experiences, both good and bad, from which we can learn and so respond more quickly and more systematically to the challenges we face (for example, through multiple crisis management, climate negotiations, eco-innovations, information technologies, or global knowledge developments).

Against this back-drop, this final chapter reflects on some emerging future environmental priorities:

- **Better implementation and further strengthening of current environmental priorities** in climate change; nature and biodiversity; natural resource use and waste; environment, health and quality of life. Whilst these remain important priorities, managing the links between them will be paramount. Improving monitoring and enforcement of sectoral and environmental policies will ensure that environmental outcomes are achieved, give regulatory stability and support more effective governance.

- **Dedicated management of natural capital and ecosystem services.** Increasing resource efficiency and resilience emerge as key integrating concepts for dealing with environmental priorities, and for the many sectoral interests that depend on them.

- **Coherent integration of environmental considerations across the many sectoral policy domains** can help increase the efficiency with which natural resources are used and thus help greening the economy by reducing common pressures on the environment that originate from multiple sources and economic activities. Coherence will also lead to broad measures of progress rather than just against individual targets.

- **Transformation to a green economy** that addresses the long-term viability of natural capital within Europe and reduced dependency on it outside Europe.

The ongoing study on The Economics of Ecosystems and Biodiversity (TEEB) aligns with these ideas from the perspective of biodiversity and the ways in which investment in natural capital can be encouraged ([7]). Recommendations to policymakers include broad actions such as investing in green infrastructure to increase resilience, introducing payments for ecosystem services, removing harmful subsidies, establishing new regimes for natural capital accounting and cost-benefit analysis, and initiating specific actions to address the degradation of forests, coral reefs and fisheries as well as the links between ecosystem degradation and poverty.

Natural capital and ecosystem services provide an integral starting point for managing many of these interconnected issues, the systemic risks inherent in them, and the transformation to a new, greener, more resource efficient economy. There is no single 'quick fix' for the challenges that Europe faces. Rather, as this report shows, there is a clear case for long-term, interconnected approaches to deal with them.

What this report also provides is evidence that existing European environmental policies present a robust basis on which to build new approaches that balance economic, social and environmental considerations. Future actions can draw on a set of key principles that have been established at European level: the integration of environmental considerations into other measures; precaution and prevention; rectification of damage at source; and the polluter-pays principle.

Implementing and strengthening environmental protection provides multiple benefits

Full implementation of environmental policies in Europe remains paramount, as key targets are still to be met (Chapter 1). However, it is clear that targets in one area can inadvertently, through unintended consequences, disrupt or counteract a target in another. Synergies and co-benefits thus need to be sought throughout the process of developing impact assessments of policies in different domains, by using approaches that fully account for natural capital.

Past decades' environmental policy efforts have provided a wide array of social and economic benefits through regulations, standards and taxation. These in turn have driven infrastructure and technological investments to mitigate against environment and human health risks, for example, by setting air and water pollution limits, creating product standards, and by building wastewater treatment plants, waste management infrastructures, drinking water systems, clean energy and transport systems.

Such policies have permitted the economy to grow well beyond what might otherwise have been feasible. For example, without tightening air pollution standards and sewage treatment improvements, the transport, manufacturing and construction sectors of the economy could not have grown as fast as they have without severe health effects.

As such, health, quality of life and environmental services have improved for most people in Europe, awareness and concerns are higher than ever, environmental actions and investments unprecedented. Other key benefits to date include: pro-growth investment strategies creating new markets and sustaining employment; level playing field for companies in internal market; driving innovation and rolling out of technological improvements; and consumer benefits.

Employment is a major benefit with an estimated quarter of total European jobs linked either directly or indirectly to the natural environment ([8]). Europe can make further progress here through eco-innovation in products and services, building on patents and other knowledge that has been acquired by governments, businesses and universities through 40 years of experience.

By contrast, however, government spending on environment and energy research and development typically remains at less than 4 % of total government spending on research and development. This has declined dramatically since the 1980s. At the same time research and development expenditure in the EU at 1.9 % of GDP ([9]) lags way behind the Lisbon strategy target of 3 % by 2010 and behind major competitors in green technologies such as the USA and Japan and, recently, China and India.

Still, in many areas (such as air pollution reduction, water and waste management, eco-efficient technologies, resource-efficient architecture, eco-tourism, green infrastructure and green financial instruments) Europe already has first-mover advantages. These could be exploited further within a regulatory framework that fosters further eco-innovation and sets standards based on efficient use of the natural capital. Past decades' efforts have borne fruit: the European Union, for example, has more patents related to air pollution, water pollution and waste than any other economic competitor ([10]).

There are also ancillary benefits from combined implementation of environmental legislation. For example, combining climate change mitigation and air pollution abatement legislation could deliver benefits in the order of EUR 10 billion per year through reductions in damage to public health and ecosystems ([A]) ([11]). Environmental producer responsibility legislation (such as REACH ([12]), WEEE Directive ([13]), RoHs Directive ([14])) has contributed to push multi-national companies, for example, to design production processes at global level that meet EU standards and so deliver benefits for consumers across the world. In addition, EU legislation is often replicated in China, India, California and elsewhere, highlighting further the multiple benefits of well-designed policies in the globalised economy.

European countries have also invested substantially in monitoring and regular reporting of environmental pollutants and wastes. They are beginning to use the best available information and communication technologies and sources to develop information flows from in-situ instruments to Earth observation with specialised sensors. The development of near-real time data and regularly updated indicators help to improve governance by providing stronger evidence for early interventions and preventative actions, supporting greater levels of enforcement and enhancing overall performance reviews.

There is now no shortage of environmental and geographical data in Europe to support environmental objectives, and many opportunities exist to exploit these data through analytical methods and information technologies. However, restrictions on access, charging fees or intellectual property rights have meant that these data are not always easily accessible to policymakers and others working in the field of environment.

There are a number of information policies and processes in place or being negotiated in Europe to support swifter responses to emerging challenges. Rethinking their uses and links between them could radically improve the efficacy of existing and proposed information gathering and harvesting activities in support of policies.

Key elements in this mixture include research from the European Research Framework Programmes, the new European space and Earth observation policy (including the Global Monitoring for Environment and Security initiative and Galileo), Europe's new legislation on spatial data infrastructure INSPIRE, and an extension of e-government in the form of the Shared Environment Information System (SEIS).

The opportunity also exists now to implement these information systems fully and in doing so support the EU 2020 strategy (15) objectives in this area, using the latest information technologies, such as smart grids, cloud computing and mobile geographical information systems (GIS) based technologies.

Past experience shows that it often takes 20 to 30 years from framing an environmental problem to a first full understanding of impacts (for example, through reporting by countries on conservation status or environmental impacts). Such extended time-lags cannot prevail given the speed and scale of challenges. Interconnected policies that take the long-term view, are monitored based on risk and uncertainty, and have built-in interim steps for review and evaluation, can help to manage the trade-offs between the need for long-term coherent action and the time it takes to put such measures in place.

There are also numerous examples, based on credible early warnings from science, where early actions to reduce harmful impacts would have been extremely beneficial (16). They include climate change, chlorofluorocarbons, acid rain, unleaded petrol, mercury and fish stocks. These show that the time-lags from the first scientifically based early warnings to the point of policy action that effectively reduced damage, was often 30 to 100 years during which time exposure, and future harm, increased considerably. For example, over a decade of extra skin cancers could have been avoided if action had been taken on the first early warning in the 1970s, rather than on the discovery of the ozone hole itself in 1985 (16). Experience in the climate change field with addressing long-term impacts (17) (18) may be helpful in other fields that face similar timescales and scientific uncertainties.

Dedicated management of natural capital and ecosystem services increases social and economic resilience

The desire to make economic and social progress that does not come at the expense of the natural environment is not new. Many European industries have decoupled emissions of key pollutants and the use of certain materials from economic growth. What is new is that management of natural capital requires decoupling of economic growth not only from resource use but also from environmental impacts within Europe and globally.

Natural capital embraces many components. It is the stock of natural resources from which ecosystems goods and services can be derived. Such capital provides the sources of energy, food and materials; the sinks for wastes and pollution; the services of climate, water and soil regulation; and the environment for living and leisure — in essence, the core fabric of our societies. Using it often involves trade-offs between different services and striking a balance between maintaining and using stocks.

Getting this balance right depends on appreciating the many linkages between natural capital and the other four types of capital that hold together our societies and economies (i.e. human, social, manufactured and financial capital). The common features between such capitals, for example over-consumption and under-investment, indicate the potential of much more coherent action across policy domains (such as spatial planning, integration between economic sectors and environment considerations), deeper longer term approaches to knowledge that recognise many of these risks may emerge over many decades (such as scenario planning), and smart decisions on near-term actions that anticipate long-term needs and avoid technological lock-in (such as infrastructure investments) (19).

There are three main types of natural capital (Chapter 6) which require different policy measures to manage them. In some cases, natural capital that is depleted can be substituted by other types of capital, such as non-renewable energy resources that are used to develop and invest in renewable energy sources. However, more often, it cannot. Much natural capital, for example biodiversity, cannot be replaced at all and needs to be preserved for current and future generations to ensure the continued availability of basic ecosystem services. Similarly, non-renewable resources need to be managed carefully so as to prolong their economic life while investing in possible substitutes.

What the explicit management of natural capital and ecosystem services offers, is a compelling and integrating concept for dealing with environmental pressures from multiple sectoral activities. Spatial planning, resource accounting and coherence amongst sectoral policies, implemented on different geographical scales, can help manage the trade-offs between preserving natural capital and using it to fuel the economy. Such an integrated approach would provide a framework for measuring progress more broadly. One advantage would be the ability to analyse the effectiveness of policy actions across a range of sectoral objectives and targets.

At the heart of managing natural capital therefore are the twin challenges of maintaining the structure and functions of ecosystems that underpin natural capital and enhancing resource efficiency by finding ways of using fewer resource inputs and having less environmental impacts.

In this context, increasing resource efficiency and security through an extended life cycle approach for energy, water, food, pharmaceuticals, minerals, metals and materials can help reduce Europe's dependence on resources globally and promote innovation. Prices that take full account of the consequences of using resources will also be an important instrument for spurring business and consumer behaviour towards higher resource efficiencies and innovation.

This is especially important for Europe given the growing competition for resources from Asia and Latin America and the growing pressures on the EU-27's current status as the world's largest economic and trading block. Japan, for example, has long been recognised as the front-runner on resource efficiency, but other countries — such as China — are setting ambitious targets in this respect, recognising the twin benefits of cost reductions and future market opportunities.

Since the industrial revolution there has been a shift away from using renewable resources to non-renewables to fuel our economy. Towards the end of the 20th century, non-renewables accounted for some 70 % of total material flows in industrialised countries compared to about 50 % in 1900 ([20]).

Europe relies heavily on the rest of the world for non-renewables, and increasingly some of these non-renewables — such as fossil fuels or rare earth metals used in information technology products — are becoming difficult to source cheaply, if at all, often for geo-political as much as supply reasons. Such trends make Europe vulnerable to external supply shocks that may result from an over-reliance on non-renewables. Addressing this bias could be a key element in meeting the resource efficiency objective under the EU 2020 strategy ([15]).

A broader argument for shifting towards long-term development based on natural capital management is that today's poor governance of natural resources is forwarding risks to future generations. Environmental impacts, as reflected by climate change, biodiversity loss and ecosystem degradation, have steadily built up as a result of decades of over-consumption and under-investment in maintenance and substitution of resources.

These impacts, often concentrated in developing countries, will be difficult to mitigate and adapt to. Moreover, property rights for natural capital are often undefined, especially in developing countries, and the relative invisibility of natural capital degradation leads *inter alia* to passing on of accumulated 'debts' to future generations.

Ecosystem-based approaches offer coherent ways of managing the existing and expected demands for non-renewable and renewable resources in Europe and avoiding further over-exploitation of natural capital. Particularly land and water resources offer viable entry points for strengthening integrated ecosystem-based approaches to resource management. The Water Framework Directive, for example, has the aim of protecting ecosystems — aquatic and terrestrial — at its core. Approaches that recognise the multi-functional benefits of ecosystems are central to proposals for post-2010 biodiversity policies and gaining traction in the marine, maritime, agriculture and forestry sectors.

Box 8.1 Accounting for natural capital can help illustrate trade-offs between uses

The following examples provide a flavour of the challenges related to accounting for natural capital:

- *Soil:* Europe's soils are an enormous carbon reservoir, containing around 70 billion tonnes, and poor management can have serious consequences: a failure to protect Europe's remaining peat bogs, for example, would release the same amount of carbon as an additional 40 million cars on Europe's roads. Other less intensive agriculture regimes, based on diverse genes and culture can be more productive ([a]), while respecting the soil carrying capacity. Under these regimes, nature protection is no longer a burden imposed on farmers but an important contributor to soil maintenance and food quality, and therefore to agriculture, the food industry, retailers and consumers. Accounting for the benefits of nature protection for all economic actors is missing in current accounting regimes ([b]).
- *Wetlands:* There has been an estimated loss of 50 % of wetlands globally since 1900, mainly due to intensive farming, urbanisation and infrastructure development. In this way natural capital has been traded for physical and manufactured capital, but accounting systems to check whether the value of the new services balance the value of the depleted services is missing. Economic impacts range across scales from those on local economies (for example, fisheries), European (when all year round strawberry south-north supplies compete with wetlands for water) and global health (increased risks of bird flu pandemic owing to degradation of wetlands habitats along migratory pathways). Such impacts are not recorded in accounts.
- *Fish:* Fish are only accounted for in terms of primary production at 1 % of total GDP in EU, with a declining trend. Broader measures of the uses of fish across the economic chain — food processing, retailers, logistics, and consumers — put the true benefits to society at many times the conventional GDP proportion. Depletion of fish stocks is often due to excess harvesting in relation to the regeneration capacity, and the stock recovery is limited by pressures (climate change, emissions) that take advantage of the marine ecosystem as a sink. Accounting for the benefits of marine ecosystems and services for all economic actors is missing in conventional accounts.
- *Oil:* Oil is the source for almost all organic chemicals contained in day-to-day products and services. It is also the primary source of environmental impacts on ecosystems and people — pollution, contamination, climate warming. The recent oil spill in the Gulf of Mexico has strongly highlighted issues of ecosystem vulnerability, economic welfare, liability and compensation. Rules for calculating the true costs in such instances are not part of existing accounting regimes. Also, in line with oil becoming scarcer, and concerns about security increase, the chemicals industry is increasingly sourcing its needs from biomass. This is creating conflicts over land use, increasing pressure on agricultural ecosystems, and calling for accounting regimes to support discussions on the trade-offs inherent in resolving such conflicts.

Source: EEA.

As integrated management of natural resources becomes more prominent, competing demand for resources increasingly requires trade-offs. This creates a need for accounting techniques — including, in particular, comprehensive accounting of land and water resources — that make transparent the full costs and benefits of ecosystem use and maintenance.

The information tools and accounting approaches to support integrated natural capital and ecosystem services management, including their relationship to sectoral activities, are not yet part of the standard administrative and statistical systems. Much can still be gained from asking new questions of existing accounts, for example, on the true benefits to society of nature derived from agriculture, fishing and forestry which currently account for 3 % of EU GDP (as far as priced) but produce benefits many times that across the economy.

In addition, the identification of critical thresholds in resource use and the development of ecosystem accounts, ecosystem service indicators and ecosystem assessments are ongoing in Europe and globally. Examples of such initiatives are The Economics of Ecosystems and Biodiversity (TEEB), the revision of Integrated Environmental and Economic Accounting (SEEA) by the United Nations (21) (22), the European Strategy for Environmental Accounting (23), and ecosystem accounting work at EEA.

More integrated actions across policy domains can help in greening the economy

Environmental policies have primarily influenced production processes and protected human health. They therefore only partly address today's systemic risks. This is because many of the causes of environmental problems, such as over-use of the land and oceans, are overwhelming the progress being made (Chapter 1). Such causes often originate from multiple sources and economic activities that compete for short-term benefits from resource exploitation. Reducing them will require cooperation across several domains to deliver coherent, cost-effective outcomes that address the trade-offs inherent in maintaining capitals in line with society's values and long-term interests, and contribute to greening the economy.

The need to integrate environmental concerns into sectoral activities and other policy domains has long been acknowledged — as attempted, for example, in the EU Cardiff integration process since 1998 ([24]). As a result, many EU-level policies explicitly take into account environmental considerations to some degree; for example the Common Transport Policy and the Common Agricultural Policy for which sectoral reporting initiatives like Transport Environment Reporting Mechnanism (TERM), Energy and Environment Reporting Mechanism and Indicator Reporting on the integration of ENvironmental concerns into Agricultural policy (IRENA) are well established. In future they would benefit further from integrated analysis of environmental, economic and social impacts, trade-offs, costs and policy effectiveness through broader use of established environmental accounting techniques.

Furthermore, there are many links between environmental issues as well as links between environmental and socio-economic activities (see especially Chapter 6) that go beyond single cause-effect relationships. Often several activities combine to enhance environmental problems: this is well recognised, for example, in the context of greenhouse gas emissions, which stem from a wide range of sectoral activities, not all of them accounted for in monitoring and trading systems.

In other cases, multiple sources and economic activities interact to either enhance or counteract each others environmental impacts. Taken together, they result in clusters of environmental pressures. Addressing such clusters can offer opportunities for more cost-efficient responses. The co-benefits between climate mitigation and air quality improvements provide an example (Chapter 2). In other cases, such clusters carry the threat that environmental action in one sector counteracts efforts done in another. An example for this is the setting of ambitious biofuels targets, which may help climate mitigation, but increases pressures on biodiversity (Chapter 6).

Either way, where environmental pressures correspond to multiple sources and economic activities, there is a need to ensure coherence in the way we tackle them as far as feasible. Clustering of sectoral policies dependent on the same resources also has the potential for improved coherence in tackling common environmental challenges to maximise benefits and avoid unintended consequences. Examples of achieving such coherence include:

- **Resource efficiency, public goods and ecosystem management.** Building on established and emerging practice around ecosystem management in environment and sectoral policies to ensure the long-term viability and efficient use of renewable resources by the main sectors (i.e. agriculture, forestry, transport, industry, fisheries, maritime).

- **Agriculture, forestry, maritime, green infrastructure and territorial cohesion.** Developing green infrastructure and ecological networks on land and at sea to secure the long-term resilience of Europe's terrestrial and marine ecosystems, the goods and services provided by them and their distributional benefits.

- **Sustainable production, intellectual property rights, trade and aid.** Implementing existing product standards and patents for innovation that accelerate substitution out of scarce and insecure non-renewable resources, reduce Europe's trade footprint, promote recycling potential, improve Europe's competitiveness and contribute to welfare improvements worldwide.

- **Sustainable consumption, food, housing and mobility.** Bringing together the three areas of consumption that together contribute more than two-thirds of major worldwide life-cycle environmental pressures from consumption in Europe.

More coherent polices across multiple sources of environmental pressures are already emerging in recognition of inter-linkages and aimed at developing cost-efficient solutions. For example, the links between climate mitigation, reduced reliance on fossil fuels, substitution by renewables, energy efficiency and multi-sectoral energy needs underpin the design of the EU Climate and Energy package. This marks a key difference compared to the situation 15 to 20 years ago and provides precedent for more effective collaboration between sectoral and environmental interests.

Stimulating fundamental transition towards a greener economy in Europe

Greening the European economy, as discussed already, can help further reduce environmental pressures and impacts. However, more fundamental conditions and actions that enable the transition to a truely 'green economy', centred on natural capital and ecosystem services, will be needed to stay within planetary limits.

The need for a green economy also becomes stronger in this time of financial and economic crisis. Intuitively, a slumping economy might be considered positive for the environment: income drops or grows only slowly, accessing credit that allows overspending is more difficult and hence we produce and consume less, with a reduced burden on the environment. However, stagnant economies are often not able to make the necessary investments to secure a responsible environmental management, and see less innovation and less attention to environmental policy. Instead, when the economy returns to its previous growth path (as it usually does), it also tends to return to its previous pattern of eroding natural capital.

Thus, a green economy will require dedicated policy approaches embedded in a coherent, integrated strategy covering demand and supply aspects, both economy-wide and at the sectoral level (25). In this context, the key environmental principles of precaution, prevention, rectification of damage at source, and polluter pays, combined with a strong evidence base, remain most relevant and need to be more broadly and consistently applied.

The **precautionary and prevention principles** were inserted in the EU Treaty in order to help cope with the dynamics of complex natural systems. Their broader application during the transition to a green economy will steer innovations that break away from the often monopolistic and conventional technologies that have been shown to cause long-term harm to people and ecosystems (26).

The **rectification of damage at source** can be maximised through deeper integration across sectors and further advance the multiple gains from investments in green technologies. For example, investment in energy efficiency and renewable energies delivers benefits to the environment, employment, energy security, energy costs, and can help combat fuel poverty.

The **polluter pays principle** can stimulate a greening of the economy through taxes that allow market prices to reflect full costs of production, consumption and wastes. This can be achieved via greater use of fiscal reform which in addition to removing harmful subsidies, replaces distortionary taxes on economic 'goods' such as labour and capital, with more efficient taxes on economic 'bads', such as pollution and inefficient resource use (27).

In a broader perspective, 'prices' as a facilitator of trade-offs can help improve further progress in sectoral integration and resource efficiency but more fundamentally shift behaviours across governments, businesses and citizens in Europe and globally. However, for this to happen — as known for decades, but rarely applied — prices need to reflect the true economic, environmental and social value of resources, relative to available substitutes.

Evidence of the benefits of fiscal reform has grown in recent years. Such benefits include environmental improvements, employment gains, a stimulus to eco-innovation and more efficient tax systems. Studies show the benefits from modest environmental tax reform in several European countries that have been implemented over the last 20 years. Similarly, they convincingly demonstrate the advantages of additional reforms designed to achieve the EU climate and resource efficiency goals (28) (29) (30) (31) (32) (33).

The revenues from environmental taxes vary significantly across EU Member States, from more than 5 % of GDP in Denmark to less than 2 % in Spain, Lithuania, Romania, and Latvia in 2008 (34). Despite the large benefits of such taxes, and consistent policy support over the last 20 years from OECD and the EU, environmental tax revenues as a proportion of overall tax revenues in the EU are at their lowest level in more than a decade, even if the number of environmental taxes is increasing.

There is substantial potential for fiscal reform in support of the triple objectives of greening the economy, supporting deficit reduction policies in many EU Member States and responding to ageing populations. These range from removing harmful subsidies and exemptions on fossil fuels, fisheries and agriculture, to establishing taxes and extending permits on the consumption of the critical natural capital that underpins a green economy (such as carbon, water and land).

A further component of a green economy transition is to move to accounting fully for natural capital — and to thus go beyond GDP as a measure of economic growth. Doing so will enable societies to record the full price of our way of life, reveal concealed debts being forwarded to future generations, make explicit ancillary benefits, highlight new ways for economic development and jobs in a green economy based on green infrastructure, and reframe the base for fiscal revenues and their use.

In practical terms, looking 'Beyond GDP' means creating measures that convey not just what we have produced in the last year but also the state of the natural capital that determines what we can produce sustainably now and in the future. Specifically, these measures would comprise two additional items, beyond the depreciation of our man-made, physical capital: the depletion of our non-renewable natural resources and how much income they generate; and the degradation of our ecosystem capital and how we should reinvest to maintain the current capacity of using ecosystem services.

A genuine measurement of natural capital depreciation should take account of the many functions of natural ecosystems to ensure that management of one function does not result in the degradation of other functions. In the case of ecosystems, the management objective is not to maintain a flow of income but to maintain the ecosystem capacity of delivering the full bundle of services. Therefore a key element of any valuation of ecosystem degradation needs to be an appraisal of required restoration costs. This can be done, for example through estimates of the reduction of yields, replantation, pollution abatement, and green infrastructures restoration. The methodology for this approach is already being tested for Europe.

Accounting fully for natural capital will also require new classifications, ideally linked to existing ones as described in the statistical frameworks and system of national accounts (SNA). Important examples are emerging, for example in the area of ecosystem services ([35]) or carbon accounting and carbon crediting.

In addition, a new information environment will have to address the widespread lack of accountability and transparency, and the loss of trust amongst citizens in governments, science and business. The challenge now is to improve the knowledge base in order to support more accountable and participatory decision making. Providing access to information is essential for effective governance; but engaging people in collecting data and sharing their lay knowledge is arguably just as important ([36]) ([37]) ([38]).

A further reflection concerns equipping Europeans with the skills to make the transformation to a green economy. Education, research and industrial policy have roles to play here by providing the next generation of materials, technologies, processes and indicators (for example related to systemic risks and vulnerabilities) that help reduce Europe's dependencies, increase resource efficiencies and enhance economic competitiveness in line with the EU 2020 strategy ([15]).

Other factors include incentives for businesses using new financial mechanisms, retraining existing workers to contribute to green industries, and deploying unskilled workers displaced by delocalised production. A good example is the European recycling industry which holds a 50 % global market and has been increasing employment by some 10 % annually, mostly for unskilled workers ([39]).

More generally, many multi-national businesses are also responding to the natural capital challenge, recognising that the future economy must have the means to manage, value and trade such capital ([40]). There is scope to foster further the role of small and medium enterprises in natural capital management.

In addition, new forms of governance will also be needed to better reflect this shared dependence on natural capital. Over recent decades the role played by civil society institutions — such as banks, insurance companies, multi-national companies, non-governmental organisations, and global institutions such as the World Trade Organisation — has increased compared to the power of territorially bounded nation states. Balancing interests will be essential to manage shared interests and dependencies around natural capital. On the eve of the 20-year anniversary of the UN Commission for Sustainable Development in 2012, the slogan *think global, act local* seems more appropriate than ever.

The responses to recent systemic shocks highlights society's predilection for short-term crisis management over long-term decision-making and actions while at the same time showing the benefits of coherent, albeit short-term, global responses in dealing with such risks. The experience should not be a surprise given the strong bias towards governance that deals with short-term considerations aligned to the policy cycle (4 to 7 years) at the expense of long-term challenges, although there are examples in several EU Member States of structures being established to consider long-term challenges ([41]).

The transformation towards a greener European economy will help secure the long-term sustainability of Europe and its neighbourhood, but it will also require shifts in attitudes. Examples include encouraging wider participation by Europeans in the management of natural capital and ecosystem services, creation of new and innovative solutions to use resources efficiently, introduction of fiscal reforms, and involvement of citizens through education and different forms of social media in tackling global issues such as meeting the 2 °C climate target. The seeds for future actions exist: the task ahead is to help them take root and flourish.

List of abbreviations

6th EAP	EU Sixth Environment Action Programme
BRIC	Country grouping including Brazil, Russia, India and China
BaP	Benzo(a)pyrene
CAFE	EU Clean Air For Europe programme
CAP	EU Common Agricultural Policy
CBD	Convention on Biological Diversity
CFC	Chlorofluorocarbons
CFP	EU Common Fisheries Policy
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CSI	EEA Core Set of Indicators
DALY	Disability-adjusted life years
dB	Decibel
DMC	Domestic material consumption
DWD	EU Drinking Water Directive
EBD	Environmental Burden of Disease
EC	European Communities
EEA	European Environment Agency
EFTA	European Free Trade Association
EMC	Environmentally-weighted material consumption
ENER	EEA energy indicators
EPR	EU Environment Policy Review
EQS	EU Environmental Quality Standards Directive
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
GHG	Greenhouse gas
GIS	Geographic information systems
GIS	Greenland ice sheet
GMES	Global Monitoring for Environment and Security
HANPP	Human appropriation of net primary production

HLY	Healthy life years
HNV	High Nature Value farmland
IPCC	Intergovernmental Panel on Climate Change
IRENA	Indicator Reporting on the integration of ENvironment concerns into Agricultural policy
LE	Life expectancy
LEAC	Land and ecosystem accounts
MA	Millennium Ecosystem Assessment
NAMEA	National accounts matrix extended by environmental accounts
NH_3	Ammonia
NH_X	Ammonium and ammonia
NMVOC	Non-methane volatile organic compounds
NO_X	Nitrogen oxides
O_3	Ozone
ODS	Ozone depleting substances
OECD	Organisation for Economic Cooperation and Development
PCB	Polychlorinated biphenyls
PM	Particulate matter — $PM_{2.5}$ and PM_{10} denote different size of PM
REACH	EU Registration, Evaluation, Authorisation and Restriction of Chemicals Directive
SEBI	Streamlining European Biodiversity Indicators
SEIS	Shared Environmental Information System
SO_2	Sulphur dioxide
SoE	State of the environment
SOER	'State and outlook of the European environment' report
TEEB	The Economics of Ecosystems and Biodiversity
TERM	Transport Environment Reporting Mechanism
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
USD	US Dollars
UWWTD	EU Urban Waste Water Treatment Directive
WAIS	West Antarctic ice sheet
WEEE	Waste electrical and electronic equipment
WEF	World Economic Forum
WEI	Water exploitation index
WFD	EU Water Framework Directive
WHO	World Health Organization

Endnotes

Chapter 1

(A) Under the SOER 2010 umbrella, a number of assessments have been developed — all of which are available on a dedicated web-portal at www.eea.europa.eu/soer:

- a synthesis report (this report) that presents an integrated assessment based on the evidence from the range of assessments developed in the SOER 2010 context and other EEA activities;
- a set of thematic assessments that describe the state of and trends in key environmental issues, review related socio-economic driving forces, and contribute to an evaluation of policy objectives;
- a set of country assessments of the environmental situation in individual European countries;
- an exploratory assessment of global megatrends relevant for the European environment.

(B) Overview of the most recent national 'state of the environment' reporting across Europe:

Austria	2010	Umweltsituation in Österreich
Belgium	2009 2008 2008	Brussels: Synthèse de l'état de l'environnement 2007–2008 Flanders: MIRA-T 2008 — Flanders Environment Report Wallonia: Environmental Outlook for Wallonia
Bulgaria	2007	Annual State of the Environment Report
Cyprus	2007	State of the Environment Report 2007
Czech Republic	2008	Report on the Environment in the Czech Republic
Denmark	2009	Natur og Miljø 2009
Estonia	2010 2010	Estonian Environmental Review 2009 Estonian Environmental Indicators 2009
Finland	2008	Finland State of the Environment
France	2010	L'environnement en France
Germany	2009 2008	Daten zur Umwelt (Environmental Data for Germany) Daten zur Natur
Greece	2008	Greece — The State of the Environment — A Concise Report

Hungary	2010	State of environment in Hungary 2010
Iceland	2009	Umhverfiog auðlindir
Ireland	2008	Ireland's environment 2008
Italy	2009	Environmental Data Yearbook — Key Topics
Latvia	2008	Nacionālais ziņojums par vides stāvokli 2008
Liechtenstein	–	n.a.
Lithuania	2009	Lithuania 2008 State of environment. Only facts
Luxembourg	2003	L'Environnement en Chiffres 2002–2003
Malta	2008	The Environment Report 2008
Netherlands	2009	Milieubalans
Norway	2009	Miljoestatus 2009
Poland	2010	Raport o stanie środowiska w Polsce 2008 — raport wskaźnikowy
Portugal	2008	Relatório do Estado do Ambiente
Romania	2009	Raport anul privind Starea Mediului în România pe anul 2008
Slovakia	2009	State of the Environment Report of the Slovak Republic 2008
Slovenia	2010	Poročilo o okolju v Sloveniji 2009
Spain	2010	Perfil Ambiental de España 2009 — Informe basado en indicadores
	2009	El medio ambiente y el medio rural y marino en España 2008
Sweden	2009	Sweden's Environmental Objectives
Switzerland	2009	Environment Switzerland
Turkey	2007	Turkey State of the Environment Report
United Kingdom	2007	England: Several, separate SOE reports for different regions in England
	2008	Northern Ireland: State of the Environment Report for Northern Ireland
	2006	Scotland: State of Scotland's Environment
	2003	Wales: A Living and Working Environment for Wales
Albania	2008	Raport per Gjendjen e Mjedisit — State of Environment Report
Bosnia and Herzegovina	2010	State of Environment in the Federation of Bosnia and Herzegovina 2010
Croatia	2007	Izvješće o stanju okoliša u Republici Hrvatskoj
Former Yugoslav Republic of Macedonia	2000	Sostojba na zivotnata sredina 2000
	2008	Environmental Indicators — Republic of Macedonia 2008
Montenegro	2008	State of Environment in Montenegro
Serbia	2008	Report on the State of Environment in the Republic of Serbia for '08

(C) The assessment is based largely on the EEA's indicator sets (CSI — Core Set of Indicators, SEBI — Streamlining European Biodiversity Indicators, ENER — Energy Indicators) plus the EU Annual Environment Policy Review (EPR):

Greenhouse gas emissions	EPR, CSI 10
Energy efficiency	ENER 22, ENER 23, ENER 24, ENER 25
Renewable energy sources	ENER 28
Global mean temperature change	EPR, CSI 12
Pressure on ecosystems	EPR, CSI 05
Conservation status	EPR, SEBI 03, SEBI 05, SEBI 08
Biodiversity	SEBI 01 (birds and butterflies) EPR (fisheries) SEBI 12, SEBI 21
Soil degradation	IRENA (soil erosion)
Decoupling	SD indicator (Eurostat)
Waste generation	EPR, SOER 2010 including CSI 16
Waste management	EPR, SOER 2010 including CSI 17
Water stress	EPR, CSI 18
Water quality	CSI 19, CSI 20
Water pollution	CSI 22, CSI 24
Transboundary air pollution	EPR, CSI 01, CSI 02, CSI 03, CSI 05
Air quality in urban areas	EPR, CSI 04

(D) The ambition is to limit global mean temperature increase to below 2 °C above pre-industrial levels. This depends critically also on greenhouse gas emissions originating outside Europe.

(E) The EU-27 in 2008 was more than halfway towards its unilateral target to reduce greenhouse gas emissions by 20 % in 2020 compared to 1990. The provisions of the EU Emission Trading Scheme and the effort-sharing decision ensures that the 2020 target will be met, although the built-in flexibility makes it difficult to foresee the exact mix of policies and measures that industry, individual countries and the EU will use to reduce emissions.

(F) Includes both terrestrial and marine areas.

(G) Soil degradation in Europe is accelerating, with negative effects on human health, natural ecosystems and climate change, as well as on our economy. Soil erosion by wind and water, which is largely the result of unsuitable land management, is of particular concern in large parts of southern Europe and increasing. (See SOER 2010 *Thematic assessment — Soil* for further details.)

[H] The most recent 'Annual Environment Policy Review' assesses the EU's generation and management of municipal waste to be of 'average performance or trend not clear, overall problem remains despite some mixed progress'. However, as the assessment presented here concentrates on the generation of waste only, it corresponds with the negative trend described in the Annual Environment Policy Review.

[I] The targets set out in the Water Framework Directive have to be reached by 2015; first assessments by member states show that a large percentage of water bodies will not reach good ecological and chemical status.

[J] The 6th Environment Action Programme (6th EAP) is a decision of the European Parliament and the Council adopted on 22 July 2002. It sets out the framework for environmental policymaking in the EU for the period 2002 to 2012 and outlines actions that need to be taken to achieve them. It identifies four priority areas: climate change; nature and biodiversity; environment and health; and natural resources and waste. Furthermore, the 6th EAP promotes the full integration of environmental protection into all Community policies and actions and provides the environmental component of the Community's strategy for sustainable development.

Chapter 2

[A] These include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) as well as various chlorofluorocarbons (CFCs). Note that much of the discussion in this section focuses on the role of carbon in general, and CO_2 in particular.

[B] The IAC (Inter Academy Council) has, in early 2010, started an independent review of the IPCC processes to further strengthen the quality of IPCC reports. Meanwhile, the conclusions from the IPCC 2007 report remain valid. (IAC, 2010. *Inter Academy Council Asked to Review Intergovernmental Panel on Climate Change*, press release, 10 March 2010).

[C] The growth in global GHG emissions increased steeply from 2000 to 2004 compared to the 1990s, but slowed down considerably after 2004. This is partly due to mitigation measures. The economic downturn is estimated to cause a decrease in global CO_2 emissions of 3 % in 2009, compared to 2008. (PBL, 2009. *News in Climate Science and Exploring Boundaries, Netherlands Environmental Assessment Agency (PBL)*, PBL publication number 500114013, Bilthoven, the Netherlands).

[D] Changes in greenhouse gas emission presented here exclude net greenhouse gas emissions from land use, land-use change and forestry (LULUCF), as well as emissions from international aviation and international maritime navigation.

[E] 'Flexible mechanisms' is a term used to summarise means of meeting national GHG emission targets by market-based approaches to account for mitigation efforts supported in other countries. Such mechanisms include the clean development mechanism (which allows countries to benefit from GHG emissions in countries without emission reduction targets), and joint implementation (which allows countries to get credit investing in emission reduction projects with other countries).

[F] Targets based on: EC, 2009. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

[G] The hot summer of 2003 in Europe, for example, has been estimated to have led to EUR 10 billion of economic losses to farming, livestock and forestry from the combined effects of drought, heat stress and fire.

[H] An updated overview table of progress towards developing national adaptation strategies is available at www.eea.europa.eu/themes/climate/national-adaptation-strategies.

[I] However, it should be noted that these benefits are expected to be greater by 2030 than in 2020, especially since a longer period would be available for implementing measures and for changes to occur in the energy system.

Chapter 3

(A) For the formal definition, see Convention of Biological Diversity (CBD). (UNEP, 1992. Convention on Biological Diversity. www.cbd.int/convention/articles.shtml?a=cbd-02).

(B) This chapter deals with biotic natural resources, such as food and fibre. Non-renewable natural resources, such as materials, metals and other minerals, as well as water as a resource, are dealt with in Chapter 4.

(C) Based on Corine land-cover data for 2006. Data coverage is for all 32 EEA member countries — with the exception of Greece and the United Kingdom — and 6 EEA cooperating countries.

(D) Forest undisturbed by man is forest which shows natural forest dynamics such as natural species composition, occurrence of dead wood, natural age structure and natural regeneration processes, the area of which is large enough to maintain its natural characteristics and where there has been no known human intervention or where the last significant human intervention was long enough ago to have allowed the natural species composition and processes to have become re-established. (This definition is based on the Temperate and Boreal Forest Resources Assessment of the Timber Committee of the United Nations Economic Commission for Europe (UNECE) and the Food and Agriculture Organization (FAO).)

(E) HNV (High Nature Value) farmland is defined as those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high species and habitat diversity or the presence of species of European conservation concern, or both.

(F) Decoupled subsidies are paid not on the basis of the product volume, but, for example, on the basis of historical rights (the received payments in a reference year).

(G) Collection of data on exposure of biota to other chemicals (industrial chemicals, pesticides, biocides, pharmaceuticals) and its mixtures would be desired to provide a basis for the evaluation of effects of chemical pollution on biodiversity.

(H) A fish stock is considered to be within safe biological limits (SBL), if the spawning stock biomass is more than approximately 17 % of an unexploited stock. This SBL indicator does not take wider ecosystem functioning into account. Much stricter criteria have therefore been proposed within the framework of the EU Marine Strategy Framework Directive. The reference level is the 'spawning stock biomass producing Maximum Sustainable Yield (MSY)', corresponding to about 50 % of an unexploited stock. An MSY indicator for Europe is not yet available.

Chapter 4

(A) The definition of natural resources given in the EU Thematic Strategy on the sustainable use of natural resources is quite broad, including raw materials, environmental media, flow resources (such as running water, tides, wind) and space (such as land area).
(EC, 2005. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions — Thematic Strategy on the sustainable use of natural resources. COM(2005) 0670 final).

(B) Marine litter is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in marine and coastal environments.

(C) For Germany, it has been estimated that the platinum group metals embedded within catalytic converters exported in used cars equals around 30 % of the annual domestic consumption of these metals.
(Buchert, M.; Hermann, A.; Jenseit, W.; Stahl, H.; Osyguß, B.; Hagelüken, C., 2007. *Verbesserung der Edelmetallkreisläufe: Analyse der Exportströme von Gebraucht-Pkw und -Elektro(nik)geräten am Hamburger Hafen*. UBA-FB-Nr: 001005, Förderkennzeichen: 363 01 133. Umweltbundesamt. www.umweltdaten.de/publikationen/fpdf-l/3200.pdf).

(D) Biowaste refers to biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants.

[E] In the EU, between 118 and 138 million tonnes of bio-waste are produced every year, of which about 88 million tonnes is municipal waste. (EC, 2010. Communication from the Commission to the Council and the European Parliament on future steps in bio-waste management in the European Union. Brussels, 18.5.2010. COM(2010)235 final. http://ec.europa.eu/environment/waste/compost/pdf/com_biowaste.pdf).

[F] WEI (water exploitation index) divides the total water abstraction by the long-term annual average resource. However, this indicator does not fully reflect the level of stress upon local water resources: this is primarily because the WEI is based on annual data and cannot, therefore, account for seasonal variations in water availability and abstraction.

[G] EEA analyses of environmental impacts — GHG emissions, acidifying substances, ozone forming substances, material resources use — are based on a sample of nine EU Member States using NAMEA (National Accounting Matrix including Environmental Accounts): Austria, Czech Republic, Denmark, Germany, France, Italy, the Netherlands, Portugal, and Sweden.

Chapter 5

[A] DALYs (disability-adjusted life years) indicate the potential number of healthy life years lost in a population, due to premature mortality, and to years spent with reduced quality of life due to disease.

[B] Sum of Ozone Means Over 35 ppb (SOMO35) — the sum of the differences between maximum daily 8-hour running mean concentrations greater than 70 µg/m^3 (= 35 parts per billion) and 70 µg/m^3.

[C] EU-25 refers to EU-27 Member States, without Bulgaria and Romania.

[D] PM_{10} — fine and coarse particulate matter with a diameter below 10 micrometer.

[E] 50 µg/m^3 — daily mean not be exceeded on more than 35 days a calendar year.

[F] $PM_{2.5}$ — fine particulate matter with a diameter below 2.5 micrometer.

[G] For a discussion of uncertainty and methodological details, see ETC/ACC Technical Paper 2009/1: http://air-climate.eionet.europa.eu/docs/ETCACC_TP_2009_1_European_PM2.5_HIA.pdf.

[H] The average exposure indicator (AEI) is a 3-year running annual mean $PM_{2.5}$ concentration averaged over the selected monitoring stations in agglomerations and larger urban areas, set in urban background locations.

[I] L_{den} is the day-evening-night noise indicator. L_{night} is the night-time noise indicator.
(EC, 2002. Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise).

[J] Such EU-funded research projects include the NoMiracle, EDEN and Comprendo project.

[K] The first outbreak of a chikungunya fever, transmitted by the Asian tiger mosquito, in Europe was reported in northern Italy in 2007.

[L] Cities in their administrative borders; see: http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/city_urban.

Chapter 6

[A] Based on EEA Corine land-cover data for 2006. Data coverage is for all 32 EEA member countries — with the exception of Greece and the United Kingdom — and 6 EEA cooperating countries.
(CLC, 2006. Corine land cover. Corine land cover 2006 raster data. www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster).

Chapter 7

[A] HANPP (human appropriation of net primary production) can be calculated in different ways, depending on the reference value for primary production. For estimating the impact on natural ecosystems, this can be related to an estimated primary production of the potential natural vegetation. In this definition, HANPP also takes changes in primary production resulting from land conversion into account.

(B) DALYs (disability-adjusted life years) indicate the potential number of healthy life years lost in a population, due to premature mortality, and to years spent with reduced quality of life due to disease.

(C) There is little agreement, however, about the definition of 'middle class' in economic terms.

Chapter 8

(A) However, it should be noted that these benefits are expected to be greater by 2030 than in 2020, especially since a longer period would be available for implementing measures and for changes to occur in the energy system.

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