ENVIRONMENTAL INDICATOR REPORT 2013

NATURAL RESOURCES AND HUMAN WELL-BEING IN A GREEN ECONOMY

European Environment Agency

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Foreword

Today's environmental challenges are not new. The priorities of the 6th Environment Action Programme a decade ago — climate change, biodiversity loss, unsustainable use of natural resources and environmental pressures on human health and well-being — remain important concerns today. What has changed is the recognition of the complex links between the many challenges and the need for integrated responses.

The EEA's *European environment — state and outlook 2010* analysed these links and identified the transition to a 'green economy' as a key priority in the years ahead. It defined a green economy as 'one in which environmental, economic and social policies and innovations enable society to use resources efficiently, thereby enhancing human well-being in an inclusive manner, while maintaining the natural systems that sustain us'.

This understanding is mirrored in the Environment Action Programme to 2020 (7th EAP) entitled *Living well, within the limits of our planet*. The 7th EAP promotes new ways of thinking and innovation in order to realise an ambitious 2050 vision building on, and going beyond, existing policy targets. The key dimensions of the green economy concept are reflected in the 7th EAP's three priority objectives: 'to protect, conserve and enhance the EU's natural capital'; 'to turn the EU into a resource-efficient, green and competitive low-carbon economy' and 'to safeguard EU citizens from environment-related pressures and risks to health and well-being'.

To explore the implications of the shift to a green economy and Europe's progress towards this goal, the EEA in 2012 initiated a series of environmental indicator reports. The *Environmental indicator report 2012* focused on the core challenge of improving resource efficiency while ensuring ecosystem resilience. Based on analysis of six environmental themes, it concluded that whilst progress has been made in improving resource efficiency it may not be sufficient to conserve the natural environment and the essential services it provides to human society.

This year's report, the *Environmental indicator report 2013*, extends the analysis to the links between resource use and human well-being, taking basic human needs (for food, energy, water and housing) as the entry points for analysis. By analysing environmental pressures associated with current resource use patterns and related well-being impacts, the report identifies possible levers for effecting change in an integrated manner.

This has not been a straightforward task as the evidence is fragmented and incomplete. The governance mechanisms involved are complex and their effects often difficult to disentangle. Nevertheless, the need for integrated policy responses that combine efficiency, resilience and well-being considerations, emerges clearly from the analysis, together with the potential of spatial planning in this context.

There is no doubt in my mind that further integrated analysis of the socio-technological systems that meet society's needs is crucial for realising the 2050 vision of the 7th EAP and other EU strategic policies. In the coming five years the European Environment Agency will, in close cooperation with our partners, work on expanding the knowledge base on these systems and how they can be transformed. In doing so, it will support the development of policies supporting long-term transition to a green economy, which today appears more necessary than ever.

Professor Hans Bruyninckx,
Executive Director

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Executive summary

In 2010, *The European environment — state and outlook 2010: synthesis* (EEA, 2010d) emphasised the increasingly systemic nature of environmental challenges and highlighted the need for greening the economy. It argued that further resource efficiency gains have to be realised to ensure resilient ecosystems that can deliver the natural resources and ecosystem services that we depend on.

In 2012 the EEA initiated a series of annual environmental indicator reports aimed at analysing selected issues in more depth and preparing the ground for the next SOER, due in 2015. The indicator reports share a common format and they use — to the extent possible — established environmental indicators hosted by the EEA.

The first report in the series, the *Environmental indicator report 2012*, measured progress towards the green economy, focusing on two key aspects of the transition: resource efficiency and ecosystem resilience. Based on analysis of six environmental themes, it concluded that European environment policies appear to have had a clearer impact on improving resource efficiency than on maintaining ecosystem resilience. While improving resource efficiency remains necessary, it may not be sufficient to conserve the natural environment and the essential services it provides in support of economic prosperity and cohesion.

This *Environmental indicator report 2013* extends the analysis of the green economy, focusing on the **environmental pressures** associated with resource use patterns and their **impact on human health and well-being**. Mapping the diverse connections between environmental change and human health impacts involves considerable conceptual complexities, and relies on a relatively fragmented evidence base.

For these reasons, the assessment in this report aims to be illustrative rather than comprehensive. Known health issues are linked to resource-use patterns and associated environmental pressures. Where relevant and possible, the analysis evaluates the distribution of impacts across society and identifies potential levers for action. Central to the analytical approach is the logic developed in the 2012 report, taking basic human needs (food, energy and water security, as well as housing demand) as the entry points for analysis.

The report is structured as follows:

Part 1 describes the policy background, the analytical approach and the indicators used. Referring to key analytical and policy frameworks at the global and national levels, it describes the evolution of ecosystem and well-being concepts. It also makes the case for integrated approaches to studying and tackling human exposure to multiple environmental pressures resulting from resource use. It argues that, in a green economy context, social equity needs to be enhanced by ensuring fair access to natural resources, sharing the benefits of nature, and securing a healthy living environment that protects society from pollution impacts.

Part 2 consists of four thematic assessments, focusing on food, water, energy and housing. It analyses the trends in demand and the corresponding supply mechanisms using, for example, consumption and production data and trade statistics. The environmental pressures arising from these resource use patterns are then described and interpreted in terms of human exposure and selected health and well-being impacts.

Overall, the environmental pressures from resource use in Europe appear to be declining (most notably for water and energy), although large regional differences persist. Moreover, the absolute environmental burden of European consumption patterns remains considerable, with some aspects appearing unsustainable in the context of rapidly growing global demand. The resource use patterns are strongly interdependent, with bioenergy and food production, for example, competing for land, energy and water resources, and with different environmental feedback mechanisms operating simultaneously.

Europe's food demand and meat consumption appear rather stable, and the average increase in cereal yields points towards increasing resource productivity. At the same time, however, agricultural

diversity appears to be diminishing, with 'high nature value' farming losing ground to more intensive farming systems. Biodiversity and amenity values of farmland are thus declining. As for possible health and well-being impacts of the current food system, the available data (for example on exposure to food and water contaminated with pesticides) are limited and not conclusive. The obesity crisis points at systemic challenges and potential co-benefits of consumption, lifestyle and environmental changes. Reducing the overall environmental impact of European agriculture would imply a fundamental shift towards more ecological approaches, such as organic farming, and an increase of overall resource efficiency in terms of external chemical inputs, water and energy use, land take and waste generation. CAP support and other measures could provide better incentives for such efficiency gains.

In the case of water, the overall abstraction rate is falling but there is considerable regional variation. Data on temporary breaches in drinking water supply are lacking, but acute water stress remains an issue in some (particularly southern European) regions. This situation is likely to be exacerbated by climate change. Water quality is generally improving, but again regional problems remain, particularly in the intensively farmed regions of lowland western Europe with high nutrient and pesticide loads. In addition, emerging chemicals pose a considerable, yet insufficiently understood risk. Governance mechanisms are increasingly based on a recognition that priority should be given to ensuring adequate allocations to ecosystems and basic human needs. Once these priorities have been met, the remaining resources should be distributed among sectors in a manner that delivers the greatest benefit to society. These principles are embodied in the Water Framework Directive, which requires Member States to ensure that all water bodies achieve 'good status' by 2015.

As for energy use, the indicators all point at a reduction of environmental pressures, with energy efficiency and renewable energy sources increasing, and emissions declining. This is reflected in a general decrease in the exceedances of exposure limits for air pollutants, with associated health benefits. Regional variation is also considerable in this case, however, and in absolute terms exposure to harmful pollution levels in urban areas remains high and continues to impact on human health. This is of particular concern in view

of the general urbanisation trend and the ageing of the European population, which will increase both the exposure and vulnerability of the population. Climate change is an important long-term stress factor that can only be partially mitigated by the current greenhouse gas emission cuts. The globalised nature of energy resource flows and pollution necessitates a coordinated international response. During recent decades European governments have thus assumed an ever greater role in correcting incentives and reshaping the energy system.

The environmental pressures from housing are partly construction-related (e.g. mining, energy and water use, waste generation), but also include the use phase, with energy use for heating and transport being the main pressures. Changing housing demand and diffuse urban sprawl are of concern, mainly because of effects on landscape infrastructure, biodiversity and energy demand for uses such as heating and transport. Access to green spaces is a relevant factor for health and well-being, for which unfortunately no trend information is available.

Part 3 provides an integrated reflection on the interlinkages between environmental problems and (policy) challenges in addressing these problems. It commences with an overview of the trends across the resource categories and then reviews the opportunities for responding to these interdependent challenges.

The emerging overall picture is characterised by resource efficiency gains in some areas and generally reducing environmental pressures. But considerable health and well-being challenges exist. European consumption remains very resource-intensive, particularly when seen in a global perspective.

Viewed separately, each of the 'resource use systems' is subject to very different governance mechanisms, and hence different intervention options apply. Water provisioning is subject to market forces in a limited way, with the EU Water Framework Directive providing a comprehensive legislative framework at European level to ensure water security in terms of quantity and quality. In contrast, Europe's systems for producing and consuming energy have been largely shaped by market forces. Indeed, the security of fuel supplies depends to a high degree on the functioning of world markets. However,

recognising the widespread environmental and human harm that the global energy system today causes, governments increasingly intervene to correct market incentives via taxation, emissions trading and incentives for renewable energy.

Food provisioning and resource use for housing take intermediate positions on the spectrum of government involvement. In the case of food provision, agricultural production and market mechanisms are strongly affected by policy interventions in the EU such as the Common Agricultural Policy. Negotiations in the World Trade Organization tend towards liberalisation, however, breaking down trade barriers and reducing protectionism. As for housing, access to construction materials and energy carriers is largely subject to free market forces, whereas urban development and construction itself are usually heavily regulated.

The interdependence of the resource-use systems highlighted in Parts 2 and 3 of the report introduces numerous trade-offs and co-benefits into governance options, necessitating an integrated response. Spatial planning and land management emerge as key approaches for framing governance strategies capable of increasing resource efficiency, maintaining environmental resilience and maximising human well-being.

1

INTRODUCTION

Part 1 Introduction

1 Policy background — moving towards a green economy

The green economy: a complex challenge

The *European environment — state and outlook 2010* report (EEA, 2010c) highlighted the considerable advances made in environmental policy in recent decades. At the same time, it drew attention to the need for Europe to adopt a more integrated approach to addressing a series of persistent, complex, systemic challenges.

Many of the persistent environmental problems that we face, such as air pollution, water stress, biodiversity loss and hazardous waste, are rooted in unsustainable production and consumption patterns. These common and interlinked drivers have largely been left unaddressed in policy practice that has mainly focused on partial and local mitigation of environmental pressures. Yet the environmental effects of human overconsumption of natural resources manifest at ever-growing geographical and time scales, as exemplified by global climate change.

The conventional economic model fails to account for environmental externalities in decisions concerning natural resource use and allocation. It is therefore increasingly regarded as insufficient to tackle these major environmental challenges. In contrast, the EU's Europe 2020 strategy (EC, 2010) articulates a vision for a smart, sustainable and inclusive economy, delivering high levels of employment, productivity and social cohesion. Within this context, environment and human-health concerns may provide incentives for innovation, for example in land use, improved building construction, efficient mobility and energy saving (EEA/JRC, 2013).

The Europe 2020 strategy explicitly acknowledges the need to create synergies between economic and environmental goals, and argues for a transition towards a 'green economy'. Improving resource efficiency is a cornerstone in this initiative, with concrete targets set in the 'Roadmap to a resource efficient Europe' (EC, 2011a). The Roadmap includes a vision that 'by 2050 the EU's economy has grown in a way

that respects resource constraints and planetary boundaries, thus contributing to a global economic transformation'.

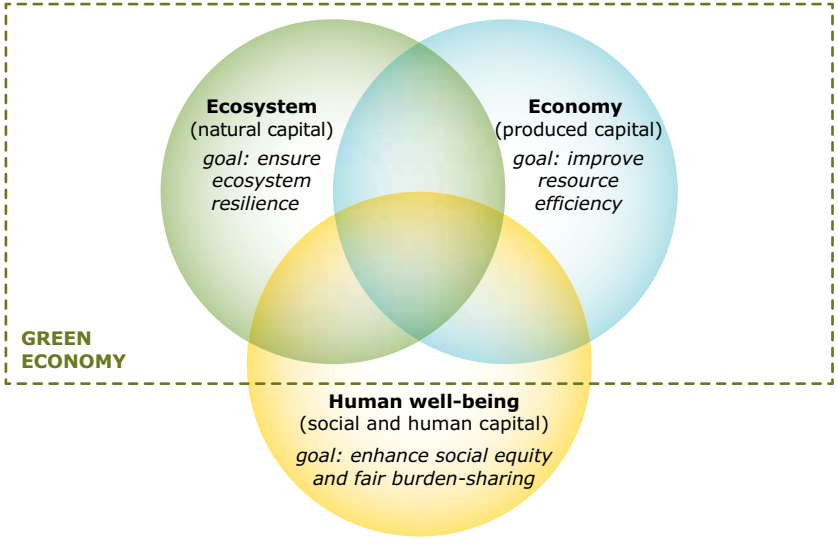
While interpretations of the 'green economy' vary to some degree, there is much common ground between the concepts employed by governments, businesses and international organisations globally. Basically, a green economy implies a departure from the 'business as usual' economic paradigm, to one with regulatory measures and strong financial incentives for innovation, investments (for example, in green technologies), sustainable consumption behaviour, and information-sharing.

A green economy can create opportunities by generating new jobs or shifting jobs from areas that rely on non-renewable resources (e.g. fossil fuels) to sectors such as the recycling industry. Such a transformation can enhance social equity and fair burden-sharing, in terms of both financial and environmental costs and benefits (EEA, 2012f). The United Nations Environment Programme (UNEP) underlines this aspect of the concept in defining a green economy as one that results in 'improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities' (UNEP, 2011).

The EEA's *Environmental indicator report 2012* interprets a 'green economy' similarly, emphasising the need to manage the multiple interactions of economic, environmental and social systems. The analysis focuses in particular on two key aspects of this governance challenge: the twin goals of increasing resource efficiency and maintaining natural capital and ecosystem resilience (Figure 1.1). It concludes that the EU has made greater progress in increasing resource efficiency than in maintaining ecosystem resilience. It further argues for the development of policy targets that explicitly recognise the relationships between resource efficiency, ecosystem resilience and human well-being, and that reflect the different timeframes needed for green economy policy actions to succeed.

The European Commission's proposal for a new general Union Environment Action Programme (7th EAP) (EC, 2012d), which would guide EU work in the environment area for the coming years, likewise recognises the interdependence of these three areas. Its first thematic priority objective, 'To protect, conserve and enhance the

Figure 1.1 The green economy



Source: EEA, 2012f.

EU's natural capital', commences with the acknowledgement that: 'The EU's economic prosperity and well-being is underpinned by its natural capital.' Building on this, its other two thematic priority objectives are 'To turn the EU into a resource-efficient, green and competitive low-carbon economy' and 'To safeguard EU citizens from environment-related pressures and risks to health and well-being'.

The human dimension: well-being beyond GDP

Both objective and subjective measures of well-being are considered indispensable for people's quality of life. While there are certainly subjective elements in quantifying well-being — for example happiness and satisfaction, pain and worry — there is a growing consensus on a range of objectively measurable factors that contribute to quality of life. These include criteria such as health, a healthy living environment, education, social equity, participation in the political process and personal and economic security.

Despite longstanding recognition that human well-being has many aspects, political decision-making is largely steered by economic indicators. For more than half a century, gross domestic product (GDP), which measures production and consumption activities in an economy, has served as the flagship indicator of progress and well-being. Today, however, most agree that GDP provides misleading signals about both current well-being and future prosperity.

Many aspects of human well-being, such as liberty, family life, social cohesion and safety from harm, are partially or wholly absent from such economic measures. From a public health perspective, the health and well-being of populations and individuals is influenced by social, economic and environmental determinants. These may interact through multiple pathways and at different spatial scales — from local conditions up to global drivers of change (Barton and Grant, 2006; EEA, 2010f).

Several policy initiatives were launched during the last decade to address the shortcomings of GDP. These include the EU's 'Beyond GDP' initiative (EC, 2013a), the OECD Better Life Initiative (OECD, 2013a), and the Stiglitz-Sen-Fitoussi Commission on the Measurement of Economic Performance and Social Progress launched by the French government in 2008 (CMEPSP, 2009).

Recognising the limitations of GDP, the Stiglitz-Sen-Fitoussi report (Stiglitz et al., 2009) identifies eight dimensions of human well-being: material living standards (income, consumption and wealth); health; social connections and relationships; insecurity (both economic and physical); political voice and governance; education; personal activities including work; and the environment (both its present and future conditions). The report argues for a sustainability perspective on human well-being, addressing economic, environmental, and social dimensions of well-being over time. Current well-being has to do with both economic resources, such as income, and with non-economic aspects of peoples' lives, including the natural environment they live in. Whether these levels of well-being can be sustained over time depends on whether stocks of capital that matter for our lives (natural, physical, human, social) are passed on to future generations.

Policy background — moving towards a green economy

Drawing largely on the recommendations of the Stiglitz-Sen-Fitoussi report, the OECD (2013b) has identified eleven dimensions that contribute to well-being, namely: community, education, environment, civic engagement, health, housing, income, jobs, life satisfaction, safety, and work-life balance. The OECD places each of these dimensions of well-being into one of three 'pillars': material living conditions; sustainability; and quality of life.

This approach to thinking about well-being is also prevalent in the global sustainable development goals, currently being elaborated pursuant to the agreement of United Nations Member States at the Rio+20 Conference. Part of this work involves the development of concrete targets for thematic areas including 'climate change', 'biodiversity', 'health and population', 'food security, nutrition, sustainable agriculture', 'energy' and 'water and sanitation'. As noted in the Rio+20 outcome document (UN, 2012), human health is 'a precondition for and an outcome and indicator of all three dimensions of sustainable development'.

The World Health Organization's Environment and Health Process is also relevant in this context, since it focuses explicitly on the well-being component of sustainable development (WHO, 2010b, 2013a). The WHO defines health in this context as: 'not merely the absence of disease or infirmity' but 'a state of complete physical, mental and social well-being'. It further acknowledges that these are multidimensional concepts, influenced by biomedical, psychological, social, economic and environmental factors, affecting people at different life stages. At the heart of the new WHO health strategy for Europe is the notion that well-being can serve as a possible focus for reorienting 21st century public policy, alongside considerations of how well-being can be defined and measured in the context of health (WHO, 2013a, 2013c).

Public health is vital for human, economic and social development (EC, 2011e; WHO, 2013a). Promoting good health is an integral part of the smart and inclusive growth objectives for Europe 2020 (EC, 2011d), and actions to reduce inequalities are important for achieving 'inclusive growth' (EC, 2011e).

Well-being in an ecosystem perspective

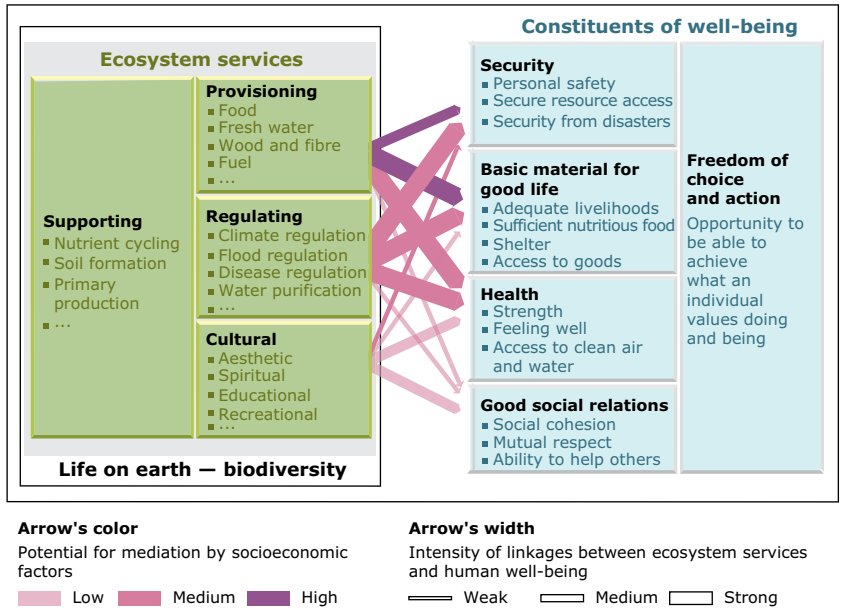
In a green economy context, social equity needs to be enhanced by ensuring fair access to natural resources, sharing the benefits of nature, and securing a healthy living environment that protects society from pollution impacts. This implies international burden-sharing — for example in addressing the hidden ecological costs of trade, sharing the costs of tackling environmental issues, and reducing the environmental footprints of consumption.

Inter-generational fairness also needs to be addressed, most fundamentally by ensuring continued flows of essential ecosystem services for future generations. Selecting appropriate 'discount rates' (which are used to derive a price in today's terms for actions that will yield costs and benefits in the future) can also play an important role in this context, shaping the economic analysis that underpins long-term economic projects and environmental policies (EEA, 2012f).

The Millennium Ecosystem Assessment (MA, 2005) has contributed greatly to understanding the consequences of ecosystem change for human well-being. It also focused on establishing the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being.

Unravelling the relations between natural capital and human well-being, the Millennium Ecosystem Assessment distinguished between provisioning services, supporting services, regulating services and cultural services (Figure 1.2). Each of these clusters of services contributes in diverse ways to the many aspects of human well-being, helping to provide the basic material for a good life, health, social relations, security, and freedom of choice and action. They can also interact in complex ways. For example human health can be affected directly and indirectly by changes in ecosystems, as well as by changes to other aspects of well-being (MA, 2005).

Figure 1.2 Ecosystem services — the link between natural capital and human well-being



Source: MA, 2005.

2 Resource use and well-being — the approach used in this report

Basic human resource needs: the foundation of well-being

Expanding on the analysis in the EEA's *Environmental indicator report 2012*, this report explores further aspects of the green economy concept, taking basic resource needs as an entry point. In Part 2, the report describes society's resource-use patterns and analyses them in terms of their impacts on the environment and on human health and well-being. This approach is akin to the analytical framework introduced in the Millennium Ecosystem Assessment (MA, 2005). In the present study, provisioning services provide the entry point for analysis.

The resources that society relies on for production and consumption can be roughly classified into four major categories: food, water, energy and (other) materials (McKinsey Global Institute, 2011). Materials include, for example, building materials, fibre, wood, chemicals and plastics. Many of these examples also overlap with the other resource categories. Rather than attempting to analyse the environmental and well-being implications of this heterogeneous category of resources, this report merely addresses a subset: materials related to housing. This emphasis is consistent with the report's focus on humanity's fundamental resource needs.

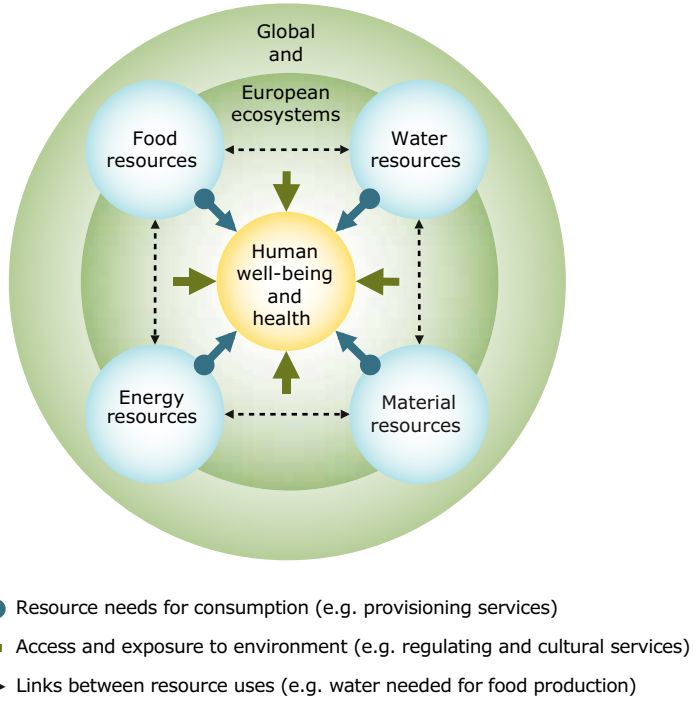
Land is not treated as a separate resource category, since it does not operate as an input to the socio-economic systems of production and consumption in the same way as food, water, energy and materials. Nevertheless, land plays an essential integrating role in the analysis, serving as the focus for important choices and trade-offs between the different resource systems, with significant implications for the environment and human well-being. This interplay is addressed in Part 3 of the report.

Exploiting each of the resource groups affects human health and well-being, **directly** or **indirectly** through multiple interdependencies and pressures on ecosystems and the services they provide

(EEA, 2010f, 2012f). Depending on the origin of the resources and the scale and intensity of the resource use, these environmental feedback mechanisms can vary from local and immediate effects to global and long-term processes. For example, changing patterns of housing, transport, food production, use of energy sources and economic activity may affect the distribution of non-communicable diseases, which is a major public health challenge in Europe and globally (WHO, 2013a, 2013c). Similarly, climate change will have long-term consequences for health and well-being, through multiple pathways, including changes in access to resources, such as food, water and energy.

This report will primarily address key pressures on the European environment (the inner green circle in Figure 2.1).

Figure 2.1 Key resource systems and human well-being



Source: EEA.

Analysing the well-being implications of resource use

It is often difficult to unravel the precise causal connection between environmental parameters and related impacts on human health and well-being. Such effects can rarely be attributed to a single environmental stressor, and cause-effect relationships are often obscured by long time-lags and modified by a wide range of contextual factors (EEA/JRC, 2013; WHO, 2013a). At the European scale, assessment of the relationship between the environment, human health and well-being is further hampered by incompatible data sources, uncertainties, knowledge gaps, and a lack of generally accepted definitions.

Conclusive evidence for health and well-being impacts of environmental pressures and the underlying resource-use patterns is therefore scarce and largely limited to issues of particular public and political concern, such as certain forms of air and water pollution. Given the multiple exposure patterns, uncertainties, and time lags in health impacts, there is a need for new ways of appraising evidence that draw on a range of sources and methods (EEA/JRC, 2013; EEA, 2013h).

The task of analysing the well-being implications of resource use is rendered more complex by the unequal distribution of environment-related costs and benefits across society (EC, 2013g; WHO, 2012b, 2013a). For example, exposure to environmental pressures is often unequally distributed in populations, with a strong social gradient. Within European countries, people with low incomes can be exposed to environmental risks five times bigger than their higher-income peers (WHO, 2012b).

In the EU, inequalities in health — within and between Member States — are influenced by economic and social factors, the environment, and living conditions (including fuel poverty, energy poverty, and housing) (EC, 2013g). While all Member States have policies to improve the health of vulnerable population groups, and many have made a specific commitment to reducing health inequalities, relatively few Member States have developed integrated policies that include actions covering the range of social, economic and environmental factors (EC, 2013g).

Globally, there are major inequalities in terms of access to basic resources (McKinsey Global Institute, 2011; Sutton et al., 2013). While Europe's comparative wealth may enable it to maintain its access to resources, this could come at increasing cost to people outside the EU. Efforts to address European inequalities could, therefore, exacerbate global inequalities.

In view of these conceptual complexities and the relatively fragmented evidence base, the assessment in this report is **illustrative rather than comprehensive**. It attempts to link known health issues to resource use patterns and associated environmental pressures, and where relevant and possible to address the distribution of well-being impacts. This report distinguishes between the **direct** impacts on human health and well-being related to the continued supply and safety of the resource concerned, and **indirect** impacts, resulting from exposure to environmental pressures associated with the resource-use pattern.

Governance aspects and identifying levers for action

In Europe and across the world, systems for meeting humanity's food, water, energy and housing needs have evolved greatly in recent centuries. From predominantly local systems of exchange or subsistence, they have transformed into complex international networks of production and trade.

Market forces have often played an important role in shaping these systems and the associated consumption patterns. Choices about which food we eat or how we generate energy have been strongly influenced by prices of production and distribution.

The current predominance of market economies globally reflects the advantages that they can offer as systems of supplying and allocating resources. In principle, competitive markets can contribute to human well-being by matching economic output to human demand, allocating resources to the uses that generate the highest returns, and creating incentives for innovation.

Such theoretical benefits notwithstanding, governance of these resource systems in Europe is today characterised by a mixed system, with market forces significantly guided by government intervention. In part, this reflects the fact that markets seldom, if ever, function as intended. Sometimes a resource's characteristics can make it hard to assign private property rights or to trade it (e.g. water). Often market prices fail to reflect the full costs (to the environment and society) of producing and using a resource, and therefore incentivise resource allocation and consumption choices that produce adverse outcomes for society. Examples include the overuse of fossil fuels to generate energy and the allocation of land to urban sprawl at the expense of natural systems.

Government intervention to regulate the supply and allocation of these resource categories is also necessitated by the fundamental role that they play in human survival and prosperity. Food, water, energy and housing are prerequisites for human existence, and societies must ensure adequate and fair access to them at affordable prices. In addition, the interdependencies between the resource categories can lead to tensions and inconsistencies, requiring careful consideration of trade-offs. Again, this may create a strong case for government intervention rather than relying on the flawed incentives inherent in most market prices.

In broad terms, therefore, global calls for a shift to an inclusive green economy appear to reflect a recognition that, while markets undoubtedly play an important role in delivering prosperity, maximising well-being and fairness today and across generations requires that society find ways to constrain and channel market forces.

In seeking to effect a transition to a green economy, governments and other social actors have a variety of tools at their disposal. Market-based tools, such as taxes and subsidies can be used to correct prices, potentially offering a means to exploit the benefits of markets (such as incentivising efficient resource use and innovation), while avoiding the drawbacks.

Market-based approaches have limitations, however. In some instances using pricing instruments may not be feasible or may generate substantial transaction costs. Moreover, even optimally functioning markets will not guarantee an equitable sharing of resources across society. Indeed, measures that increase the price of necessary goods are likely to have a regressive impact and could even deny poor households access to essential resources, which appears socially undesirable and may be politically unrealistic.

Together, these realities mean that there is a need to employ other governance mechanisms to achieve a shift to a genuinely green economy. Regulatory interventions and information-based tools certainly have an important role to play in ensuring equitable, integrated and sustainable resource management.

In addressing each of the resource categories, this report will touch upon these governance aspects, identifying possible policy actions that can be taken to reduce pressures on the environment and enhance human well-being. As with the analysis of well-being impacts, the assessment aims to be indicative, rather than attempting to provide a comprehensive overview of potential governance tools and mechanisms.

3 Indicators of resource use and well-being

EEA indicators and the DPSIR framework

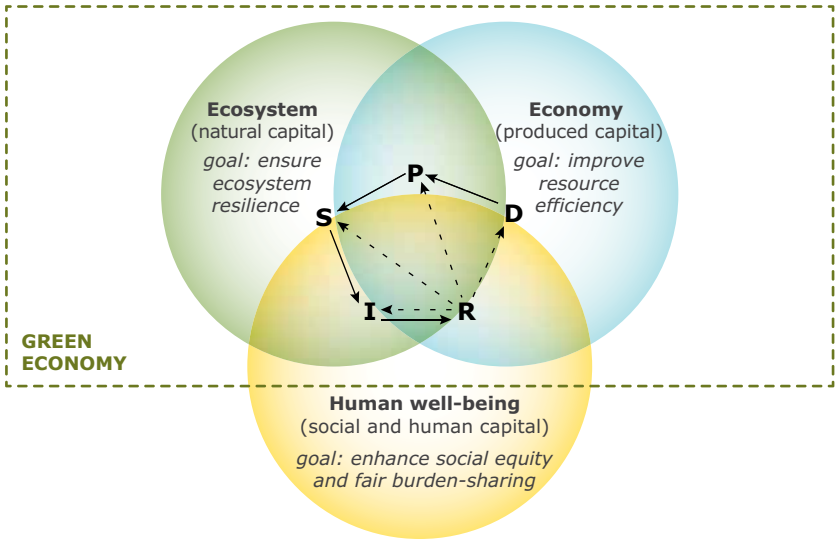
Environmental indicators can provide insights into resource use patterns, and help in identifying the governance tools available to improve human well-being. The EEA maintains an extensive set of 146 environmental indicators, grouped into 12 environmental themes (see Annex). Thirty-seven of them are designated as 'Core Set Indicators'. Most of the EEA indicators are explicitly designed to support environmental policies. The indicators are based on data compiled by the EEA, as well as statistics from other international organisations ([1]).

EEA indicators are developed and categorised according to a causal framework that organises interactions between society and the environment into five stages: driving force, pressure, state, impact, and response. In simple terms, this DPSIR assessment framework works as follows: social and economic developments drive (D) changes that exert pressure (P) on the environment. As a consequence, changes occur in the state (S) of the environment, which lead to impacts (I) on society. Finally, societal and political responses (R) affect earlier parts of the system directly or indirectly. This framework helps to structure thinking about the interplay between the environment and socio-economic activities (Stanners et al., 2007).

For this report, the existing indicators have been considered through the lens of the green economy, focusing on the linkages between resource use and human well-being. Whereas the *Environmental indicator report 2012* primarily used **pressure** and **state** indicators to quantify resource efficiency and resilience aspects (depicted as 'P' and 'S' in Figure 3.1), this report extends the analysis to consider how such pressures result in **impacts** on human well-being (depicted as 'I' in Figure 3.1). As data availability for such impacts is limited, the

([1]) In this report, EEA indicators are referred to by their indicator set and number. For example, the 37 Core Set Indicators are referenced as CSI 001–037.

Figure 3.1 DPSIR indicators in the green economy framework



EEA indicators have been complemented by relevant indicators from external sources such as Eurostat.

Resource use and efficiency indicators

Resource use and resource efficiency are captured in a wide range of indicators hosted by the EEA and others. To support implementation of the EU's 'Roadmap to a resource efficient Europe' (EC, 2011a), the EEA contributes to the development of a suite of resource efficiency indicators. The Roadmap proposes a three-layered pyramid structure comprising: one lead indicator on material use, a dashboard of macro-indicators on water, land and carbon, and a set of theme-specific indicators (EC, 2012c).

The proposed theme-specific indicators address energy use, water use, material use and land use (the latter mainly determined by agriculture), as well as related environmental pressures. While they are still in development, the proposed logic is largely consistent with the analytical approach presented in this report.

Consistent with Figure 2.1, this report makes a distinction between analysis at the global scale and within Europe. As the DPSIR indicators mature, a comprehensive assessment of resource use, efficiency, and related environmental pressures will become possible. This indicator report is a first test of the concept on the basis of available EEA data.

The 2012 indicator report relied primarily on the EEA's pressure indicators to analyse resource efficiency. In order to capture the resource use patterns and the associated pressures on the environment, a selection of these indicators will also feature in the present report.

Health and well-being indicators

Researchers in the field of environment and health employ a modified DPSIR analytical framework to convey the complex nature of the relations between the environment and human health and well-being. In their work, the impacts component ('I' in 'DPSIR') is separated into two elements — 'exposure' and 'effects'. This helps to clarify the link from the environment's **state**, to human **exposure** to hazards, and on to measurable **effects** on health and well-being (Corválan et al., 1996). The DPSEEA (driving forces-pressures-state-exposure-effect-action) framework has been used extensively in World Health Organization (WHO) assessments (e.g. WHO, 2004, 2010a), and work on designing environment and health indicators (WHO, 2013d). As conclusive evidence on the effects is usually scarce, the exposure indicators can be interpreted as proxies for effects. Actions (responses) can take many forms and can target different points within the environment-health continuum (WHO, 2004).

Underlying the DPSEEA framework is the crucial notion that measurable effects of environmental pressures on human health and well-being will always be the combined result of **multiple exposures** and multiple **contextual factors**. These contextual factors include demographics, education, wealth, lifestyles, and the psychosocial effects of the physical environment (Morris et al., 2006). Policies and actions may target these contextual factors in order to improve health and well-being (The Scottish Government, 2008).

Assessments of the environment's effects on health and well-being are subject to large and partly irreducible uncertainties, knowledge gaps and imperfect understanding. Given the complex nature of interactions between humans and the environment, adequate analytical frameworks are still required. There is also a need for ways to appraise health risk evidence that draw on a range of sources and methods. In addition, a growing body of evidence underlines the need for appropriate precautionary measures to reconcile competing economic, political, and societal values (EEA/JRC, 2013; EEA, 2013h).

This report does not attempt to provide a full analysis covering all relevant socio-economic aspects. Instead it will highlight some health and well-being issues that can plausibly be connected (on the basis of available data) to the use of natural resources. In the EEA's DPSIR framework, the indicators used should be classified as **impact** indicators, but often they provide information on exposure patterns only, without giving information on effects. Where necessary, the EEA indicators are complemented by relevant health or human well-being indicators developed by other sources.

2

THEMATIC ASSESSMENTS

Part 2 Thematic assessments

Chapter 4 Food

- Resource-use pattern
- Environmental pressures
- Human exposure and well-being implications
- Governance aspects and levers for action

Chapter 5 Water

- Resource-use pattern
- Environmental pressures
- Human exposure and well-being implications
- Governance aspects and levers for action

Chapter 6 Energy

- Resource-use pattern
- Environmental pressures
- Human exposure and well-being implications
- Governance aspects and levers for action

Chapter 7 Housing

- Resource-use pattern
- Environmental pressures
- Human exposure and well-being implications
- Governance aspects and levers for action

4 Food

Answering to a basic human need, food provision is one of the most obvious ecosystem services to society. It is a key determinant of human health and well-being but is also associated with major impacts on land cover, ecosystem dynamics, and the distribution and abundance of both habitats and species. Food provision also affects the quality of soils, water and air. The impacts of food provision on human health and well-being are both direct (e.g. in terms of food quality or contamination) and indirect (e.g. related to environmental pollution or the amenity value of the farmed landscape). The demand for food and the way we secure it is thus a key issue in a green economy context.

Food security — access to enough food of sufficient quality — relies to a certain extent on market mechanisms, but is also subject to strong policy interventions, most notably through support to the agriculture sector and food safety standards. Interdependencies between the food, water and energy systems can lead to tensions and inconsistencies, requiring careful consideration of trade-offs in responses.

This chapter commences by depicting trends in food demand and supply, based on indicators from the United Nations Food and Agriculture Organization and Eurostat. The associated land use is addressed using Corine Land Cover data (CSI 014). Environmental pressures are illustrated using EEA and Eurostat indicators, including data on pesticide and fertiliser use (e.g. CSI 025). The EEA and the European Commission have developed a sector-specific set of agri-environment indicators (IRENA), but only a few are regularly updated (Eurostat, 2013a). Indicators for the specific impacts of the European food system on human health and well-being are scarce, as the individual effects of multiple exposures can seldom be disentangled. Information on pesticide exposure and obesity is provided to illustrate the health impacts of the food system.

Other related EEA indicators (see Annex) and reports include:

- Indicators and indicator sets: Streamlining European Biodiversity Indicators (SEBI)
- *Hazardous substances in Europe's fresh and marine waters — An overview* (EEA, 2011c)
- *A Green CAP? — Reform options from an environmental angle* (EEA, 2012a)

Resource-use pattern

Food demand is primarily driven by population growth and lifestyle changes. At the global scale, the growth rate of the human population is decreasing, but total population size is nevertheless projected to increase from 7 billion people today to about 9 billion people by around 2050 (UN, 2009). Combined with a general trend towards increased consumption of meat, which is relatively resource-inefficient to produce, this could drive the global demand for agricultural production up by 70 %, increasing pressure on global ecosystems (see Box 4.1)

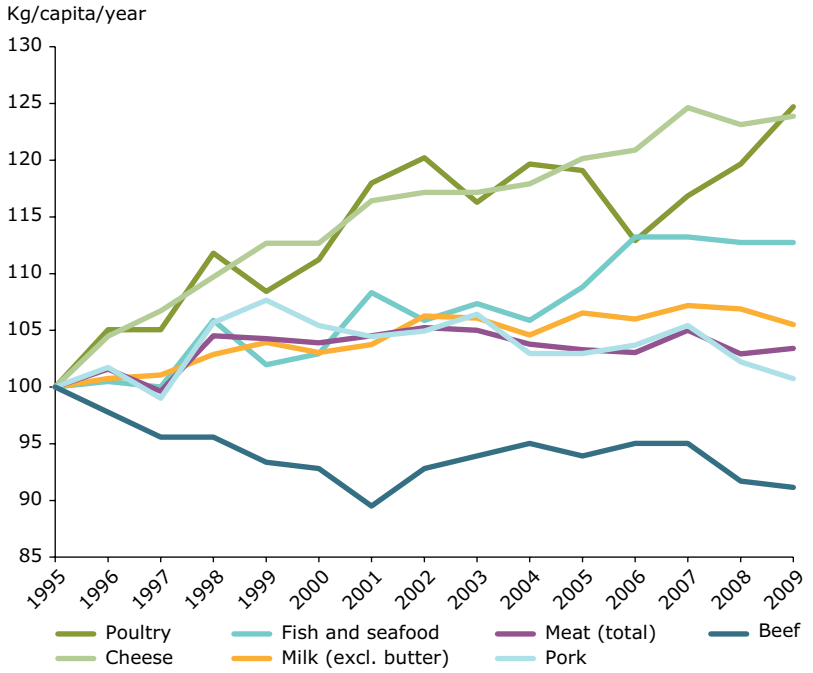
By comparison, the increase in demand for food in Europe is likely to be modest. The EU-27 population grew during the last five decades by approximately 20 % to around 500 million people in 2010. It is projected to peak at 526 million in around 2040 and to decline to 517 million in 2060 (Eurostat, 2011e). In the medium term, therefore, EU-27 food demand is likely to rise by around 5 %, but may remain relatively stable if viewed in a 2060 perspective.

Apart from these changes in overall demand, dietary shifts have occurred related to increasing incomes, price incentives and changing lifestyles. Per capita meat consumption in the EU-27 increased by around 60 % over the last five decades, although the most recent data suggest that the upward trend has levelled off. Between 1998 and 2009, per capita meat consumption actually declined by 1 % (Figure 4.1).

This comparative stability masked widely divergent trends between meat types, however, most notably between consumption of poultry (which grew by a quarter) and beef (which declined by almost 10 %). In addition, per capita consumption of fish and seafood has increased markedly since 1995.

Fruit consumption is also on the rise, with EU-27 per capita consumption increasing by 17 % (in weight terms) between 1995 and 2009, and by almost 60 % in the last half century, according to FAO data. Apart from reflecting increased consumer awareness of healthy diets, this may be due to greater availability and reduced prices of fruit.

Figure 4.1 Per capita EU-27 consumption of meat, fish and dairy (by weight), 1995–2009



Source: FAO.

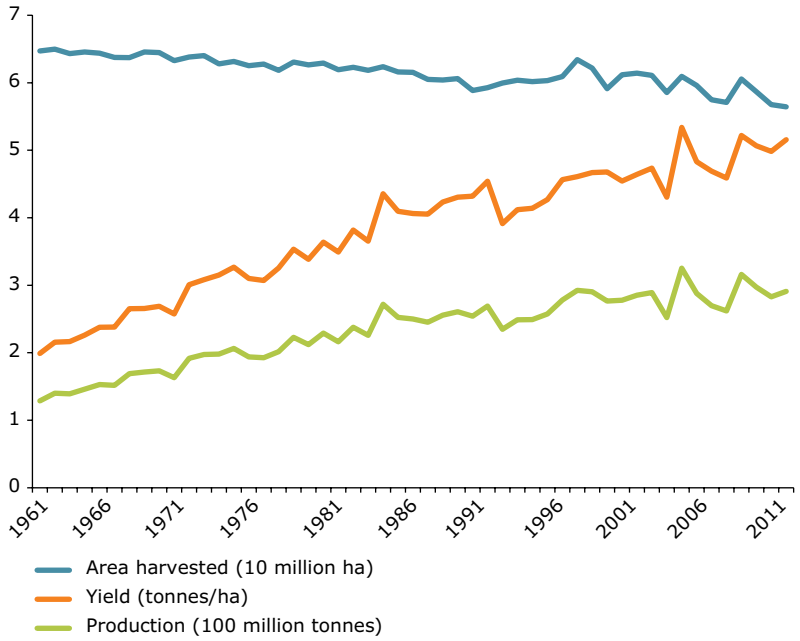
These most recent changes in European consumption patterns are in contrast with the trend in developing countries, where increasing wealth typically leads to a dietary shift towards meat (EEA, 2010d).

Europe relies to a considerable extent on external trade to meet domestic food demand. The EU-27 is currently the world's biggest importer of food, but also the second biggest agricultural exporter after the US (Eurostat, 2011c). Following many years of trade deficit, the EU has recorded a positive trade balance for food products since 2010, mainly due to exports of processed food ready for consumption, with high added value (EC, 2012a). Volume-wise, the EU-27 is largely

self-sufficient for the main commodities and products (meat, dairy, cereals and beverages), while it is a net importer of fodder. Vegetables and fruit, fish, crustaceans, coffee, tea and cocoa are the main food products imported to meet domestic demand (Eurostat, 2011c).

On the production side, European agriculture is very diverse, with the most productive and specialised farming systems in lowland western Europe and more extensive practices in southern, eastern and mountainous regions. Due to a mix of production-related subsidies, technological innovations and market incentives, European agricultural production capacity has increased significantly, particularly in the second half of the 20th century. The total area of farmland has declined but this has been more than offset by a strong increase in productivity. Total cereal production, for example, more than doubled in the period 1961–1997 (Figure 4.2).

Figure 4.2 EU-27 production of cereals, 1961–2012



Source: FAO.

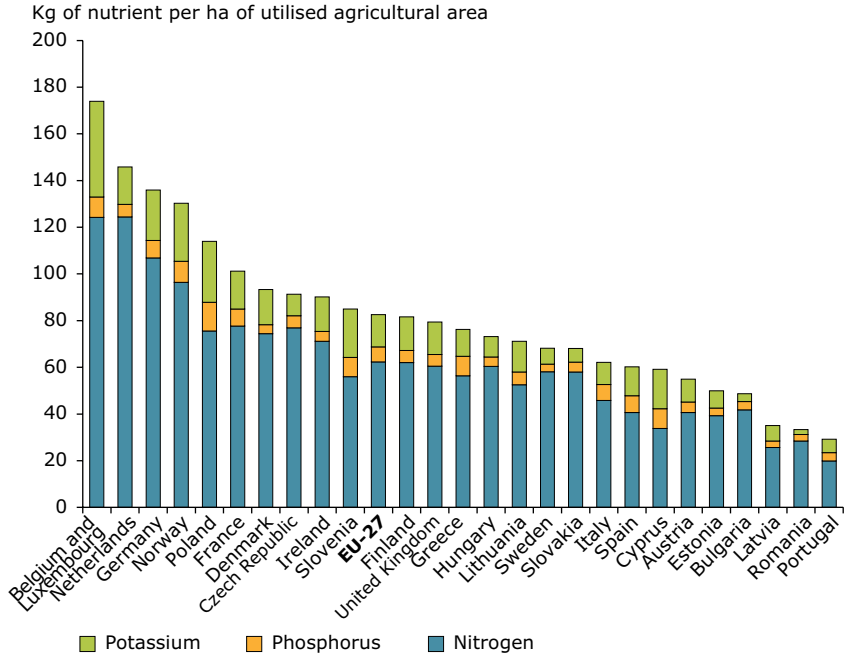
The productivity increase has been realised by rationalising agricultural production methods, for example via mechanisation and increasing fertiliser and pesticide inputs. From 1960 to 2000 nitrogen fertiliser application in the EU almost quadrupled to around 70 kg/ha (EEA, 2004). In 2010, approximately three quarters of the fertilisers used in the EU were nitrogen based, with an average application rate of approximately 60 kg per hectare. Phosphate- and potash-based fertiliser application rates are much lower, averaging 6 and 14 kg per ha respectively (Figure 4.3). In 2009, Europe accounted for approximately 13 % of the global consumption of fertilisers (FAO, 2011).

Total fertiliser consumption (including all nitrogen-, phosphate- and potash-based fertilisers) varies greatly across countries, with application rates from 30 kg/ha in Portugal and Romania in 2009 to more than 100 kg/ha in the Benelux countries, Norway, Germany, Ireland and Poland (Figure 4.3). Before the political changes at the end of the 1980s, average application rates in countries in central and eastern Europe were comparable to western levels. Due to a lack of investment capital they dropped abruptly to less than 50 % of that level in the 1990s (EEA, 2004). In the last decade, application rates in this region increased again, while they appeared to stabilise in the EU-15 (Eurostat, 2011b).

Whereas the supply of nitrogen- and potash-based fertilisers appears fairly secure ([2]), phosphorus is a limited resource of increasing concern. Exploitable phosphate-bearing rock is largely confined to the US, China, and Morocco, meaning that the EU is critically dependent on imports. In view of the projected resource scarcity and recent price volatility, the EU has taken strategic action to use phosphorus in a more sustainable way, for example by improving application techniques and by recycling from organic sources such as manure, sewage sludge and compost. This is expected to bring economic, social and environmental co-benefits (EC, 2013d).

([2]) Nitrogen fertilisers can be industrially produced from abundant atmospheric nitrogen gas, potash fertilisers are produced from abundant salt deposits around the globe.

Figure 4.3 Estimated consumption of manufactured fertilisers, 2010



Note: Covers EEA-33 countries for which data are available. Data are not available for Malta, therefore they are not included in the EU-27 value.

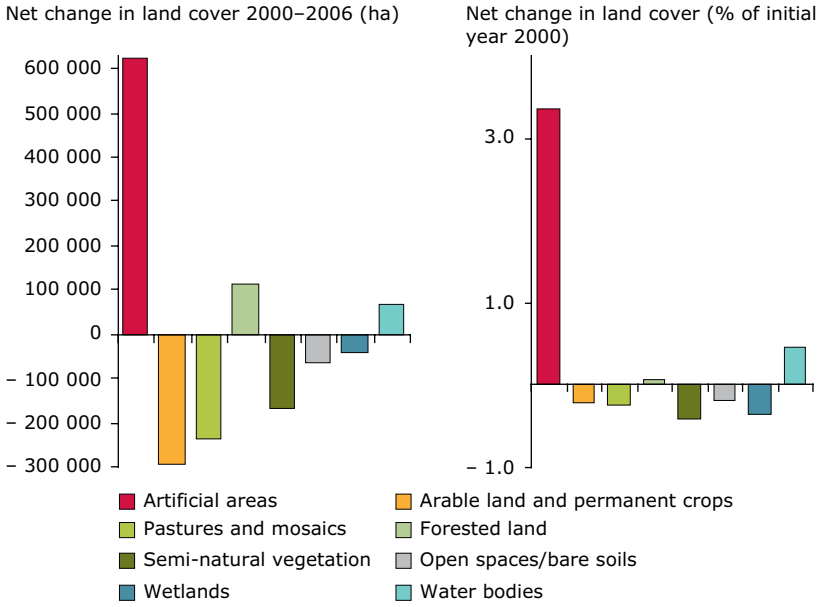
Source: Eurostat.

Data on land-cover changes in the period 2000–2006 suggest that farmland has given way to built-up areas and forest, either through afforestation or spontaneous regrowth on abandoned land (Figure 4.4, Maps 4.1 and 4.2). Land abandonment typically occurs in marginal regions with extensive farming practices. At present, the trend does not appear to jeopardise European food security (in terms of sufficiency of supply), as both domestic agricultural production capacity and Europe's buying power on the global market are

relatively high. However, European consumption and production patterns are certainly relevant for global food security; with world food demand expected to continue rising, maintaining European agricultural production capacity appears vital (Box 4.1).

The loss of extensive farming systems is also a concern because these are often areas with relatively rich biodiversity. High-nature-value (HNV) farming systems face a dual threat of intensification in some areas and abandonment in others, meaning that although they still cover roughly 30 % of EU agricultural land they are generally in decline (Paracchini et al., 2008; EEA, 2009b).

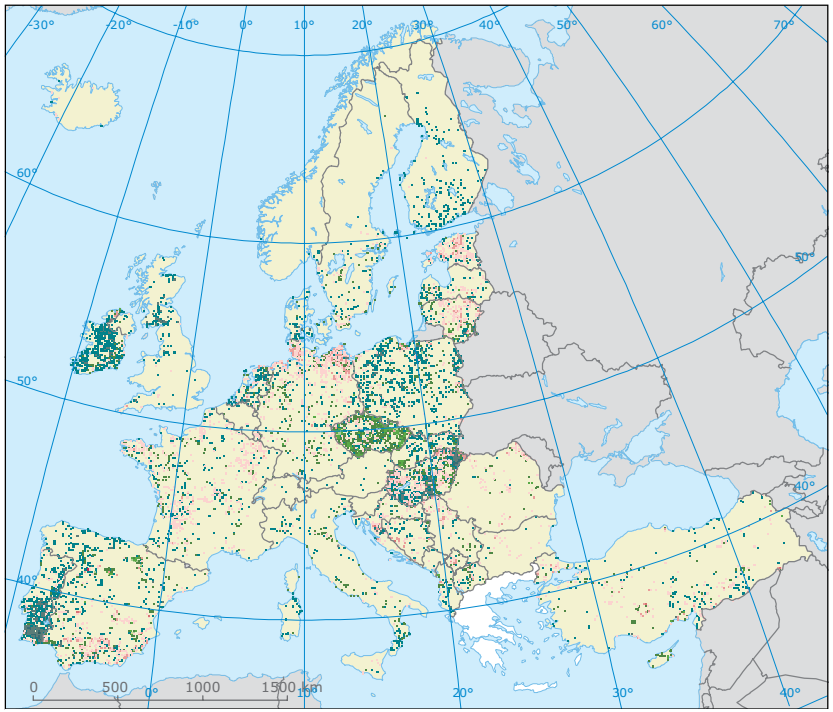
Figure 4.4 Net land-cover changes 2000–2006 in Europe — total area (left) and percentage change (right)



Note: The data presented here cover the 36 European countries in the Corine Land Cover 2006 data set.

Source: EEA/ETC-LUSI, 2010.

Map 4.1 Agricultural land cover changes, 2000–2006

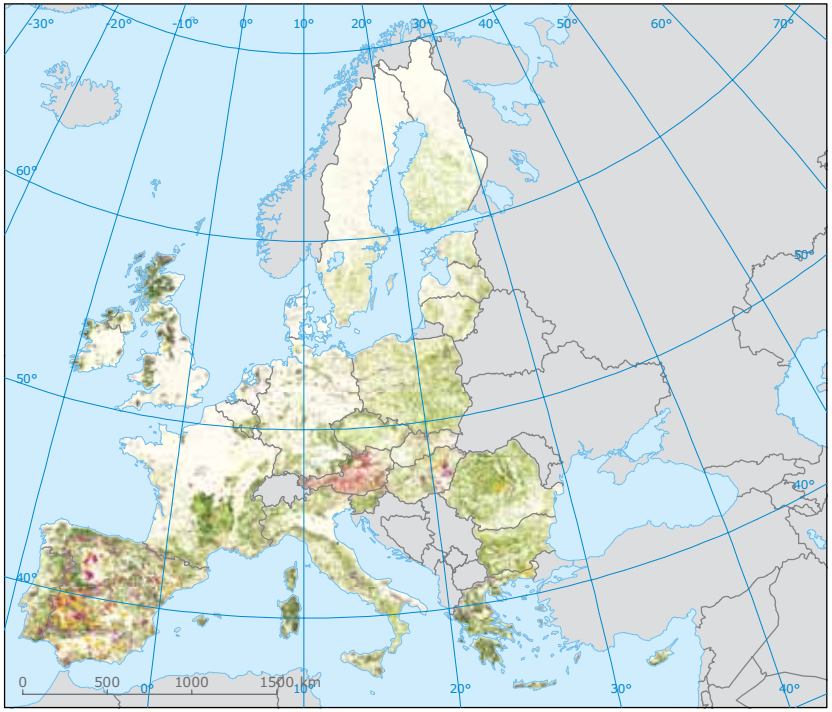


Agricultural land cover changes, 2000–2006

Conversion from pasture to arable land and permanent crops (%)	Extension of set–aside fallow land and pasture (%)	Withdrawal of farming (%)	
0–1	0–1	0–1	No data
1–5	1–5	1–5	Outside coverage
5–10	5–10	5–10	
> 10	> 10	> 10	

Source: Corine Land Cover.

Map 4.2 Approximate distribution of high nature value (HNV) farmland



Approximate distribution of high nature value (HNV) farmland across Europe

Nature areas	HNV farmland %	
Nature 2000 sites	0	Outside coverage
Prime butterfly areas (PBAs)	1–25	
Important bird areas (IBAs)	25–50	
	50–75	
	75–100	

Source: Paracchini et al., 2008; and Corine Land Cover.

Organic farming is one example of a relatively extensive farming system (at least in terms of chemical inputs) that is bucking this trend by growing in popularity. With a land share well below 10 %, this type of production still caters for a niche market. Demand is growing, however, driven by lifestyle changes and increasing consumer awareness of the health and environmental issues related to food and farming.

The overall loss of farmland is indicative of agriculture's marginalisation as an economic activity in Europe. The average age of farmers is increasing, and a growing share of Europe's population is living in cities, leading to a projected decline in populations in rural areas. These trends all mean that the prospects for agriculture in certain areas look poor, particularly in extensively farmed peripheral regions. It is debatable whether economic incentives could turn the tide: available scenario studies suggest that a number of regions will see further land abandonment, regardless of policy scenarios (Nowicki et al., 2009).

Environmental pressures

Food is one of the household consumption categories with the highest embedded environmental pressures, triggering more than one third of consumption-related acidifying emissions and one sixth of greenhouse gas and ground ozone precursor emissions (EEA, 2012d). These pressures originate throughout the life cycle, from agricultural production (via conversion of land, greenhouse gas emissions, eutrophication, etc.), to processing, packaging, distribution and storage (via use of water, energy and materials), to waste production and management (via greenhouse gas emissions and eutrophication).

The embedded pressures vary greatly across food categories. Meat and dairy products have the highest global footprints of carbon, material, and water per kilogram produced of any food (Figure 4.6). Meeting human dietary needs via meat and dairy is comparatively inefficient in the sense that it involves substantial land take, energy inputs and nutrient losses relative to the protein produced. In addition, cattle produce methane, a powerful greenhouse gas, and livestock today account for 10 % of EU greenhouse gas emissions (PBL, 2011).

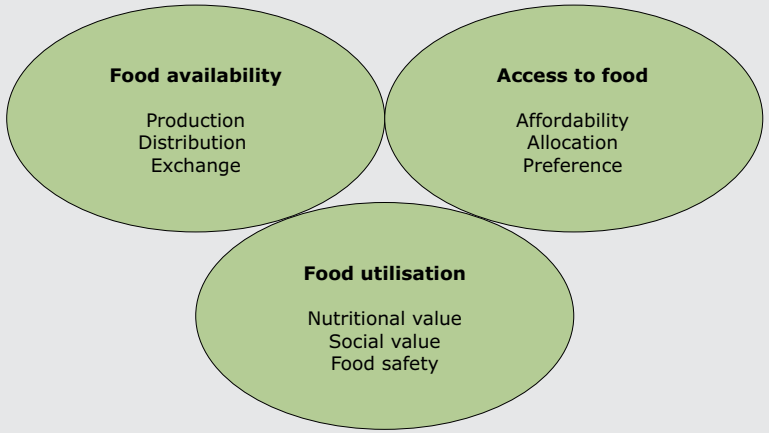
Box 4.1 Vulnerability of the global food system

Production volumes, food quality and access to food are key determinants of food security (Figure 4.5). The global food system shows shortcomings in each of these respects. Although agricultural production is currently sufficient to meet global food demand, wealth inequalities, and patterns of distribution and trade nevertheless lead to uneven access to food of sufficient quality, with recurring food crises in vulnerable regions. The situation may worsen in coming years as the global human demand for agricultural produce is projected to grow by 70 % up to 2050 (FAO, 2009).

Major gains in productivity or conversion of land to agricultural use will be required to meet increasing global food demand. Despite large-scale deforestation, particularly in the tropics, the available arable land per person declined globally from 0.43 ha in 1962 to 0.24 ha in 2007. The United Nations Food and Agriculture Organization projects that it will decrease further to 0.18 ha in 2050 (FAO, 2012). In the same period, increasing water erosion of land (caused by inappropriate land management) is projected to affect an area of 27 million km^2, which is about 21 % of the world's land area. The most impacted regions are projected to be in China, India, Africa, the United States and South America (WCRF/AICR, 2009).

Together these trends point to considerable food security risks. Coupled with expected climate impacts on agriculture, this combination could put unprecedented stresses on ecosystems and their ability to continue delivering multiple services.

Figure 4.5 Food system outcomes related to food security



Source: Adapted from Ingram, 2011.

Box 4.1 Vulnerability of the global food system (cont.)

Each of the three dimensions presented in Figure 4.5 comprises three elements that must be consistently guaranteed in order to achieve food security:

- **Food availability**: This dimension uses food production and stocks as a starting point for calculating the quantity, type and quality of food available to individuals, households or an entire country.
- **Access to food**: This refers to the ability of people to access the amount, type and quality of food required. Access is determined by how well people can convert their assets into food and helps in understanding inequity in food distribution and allocation.
- **Food utilisation**: This refers to the capacity of individuals or groups to consume and benefit from food. It is affected by factors such as age, health, hygiene, food preferences and physiological condition.

The recent trend in Europe towards consuming less meat (particularly beef) and more fruit and vegetables therefore appears to have environmental benefits. As already signalled, however, the opposite trend is predominant globally.

Agriculture dominates the food system's environmental impacts through the associated conversion of natural habitats, as well as irrigation and drainage of land. Agriculture further affects the environment via emissions of substances such as phosphates, ammonia, nitrogen oxides, methane, pesticides and herbicides to the air, soil and water.

Agriculture's emissions of nutrients to air and water are considerable, causing eutrophication of natural habitats and ecosystems. For example, agriculture accounted for 94 % of EEA-33 air emissions of ammonia in 2011 (Figure 6.5). Although agricultural nutrient balances in European countries have generally improved in recent years (see Figure 4.7), some 50–80 % of the total nitrogen load of Europe's freshwater still stems from agriculture, ultimately contributing to algal blooms and biodiversity loss in freshwater systems and coastal waters (EEA, 2010j, 2012f).

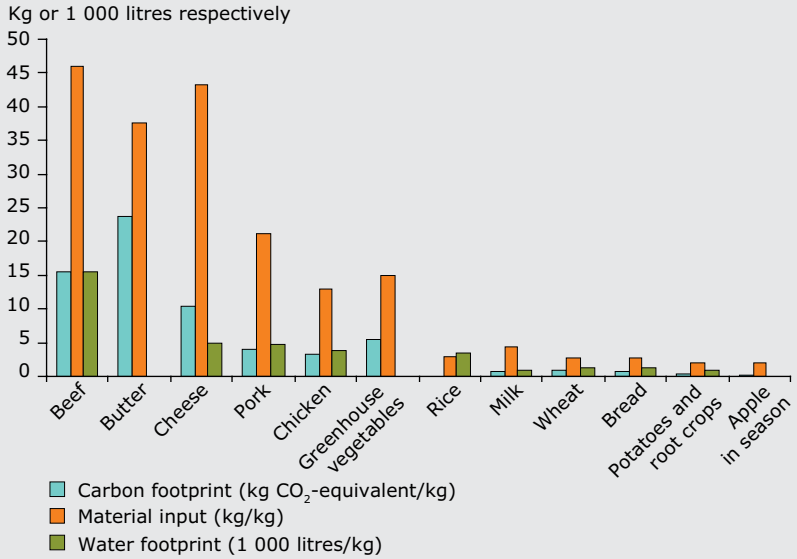
Box 4.2 Environmental pressures embedded in different food types

Environmental pressures triggered by European consumption of different food types can be estimated using environmentally extended input-output analysis (EE-IOA) and water footprint analysis.

EE-IOA covers raw material use, greenhouse gas emissions, acidifying air emissions, and air pollutants leading to harmful ground-level ozone. This approach not only analyses direct pressures caused by domestic production but also takes into account the pressures that are embedded in goods imported into the EU.

Figure 4.6 illustrates that the embedded pressures in meat and dairy products are much higher than in vegetables. The differences are mainly due to the low conversion efficiency, with fodder inputs resulting in high land take and energy demands.

Figure 4.6 Carbon, material and water footprints for different food types

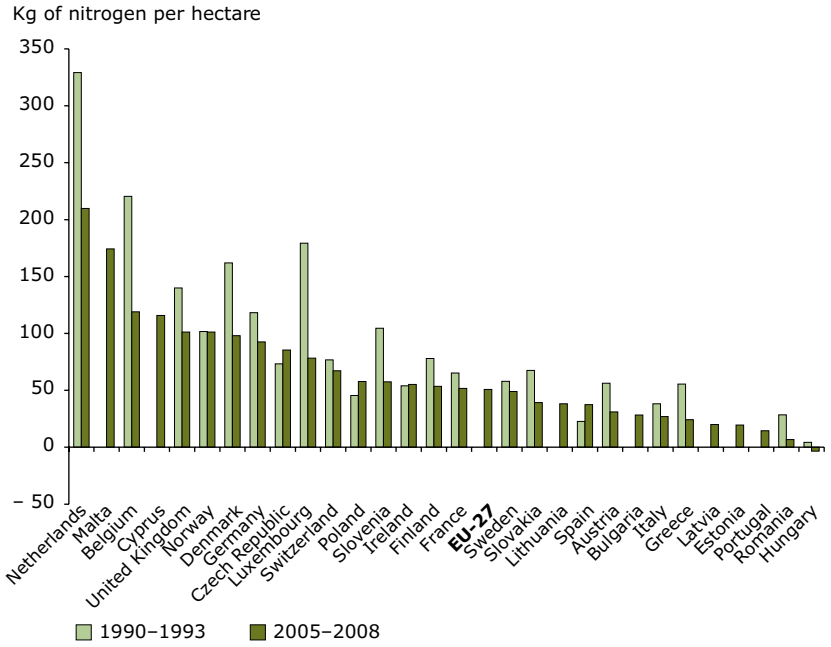


Note: The original data sources do not contain information on water footprint of butter and greenhouse vegetables, nor on carbon footprint of rice.

In interpreting the water footprint data, it is worth noting that the actual environmental pressures resulting from farming will depend on local water availability in the areas of agricultural production.

Source: EEA, 2012d.

Figure 4.7 Comparison of average gross nitrogen balances in the periods 1990–1993 and 2005–2008



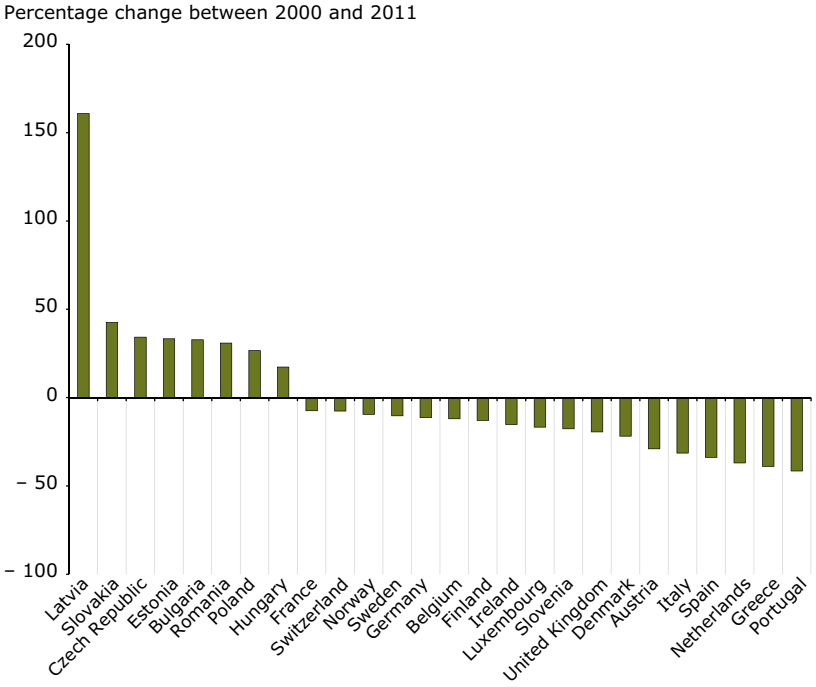
Note: The gross nitrogen balance is calculated as the balance between inputs and outputs of nitrogen per hectare of agricultural soil. The inputs are consumption of fertilisers, gross input of manure and other inputs. The outputs are removal of nitrogen with the harvest of crops, removal of nitrogen through the harvest and grazing of fodder and crop residues removed from the field.

For the United Kingdom, the 1990–1993 average is based on data for 1990 only; for Romania and Slovenia it is based on data for 1992 and 1993 only. For Bulgaria, Estonia, Cyprus, Latvia, Lithuania, Malta and Portugal, no data are available for 1990–1993.

Source: Eurostat.

Diffuse emissions of nitrogen from agriculture to freshwater remain particularly high in the western European regions where agricultural production is most intensive. These areas include the Netherlands, Belgium, Denmark, and south-west England (EEA, 2012f). In the last two decades, these areas have managed to reduce the use of nitrogen-based fertilisers. The use of fertilisers in central and eastern European countries, where absolute application levels are relatively low, has increased in the past decade, probably reflecting the agricultural sector's recovery after the economic restructuring (Figure 4.8).

Figure 4.8 Percentage change in use of nitrogenous fertilisers, 2000–2011



Note: Covers EEA-33 countries for which data are available. For Belgium, the most recent data available are for 2010; for Slovenia, they are for 2009.

Source: Eurostat.

Widespread use of pesticides in agriculture is another major concern. A quarter of all groundwater bodies examined in the EU are considered to have a poor chemical status, and pesticide contamination levels account for 20 % of these cases. The corresponding figure for rivers and transitional waters is 16 % (EEA, 2012h). Some pesticides have declined due to use restrictions (Eurostat, 2011b) but they tend to be very persistent, which means that they may continue to be present in the aquatic environment for decades (EEA, 2012h).

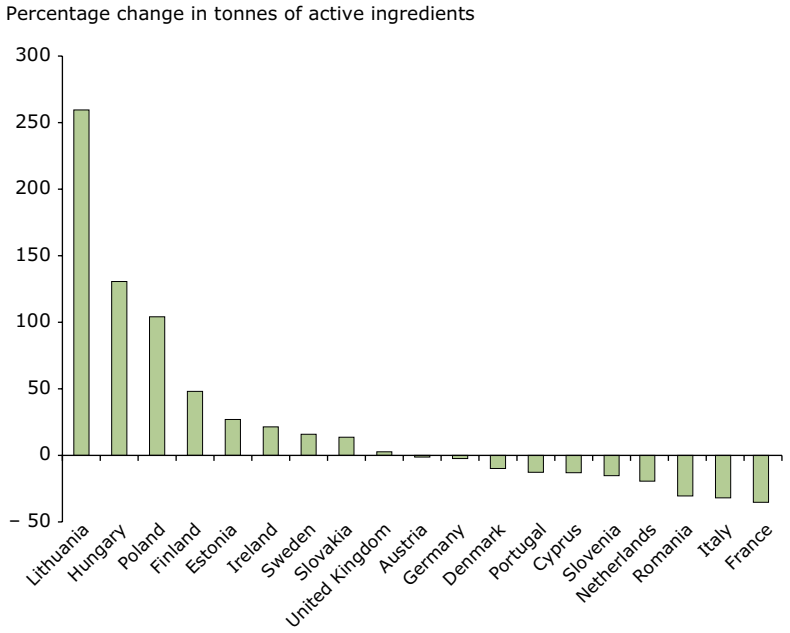
Pesticides are not only toxic for their respective target species, but can also affect the wider environment, including aquatic organisms (EEA, 2010j, 2011c). Chemicals with endocrine-disrupting properties, including several pesticides, have been shown to trigger feminising effects in fish in some polluted water systems (EEA, 2011c, 2012j).

Pesticide use has generally increased over the past ten years in northern and eastern EU Member States, with declines primarily in southern and western Europe (Figure 4.9). It is increasing fastest in central and eastern European countries, such as Latvia, Poland and Hungary. As in the case of fertilisers, these countries appear to be catching up after application reductions in the 1990s (EEA, 2004). Due to reductions in pesticide use in countries with high application rates, such as Italy and France, overall pesticide use across Europe declined in the period 2000–2009.

In addition to its impacts on water quality, agriculture also significantly affects water flows within ecosystems, primarily as a result of cultivation patterns that depend on drainage and irrigation. Agriculture is the second-largest water-abstracting sector in Europe (after energy), accounting for around 33 % of total water use, and this can reach up to 80 % in some regions (EEA, 2012k). The irrigation need is highest in southern Europe, where it aggravates water stress on natural habitats. Climate change is expected to add to this problem (EEA, 2010j, 2012c).

The combined environmental pressures from agriculture become apparent in the conservation status of natural ecosystems and habitats.

Figure 4.9 Net change in pesticide use, 2000–2009



Note: Based on data on the use of insecticides, herbicides, fungicides and bactericides in the EEA-33 countries for which data are available.

Source: FAO.

Only 7 % of the assessments of agricultural habitats protected under the Habitats Directive (EU, 1992) show a favourable conservation status, compared to an average of 17 % of the assessments of all habitat types (EEA, 2012a). The conservation status of lake and river ecosystems is also comparatively poor. This is partly due to nutrient and pesticide run-off. Marine habitats, particularly in the Baltic Sea, are generally considered to be in a bad or inadequate state, with eutrophication from agricultural sources a major cause (EEA, 2010a).

Human exposure and well-being implications

Food security — access to enough food of sufficient quality — is a key determinant of human health and well-being. The entire food system — encompassing agricultural production, processing, storage, transport, retailing and consumption — influences the availability, accessibility and quality of different types of foods. This in turn influences people's dietary choices, consumption patterns and exposure to food safety risks.

Human health is **directly** impacted by three aspects of food: nutritional value, chemical safety and microbiological safety. Malnutrition can manifest itself in undernourishment as well as in obesity, whereas chemical and microbiological contaminations of the food can lead to acute and chronic diseases. In Europe, six of the seven biggest risk factors for premature death — blood pressure, cholesterol, being overweight, inadequate fruit and vegetable intake, physical inactivity and alcohol abuse — relate to what people eat and drink, and how they physically exercise (Eurostat, 2011d).

The nutritional outcomes of the food system are determined by many factors, including incomes, prices and consumer understanding (FAO, 2013). Pricing mechanisms are considered to play a role in the growing obesity epidemic (see Box 4.3), with food of higher caloric and less nutritious value typically being cheaper than 'healthy' food (World Bank, 2013). People of low socio-economic status tend to consume more processed food and are more likely to be overweight or obese and to be less physically active; they also tend to live in environments less encouraging to physical activity (WCFR/AICR, 2007; IASO, 2013).

Food safety can be undermined by chemical or microbial contamination throughout the food chain, from production through to trade and distribution. The European Rapid Alert System, set up by the EU to monitor the safety of food entering the EU market, was activated 8 797 times in 2012. Reported contaminations of food and feed included pesticides, heavy metals, aflatoxins, plasticisers, dioxins and microbial contaminants (EC, 2013f). Reported incidences of pesticide residues have increased sharply since 2006 due to increased control efforts. The majority of pesticide notifications concern food and feed imported from outside the EU (317 out of 363 cases in 2011), illustrating the food safety challenges associated with increasingly global supply chains.

Within the EU, the monitoring information on pesticide residues in food from 27 EU Member States, Iceland and Norway is published by the European Food Safety Authority (EFSA) in annual reports (IASO, 2013). In 2010, more than 77 000 food samples were analysed for pesticide residues. The results of the EU-coordinated programme showed that 1.6 % of total samples analysed exceeded the European legal limits for pesticide residues. Reported for the first time, the results of a pilot cumulative risk assessment of multiple chemical residues show significant uncertainties and a need for further revision of methodology (EFSA, 2013).

In addition to direct impacts on food security, the food system may affect human health and well-being **indirectly** through the environmental pressures described previously. Air and water quality, climate change, and access to green spaces with biodiversity and landscape amenity value are all affected by agriculture. The causal links between health and well-being outcomes and these indirect environmental factors are in general difficult to establish, however, as multiple pressures and exposures interact.

Probably the most straightforward links are in the area of water quantity and quality. Agricultural water extraction may increase regional water stress and shortages of drinking water supply. Moreover, nutrient and pesticide loads may affect drinking water quality and the need for water purification (see also Chapter 5). Human health concerns have been raised in connection with occupational and non-occupational exposure to pesticides (EEA/JRC, 2013). Information on actual emissions of pesticides and their fate in the environment is limited. Risk assessments are hampered by the long time-lags between emissions and seepage into groundwater bodies, and by uncertainties in the data regarding (eco)toxicity.

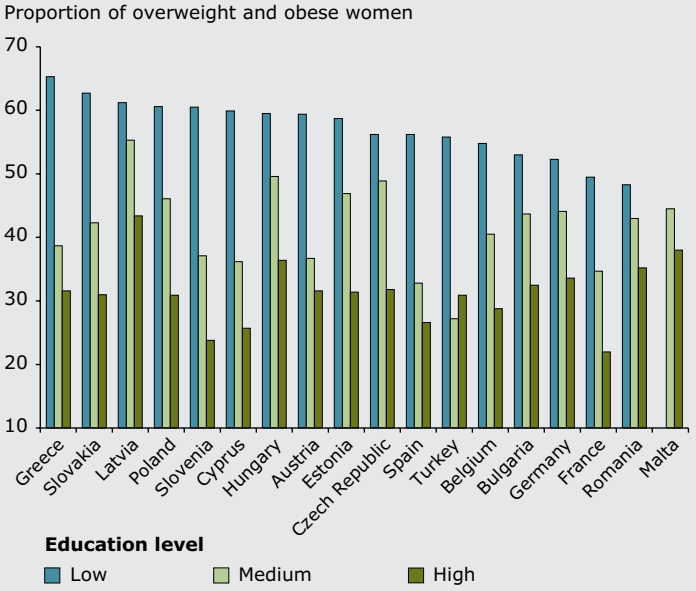
Triazine pesticides (atrazine and sumazine) are of particular concern because of their high water solubility, strong persistence and low soil adsorption. They have been used as herbicides on cropland, on transport highways and in domestic gardens. Despite being banned and classified as priority substances under the EU Environmental

Box 4.3 The obesity crisis

Obesity today constitutes a global public health challenge linked to a variety of diseases, including diabetes, hypertension, cardiovascular diseases, certain cancers and premature death (Foresight Programme, 2008; WHO, 2013b). Changes in food systems and dietary patterns, with increasing access to and consumption of energy-rich foods, as well as increasingly sedentary lifestyles are recognised as key drivers (IASO, 2013; Kelly et al., 2008; WCRF/AICR, 2009; World Bank, 2013).

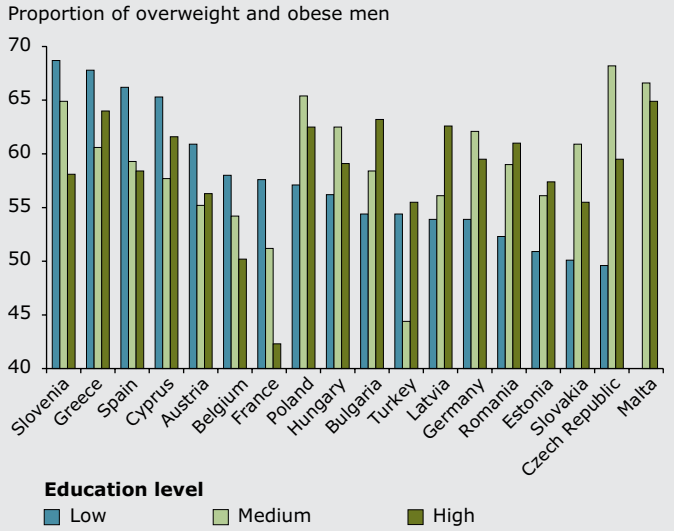
In the EU, the proportion of the population that is overweight has increased considerably over the last decade, such that more than half the EU population was overweight or obese in 2008/2009. The distribution of obesity is not uniform across categories of age, socio-economic status, and educational attainment (Eurostat) (Figure 4.10). Among the 19 Member States for which data were available, 37–57 % of women and 51–69 % of men were overweight or obese (ESTAT). Childhood obesity is of particular concern, as it amplifies several health risks and may affect life expectancy (Hulsegge et al., 2013). A 2004 study estimated that more than 20 % of European children were overweight (IASO, 2013).

Figure 4.10 Proportion of overweight and obese adults in selected EU Member States by education level, 2008



Box 4.3 The obesity crisis (cont.)

Figure 4.10 Proportion of overweight and obese adults in selected EU Member States by education level, 2008 (cont.)



Note: Based on the body mass index (BMI) values: overweight — BMI between 25 and 30; obese — BMI equal or greater than 30.

Educational level attainment according to the International Standard Classification of Education: 'low level' comprises ISCED levels 0–2 (pre-primary, primary and lower secondary education); medium level comprises ISCED levels 3–4 (upper secondary and post-secondary education); high level comprises ISCED levels 5–6 (first and second stage tertiary education).

Data collected in the frame of the European Health Interview Survey; Malta: reduced reliability due to a large proportion of missing answers.

Source: Eurostat, 2011d.

Obesity is a complex societal problem, which relates not only to individual consumption patterns but also to the food production and distribution mechanisms, and a person's social and physical environment. A correlation between increasing wealth, meat consumption and obesity cannot be simply interpreted as a causal relationship. Nevertheless, a shift towards more plant-based food consumption, in combination with increasing health awareness and more active lifestyles, could deliver health and environmental co-benefits (WCFR/AICR, 2007).

Quality Standards Directive (EU, 2008a), both pesticides can be found in groundwater bodies at concentrations exceeding drinking water standards. Encouragingly, the reported occurrence of triazine pesticides is declining, and exceedance of safety standards is relatively rare for all countries reporting to the EEA (EEA, 2011c; ETC/ICM, 2013).

Another area of increasing scientific and policy attention is the role that agriculture plays at the landscape scale. Drainage and loss of the water retention capacity of farmland are major factors affecting flooding risk, and will need increased attention in view of adaptation to climate change (EEA, 2013a). There is also growing evidence that better access to green spaces spurs outdoor activity and healthy lifestyles (EEA/JRC, 2013).

Governance aspects and levers for action

Food production plays an extremely important role in supporting human well-being — most directly by meeting our dietary needs, but also indirectly by shaping national economies and the environment we inhabit. Given its complex mixture of functions and the need to create a stable flow of affordable food despite major inter-annual variations in weather and prices, it is perhaps unsurprising that governments have adopted a central role in directing the European food system. Although global food prices certainly have a role in determining the types and quantities of European agricultural output, the influence of market forces is significantly influenced by state interventions.

Since its introduction in 1962, the Common Agricultural Policy (CAP) has dominated governance of agriculture, providing a means to balance the sector's evolving economic, social, and environmental goals: enhancing European food production, securing adequate farm incomes, stabilising food price levels, maintaining rural social fabric, and reducing environmental pressures. Viewed against this complex (and potentially contradictory) mixture of objectives, the CAP can be seen as a partial success.

The CAP's historic importance is apparent in its dominance of EU budgets, accounting for almost three-quarter of total spending in the early 1980s and still equalling approximately 40 % in 2013 (EC, 2013b).

The agriculture sector is the biggest recipient of public financial support relative to its contribution to EU economic output.

Through subsequent reforms since 1990, the CAP has been increasingly geared to tackling environmental pressures and market distortions. The subsidies have largely been decoupled from production, and made subject to management and animal welfare standards and 'cross-compliance' with environmental legislation. However, these financial incentives still do not sufficiently correct some aspects of market failure of the agricultural system.

For example, the estimated costs of the environmental damage by nitrogen fertilisers are currently in the same order of magnitude as their economic benefits to farmers, but since farmers do not bear these costs they are not reflected in production decisions (EEA, 2012f). Similarly, the benefits of some types of land use (e.g. carbon sequestration) are dispersed across society and the landowner responsible cannot claim reimbursement — again meaning that these benefits are excluded from decisions about land use.

Although the 'greening measures' in current reform proposals go some way to addressing remaining environmental concerns, the CAP still lacks an overarching strategy addressing agriculture's resource efficiency and its impact on carbon, water and nutrient cycles. Consumption-based interventions, such as labelling and price incentives, could favour consumption of less environmentally harmful products. Production-based interventions, such as agricultural subsidies, could be geared better towards practices with lower environmental impact.

As outlined in the EEA's 2012 'green CAP' analysis (EEA, 2012a), there are several opportunities for improving agriculture policy. First, the clarity and direction of the CAP can be improved by paying farmers for the delivery of ecosystem services, rather than providing unspecified direct payments and only compensating them for costs incurred in mitigating environmental impacts. Such payments follow directly from the recognition that many of the ecosystem services provided by EU farms benefit society, rather than the farmer. It therefore makes sense to reimburse the farmer providing the services from the public purse.

Second, long-term food security can probably best be protected by reducing the overall ecological impact of agriculture. This implies a fundamental shift towards more ecological approaches, such as organic farming, and an increase of overall resource efficiency in terms of external chemical inputs, water and energy use, land use and waste generation. CAP support and other measures could provide incentives for such efficiency gains.

Precision farming techniques (which seek to reduce inputs of fertilisers, pesticides, and water by applying them more prudently) and organic practices have the potential to deliver on these goals. Organic farming systems already receive some policy support through labelling and certification of products, and may in the future qualify for financial support under the greening measures. Uptake of organic farming across Europe shows a positive trend (EEA, 2010b).

Third, dietary shifts (less meat consumption) and reduction in food waste will likely lead to large efficiency gains for European agriculture. The CAP could be embedded in a wider food-system perspective that also addresses distribution and consumption. Food distributors, caterers and retailers play a key role here. A carefully designed mixture of different instruments (including for example economic incentives, awareness-raising and education) will be needed to change diets and food waste habits.

Fourth, the diversity of European agriculture also provides different opportunities to balance agricultural production against other land management goals. There is scope for intensive and innovative production systems (particularly in peri-urban settings) as well as extensive systems with high natural and cultural values. Different situations call for different tools and approaches, with CAP implementation firmly embedded in a broader rural development perspective.

Agriculture's role in shaping the landscape and its ecological infrastructure points to the potential for integrated spatial planning to deliver environmental and well-being co-benefits. With an optimised mix of urban and rural regions, and good access to farmland and natural habitats with high associated biodiversity and amenity value, a reinforcing feedback loop appears possible. A greener environment could invite active lifestyles and dietary change, with environmental benefits in return.

5 Water

Freshwater of good quality is a vital resource for human society. Water is abstracted from groundwater and surface water (rivers and lakes) to provide drinking water and for economic activities — predominantly energy production (cooling water), agriculture and industry. These uses affect both the quantitative status and the quality of water bodies. How and where water is used has consequences for ecosystem functioning and biodiversity, which are themselves vital for ensuring the sustainability of water supplies.

Competitive market forces have only a limited role in shaping water provisioning. Regulatory measures dominate governance of water access and quality, influencing water distribution, pollution abatement and spatial planning. Preventing pollution is a key concern, and regulatory measures to reduce pollution by industry, agriculture and wastewater treatment have an important role. However, water policies necessarily do not only focus on water quality. Water quantity considerations (i.e. ensuring adequate amounts of water at the right time) as well as drought and flood prevention get increasing attention in view of concerns about climate change and regional water stress.

Using EEA indicators and information derived from reporting under the Water Framework Directive and elsewhere, this chapter describes water exploitation patterns (CSI 018) and the pressures exerted on the quantitative, ecological and chemical status of water bodies (WISE data and CSI 019). Potential impacts on human health and well-being are illustrated using water-safety data concerning drinking- and bathing-water quality (CSI 022 and 024).

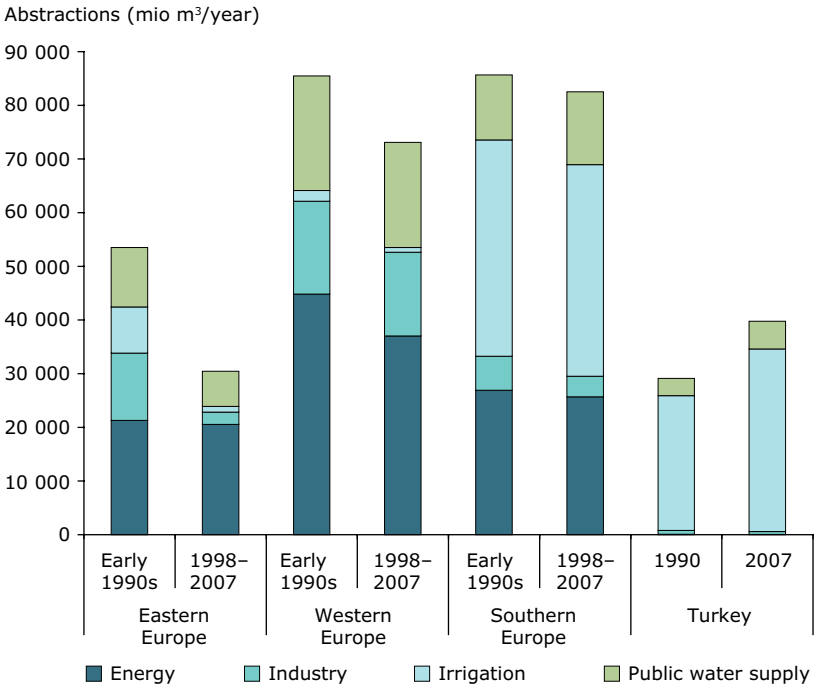
Other related EEA indicators (see Annex) and reports include:

- Indicators and indicator sets: water (including CSI 018 to CSI 024)
- *Towards efficient use of water resources in Europe* (EEA, 2012k)
- A series of EEA reports on the state of water in Europe published in 2012 and 2013.

Resource-use pattern

Freshwater resources are essential for well functioning terrestrial, marine and atmospheric ecosystems and for supporting human health. They also play a crucial role in the European economy; all economic sectors depend on water for their development (EEA, 2012f). As a whole, Europeans appropriate on average around 13 % of all freshwater resources annually. This amounts to approximately 288 km^3 or 500 m^3 per capita (EEA, 2009c). Of this total, 37 % of freshwater abstraction is used for cooling in energy production, and 33 % is used by agriculture. Public water supply accounts for 20 %, and industry uses the remaining 10 %. In southern Europe agriculture

Figure 5.1 Water use for irrigation, industry, energy cooling and public water supply in the early 1990s and 1998–2007



Note: For geographical coverage, see EEA, 2010i.

Source: EEA (CSI 018).

accounts for more than half of total national abstraction, rising to more than 80 % in some countries, while in western Europe more than half of water abstracted is used for cooling in energy production (Figure 5.1).

Sectors differ significantly in their consumptive use of water, i.e. the extent to which the water is returned to local water systems after use. Almost all water used as cooling water in energy production is returned to local water systems. In contrast, the consumption of water through crop growth and evaporation typically means that only about 30 % of the amount abstracted for agriculture is returned.

Europe's total water abstraction has declined since the early 1990s, with particularly large decreases in water abstraction for irrigation in eastern Europe — mostly due to the decline of agriculture in Bulgaria and Romania during the period of economic transition. Total irrigable area has declined by about 20 % in other eastern EU Member States, with associated reductions in water use. Water abstraction for irrigation has remained relatively stable in southern Europe, except in Turkey, where it has increased by more than 30 % from the 1990 level (EEA, 2012f).

In the same period, water abstraction for power plant cooling in Europe has decreased overall by more than 10 %, due mainly to implementation of advanced cooling technologies that require less water. Abstraction of water for industrial and manufacturing uses has also decreased over the past 20 years, ranging from a 10 % reduction in western European countries, up to a 40 % cut in southern European countries, and even greater reductions in eastern countries. The decrease is partly because of the general decline in water-intensive heavy industry but also because of increases in the efficiency of water use (EEA, 2012f).

Trends in abstraction for public water supply and water use in households since the early 1990s have varied across Europe. In southern Europe, domestic water use increased by 12 %, with increases above 50 % in Turkey. At the same time, public water demand in eastern Europe declined by 40 %, while a more moderate reduction in demand occurred in western Europe. A variety of factors

influence public water use, including population and household sizes, tourism, income, technology and lifestyles, changes in awareness and behaviour, and increases in water prices (EEA, 2012f).

Total water abstraction as a percentage of available freshwater resources (i.e. the 'water exploitation index', or WEI) provides an indicative picture of the pressures water use exerts on water systems. Based on Eurostat data for the period 1985–2009, surface waters (such as lakes and rivers, from which water can generally be abstracted comparatively easily) account for 81 % of the total abstracted water volume. Groundwater provides the predominant source (about 55 %) for public water demand, due to its generally higher quality and, in some locations, more reliable supply (EEA, 2009c).

Generally speaking, the water exploitation index helps identify river basins and countries where abstraction is high in comparison to resources and that are therefore prone to water stress.

Based on this, five European countries can be considered water-stressed: Cyprus, Belgium, Italy, Malta and Spain. However, this does not necessarily reflect the extent and severity of over-exploitation of water resources in sub-national regions or during dry seasons. Also, for some countries (e.g. Belgium) the high water abstraction is partly linked to primarily non-consumptive uses (such as cooling water), whereas in others (e.g. in southern Europe) it is due to predominantly consumptive uses (notably irrigation).

Environmental pressures

As a whole, Europe abstracts a relatively small proportion of its renewable freshwater resources. Nonetheless, abstraction and use of water resources can be associated with a number of direct and indirect pressures on water bodies that may affect their status and ultimately impact on human health. The EU Water Framework Directive (WFD) distinguishes three aspects of water body status:

- Quantitative status, i.e. the volume of water present in a water body at any given time. Related environmental impacts can include phenomena like floods, droughts and water scarcity — often as result of over-abstraction. Over-abstraction not only has a direct impact on the ecological health of aquatic ecosystems, it also reduces an ecosystem's capacity to absorb other pressures from pollution.

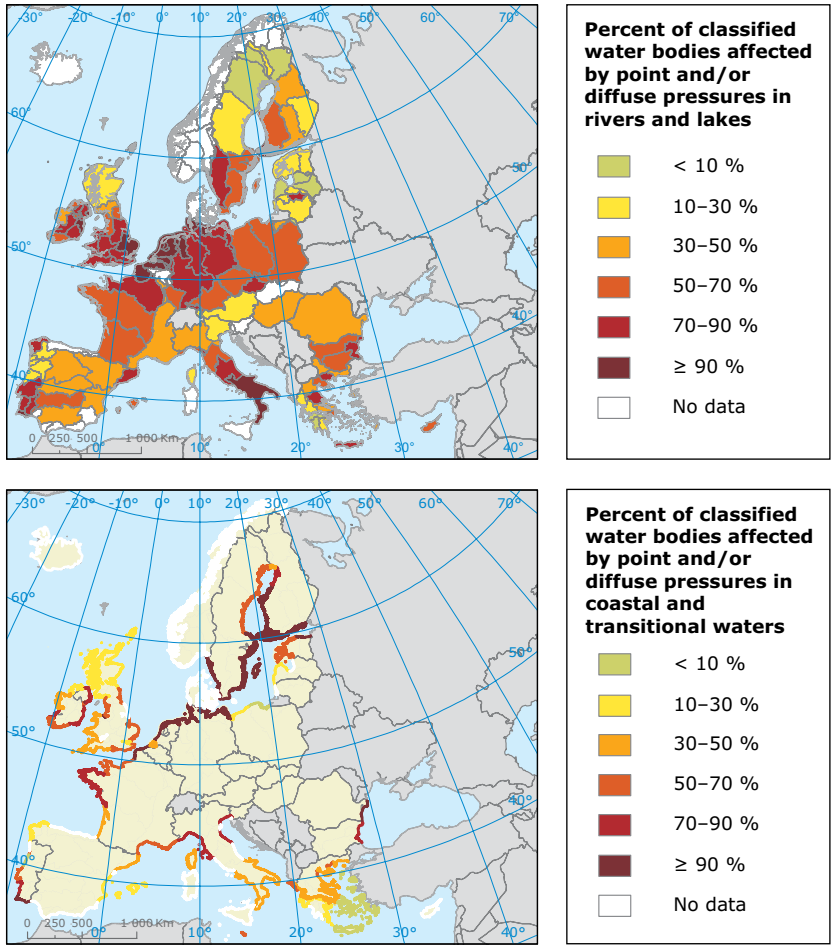
- Ecological status, defined in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics of water bodies.

- Chemical status, defined in the Water Framework Directive in terms of compliance with all the quality standards established for chemical substances at European level, to ensure at least a minimum chemical quality, particularly in relation to hazardous substances.

The Water Framework Directive (WFD) requires that by 2015 all water bodies have good status. For surface waters, the directive focuses on ecological and chemical status; for groundwater bodies, it focuses on chemical status and quantitative status. Comprehensive information on the status of water bodies is available in the River Basin Management Plans (RBMPs) reported under the EU WFD. These plans are created by Member States to describe the status of the water bodies in their countries and their plans to improve them. The plans cover more than 13 000 groundwater bodies and 127 000 surface water bodies (82 % of the plans cover rivers, 15 % cover lakes, and 3 % cover coastal and transitional waters).

Less than half of Europe's surface waters are reported to have good ecological status. Rivers and transitional waters are on average in a worse condition than lakes and coastal waters. Concerns about the ecological status of freshwater bodies are most pronounced in central and north-western Europe, and for coastal and transitional waters in the Baltic Sea and greater North Sea regions. Many water bodies, particularly in regions with intensive agriculture and high population density, suffer from 'diffuse pollution' (i.e. pollution caused by a variety of activities that have no specific point of discharge) from agriculture. More than 40 % of river and coastal water bodies are affected by this diffuse pollution, while 20–25 % are subject to 'point source' pollution (pollution from a single large source), for example from wastewater treatment plants, industries and sewage systems (Map 5.1) (EEA, 2012i). The resulting eutrophication can manifest in biodiversity loss, algal blooms and reduced oxygen levels.

Map 5.1 **Proportion of classified water bodies in European river basin districts affected by pollution pressures — rivers and lakes (top) and coastal and transitional waters (bottom)**



Note: A water body is considered to be affected by pollution pressures if it is reported with the aggregated pressure type 'Point sources' and/or 'Diffuse sources' and/or any of the corresponding disaggregated pressure types (e.g. urban wastewater, industry emissions or agriculture diffuse pollution).

Source: EEA, 2012h.

While the ecological status of water ecosystems is often poor, some pollutant emissions have been reduced significantly in the past 25 years. Implementation of the Urban Waste Water Treatment Directive, together with national legislation, has led to improvements in wastewater treatment across much of the continent (EEA, 2012i). Data for the last decade show that the concentration levels of oxygen-consuming substances and ammonium in water have declined (see Figure 5.2). Trends related to diffuse sources of pollution are less positive, however, with nitrate pollution from agriculture a continuing problem (EEA, 2012i).

Figure 5.2 **BOD5 concentrations and total ammonium concentrations in rivers between 1992 and 2011 in different geographical regions of Europe**

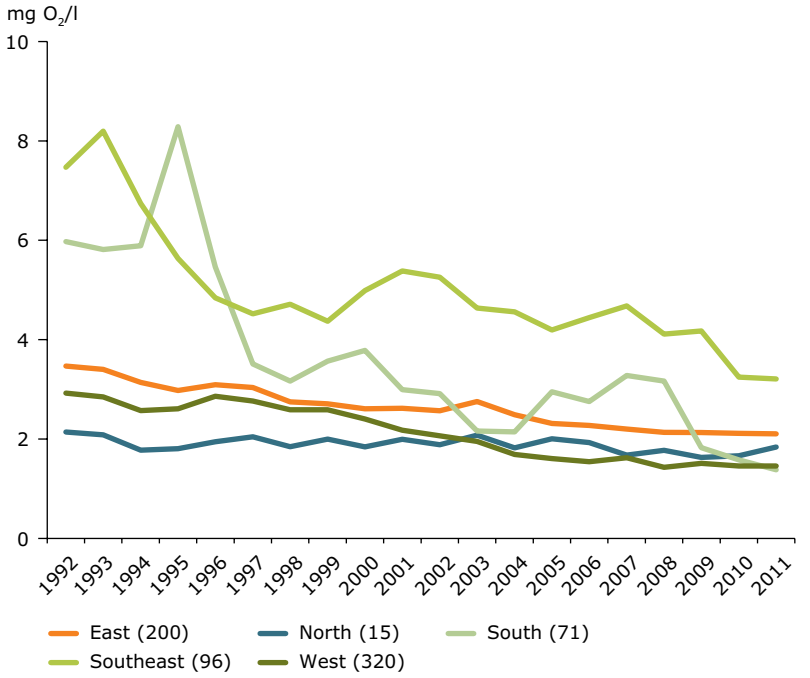
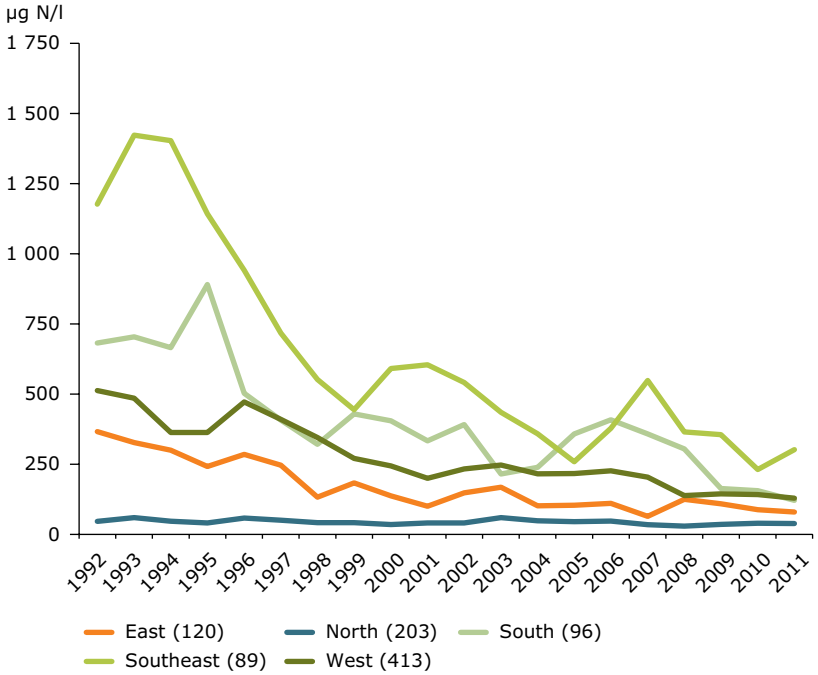


Figure 5.2 BOD5 concentrations and total ammonium concentrations in rivers between 1992 and 2011 in different geographical regions of Europe (cont.)



Note: The data series per region are calculated as the average of the annual mean for river monitoring stations in the region. Only complete series after inter/extrapolation are included (see indicator specification). The number of river monitoring stations included per geographical region is given in parentheses.

Geographical coverage:
North (Finland, Norway (**), Sweden (**));
West (Austria, Belgium, Denmark (*), Germany (**), France, Ireland, Liechtenstein (**), Luxembourg, United Kingdom);
South (Spain);
East (Czech Republic (*), Estonia, Latvia, Lithuania, Poland (**), Slovenia, Slovakia (*));
Southeast (Albania, Bulgaria, and former Yugoslav Republic of Macedonia).

(*) Denotes countries included in the top figure only.

(**) Denotes countries included in the bottom figure only.

Source: EEA (CSI 019).

The chemical quality of water bodies has improved significantly in the last 30 years but monitoring of priority substances listed in the WFD is inadequate in many Member States. The chemical status of a large proportion of water bodies is thus reported as unknown. Available information suggests that about 25 % of Europe's groundwater bodies (by area) have poor chemical status. High levels of chemicals, such as nitrates in groundwater bodies, are the most frequent cause.

Less than 10 % of Europe's surface waters (rivers, lakes, transitional and coastal waters) have poor chemical status. But the chemical status of 40 % of Europe's surface waters remains unknown, ranging between one third of lakes and more than half of transitional waters.

Human exposure and well-being implications

The quantitative, ecological and chemical status of European water bodies affects human well-being both directly (e.g. by impacting human health via drinking and/or bathing water quality) and indirectly (e.g. by undermining the ability of ecosystems to provide essential services that underpin human well-being). This section focuses on the former.

Human health can be adversely affected through lack of access to drinking water, inadequate sanitation, consumption of contaminated freshwater and seafood, and exposure to contaminated bathing water. For example, bioaccumulation of mercury and persistent organic pollutants may raise health concerns in vulnerable population groups such as pregnant women. Understanding of the relative contributions of different exposure routes is, however, incomplete. Similarly, the burden of water-borne diseases in Europe is difficult to estimate, and is most likely underestimated (ECDC, 2013; EEA/JRC, 2013; WHO, 2010a).

The Drinking Water Directive (DWD) (EU, 1998) sets quality standards for water 'at the tap', and 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. In a 2009 survey, the compliance rate with drinking water standards in smaller supplies was 65 %, while for larger ones it exceeded 95 % (EEA, 2010f).

In 2010, seven Member States reported 14 waterborne disease outbreaks involving 17 733 human cases. The largest outbreaks were caused by contamination of public water sources, mainly by *Campylobacter,* calicivirus*, Salmonella enteritidis* and *Cryptosporidium hominis* (EFSA, 2012). The largest cryptosporidiosis outbreak was reported in Sweden and involved 12 700 cases, related to contamination of drinking water source with raw sewage (EFSA, 2012). Several outbreaks were also reported in 2010 after the consumption of untreated natural spring water (ECDC, 2013).

In 2011, four Member States reported 11 outbreaks of waterborne disease, which involved 20 167 human cases in total. The pathogens detected were *Campylobacter*, calicivirus, verotoxigenic *E. coli* (VTEC) and *Cryptosporidium hominis*. The largest outbreak, due to *Cryptosporidium* in Sweden, accounted for 99 % (20 000) of cases reported in the four countries (EFSA, ECDC, 2013).

Another important link between water quality and human well-being relates to bathing water. The major sources of bathing water pollution are malfunctioning sewage systems, slurry and manure spills from farms and farmland, and mammal and bird excreta. Heavy rains increase pollution from farmlands and sewage, washing more pollution into water bodies and overflowing sewage systems.

To safeguard public health and protect the aquatic environment in coastal and inland areas from pollution, the first European bathing water legislation, the original Bathing Water Directive (EU, 1975) was adopted in 1975. New European legislation on bathing waters was adopted in 2006, updating the measures for management and surveillance of water quality (EU, 2006). Where short-term pollution occurs at bathing waters, the revised Bathing Water Directive requires that management measures (such as warnings or bathing prohibitions) be implemented to prevent bathers' exposure, and to prevent, reduce or eliminate the causes of pollution (Box 5.1).

Box 5.1 Waterborne disease in triathlon participants linked to contamination of coastal waters in Denmark

In August 2010, an unusual outbreak occurred in Denmark, when triathlon participants fell ill after competing in contaminated sea water outside Copenhagen. The swimming part of the competition was held on the morning following unusually heavy rainfall, which flooded the Copenhagen sewer system and lead to a sudden, transient microbial pollution of coastal waters. In a questionnaire survey, answered by almost 800 participants (about 60 % of the total), 55 % reported having had symptoms of acute gastroenteritis. There was an association between illness and the amount of sea water accidentally swallowed by triathlon participants.

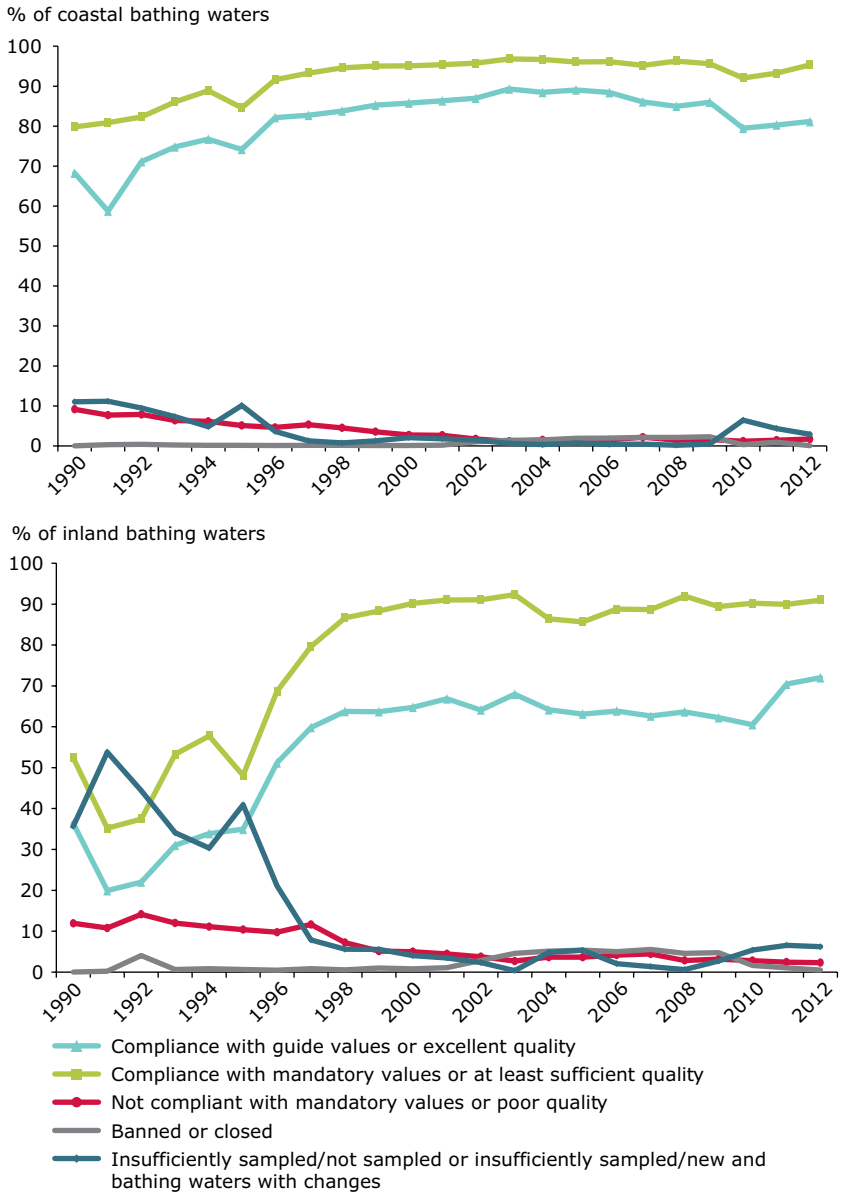
Source: Statens Serum Institute, 2010, in EFSA, 2012.

Information on short-term pollution should be made available to the public at the bathing site and in the media. In the event of short-term pollution, one additional sample must be taken to confirm that the incident has ended (EEA, 2012g).

Following many years of investment in the sewage system, combined with better wastewater treatment (see Figure 5.4), Europe's bathing waters have become much cleaner in recent decades (Figure 5.3). Sampling during the 2012 bathing season showed that bathing waters in Europe remained at the high level of quality reached in prior seasons (EEA, 2013g). Up to 94 % of bathing waters met the minimum water quality standards set by the EU directives (complying with the quality standard known as 'mandatory or at least sufficient').

Finally, the wide range of 'emerging contaminants' present in European waters is a growing environmental and human concern. These substances are used in pharmaceuticals, personal care and other consumer products, and their adverse effects have only recently become apparent. Understanding of their sources, emissions, levels and effects in the aquatic environment is also limited (EEA, 2011c, 2013h).

Figure 5.3 Percentage of bathing waters in the EU per compliance category, coastal (top) and inland (bottom)



Source: EEA, 2013g.

Governance aspects and levers for action

Protecting Europe's common water resources and ecosystems from pollution, over-abstraction and structural changes requires concerted action at the EU level. Over the past three decades, governance of EU waters has contributed successfully to water protection. Pollution from urban, industrial and agricultural sources is regulated, and this has brought about significant improvements in the quality of European waters, particularly by reducing excess nutrients (EC, 2012b).

The Water Framework Directive provides a framework for water protection and management, complementing earlier EU water policies that are still in place, such as those concerning urban wastewater and bathing water. In 2012, the Commission published the communication 'A blueprint to safeguard Europe's water resources' (EC, 2012b), which focuses on policy actions that can help improve implementation of current water legislation. The Blueprint focuses on the integration of water policy objectives into other policies. In addition, in recent years European countries that are not EU Member States have developed similar river basin activities to those introduced by the WFD in the EU Member States (EEA, 2012h).

Historically, the allocation of water to different sectors and users in Europe has not relied on free market mechanisms. In part, this reflects the relative abundance of water resources across much of the continent. But the characteristics of the resource have also prevented the emergence of water trading, meaning that competitive market forces have played little role in setting prices and incentivising economically efficient allocations of scarce water resources to the uses that generate the highest returns.

Further implementation of pricing policies could provide an incentive for more efficient water use. The Water Framework Directive explicitly requires cost-recovery for water services (including environmental and resource costs), taking into account the 'polluter pays' principle. Indeed, in its Article 9, the directive asks Member States to take account of the recovery of the costs of water services (including environmental and resource costs), assessed at the level of different sectors (disaggregated into agriculture, households and industry). In many instances, however, water users currently do not pay prices

that reflect the full cost of water supply, let alone the environmental impacts of water consumption or its value in alternative uses (EEA, 2012k).

In the context of growing concerns about the quantity and quality of available water resources, governance mechanisms are increasingly based on a recognition that priority should be given to ensuring adequate allocations to ecosystems and basic human needs, and that any remaining water resources should be distributed among sectors in a manner that delivers the greatest benefit to society (EEA, 2012k).

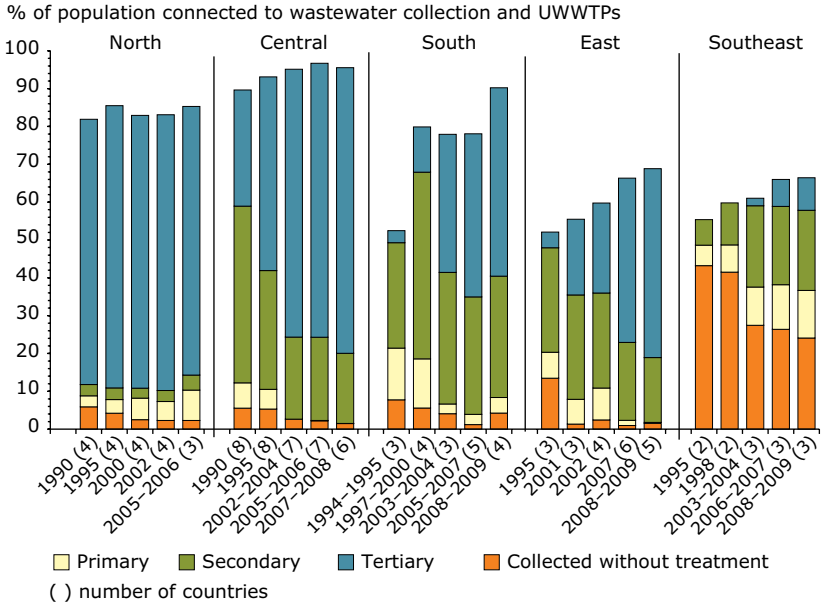
These principles are embodied in the Water Framework Directive, which requires Member States to ensure that all water bodies achieve 'good status' by 2015. To incentivise sustainable and efficient allocation of all water resources, the directive introduces the principle of recovery of resource and environmental costs. Recognising the importance of basic human needs, however, it also includes the possibility of derogations, for example in less-favoured areas or to provide basic services at an affordable price.

States have a range of tools available for achieving cost recovery, including direct regulation of prices of public supplies, water taxes (as exist in the Netherlands, Denmark) and establishing markets for water allocations (as in Spain). Introduction of metering and tackling illegal abstraction are important complementary measures.

In addition to the quantitative aspects of water security, human well-being is also affected by water quality. These two aspects are interlinked since greater scarcity normally implies the need for more efforts and resources to clean available water. Water stress can thus be tackled by efficiency measures that reduce the total volumes extracted, as well as by pollution abatement.

Two alternative approaches are available for pollution abatement: 'end-of-pipe' solutions, such as wastewater treatment; or 'at source' measures, which aim to reduce the use and emission of polluting substances by economic sectors (e.g. through resource-efficiency measures or spatial legislative restrictions that limit the use of certain substances such as pesticides in designated areas).

Figure 5.4 Regional variation in wastewater treatment between 1990 and 2009



Note: Primary (mechanical) treatment removes part of the suspended solids.

Secondary (biological) treatment uses aerobic or anaerobic micro-organisms to decompose most of the organic matter and retain some of the nutrients (around 20–30 %).

Tertiary (advanced) treatment removes the organic matter even more efficiently. It generally includes phosphorus retention and in some cases nitrogen removal.

This figure illustrates the percentage of the population in each European region that was connected to wastewater collection and treatment systems over the period 1990–2009. In addition, a breakdown by treatment type is portrayed. The development of wastewater 'collected without treatment', in particular for northern Europe, seems to be partly due to a change in data sources used to underpin this parameter during the reporting period — this will be accounted for in the next update of this indicator.

Geographical coverage:
North (Norway, Sweden, Finland and Iceland);
Central (Austria, Denmark, England and Wales, Scotland, the Netherlands, Germany, Switzerland, Luxembourg and Ireland);
South (Cyprus, Greece, France, Malta, Spain and Portugal);
East (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovakia);
Southeast (Bulgaria, Romania and Turkey).

Source: EEA, 2010 (CSI 024).

Regarding 'end-of-pipe' approaches to cleaning up pollution, the implementation of the Urban Waste Water Treatment Directive 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 reduced discharges of nutrients, microbes and some hazardous chemicals to receiving waters. It has also led to substantial improvements in the microbial quality of Europe's inland and coastal bathing waters (EEA, 2010e, 2010f).

Looking ahead, there will be a need to focus on both 'end-of-pipe' and 'at-source' approaches to pollution abatement. Major investment will certainly be needed to maintain and upgrade existing wastewater treatment infrastructure. Furthermore, improved recycling of nitrogen and phosphorus from wastewaters, also by utilising new sewage management technologies, would reduce pollution in water resources.

Greater adoption of pollutant-recovery techniques in sectors such as industry could be stimulated by greater awareness of their potential economic benefits. This in turn would also help deliver environmental benefits, particularly in water saving, thus contributing to more sustainable water supplies.

Equally, it is clear that certain pollutants, such as endocrine-disrupting chemicals and pharmaceuticals, can pose persistent environmental and human risks even in treated effluent. This shows that although 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.

6 Energy

Although fundamental to modern lifestyles and living standards, energy production is also responsible for considerable harm to the environment and indirect impacts on human well-being. While all energy sources and technologies impose a mixture of financial, environmental and human costs, fossil fuels today impose the greatest aggregate burden, causing damage across the life cycle, including resource extraction, transportation, and energy generation and use.

Market forces have played an important role in shaping the European and world energy systems — both in terms of the choice of fuels and the amount of energy consumed. After decades of public support, fossil fuels generally dominate the energy system. They can be acquired, stored and converted into energy comparatively cheaply. But because market prices do not reflect the substantial environmental and human costs that fossil fuels inflict on current and future generations, they incentivise the creation of an energy system that fails to produce the best outcomes for society. The globalised nature of energy resource flows and related pollution necessitates a coordinated international response. During recent decades European governments have thus assumed an ever greater role in correcting incentives and reshaping the energy system.

This chapter describes resource use based on indicators of past energy consumption trends (CSI 027, 028) and the resources used to meet that demand (CSI 029). Environmental pressures are exemplified using data on emissions of pollutants associated with fossil fuel combustion (CSI 001, 002, 003). The impacts of energy use on humans are likewise illustrated using indicators of air pollutant exposure (CSI 004) and of damage caused by weather and climate-related events (CLIM 039). Governance aspects are presented using Eurostat data on national taxation of energy use.

Other related EEA indicators (see Annex) and reports include:

- Indicators and indicator sets: air pollution (APE), climate change (CLIM), energy (ENER) and transport (TERM)
- *EU bioenergy potential from a resource efficiency perspective* (EEA, 2013f)
- *Climate change, impacts and vulnerability in Europe 2012 — an indicator-based report* (EEA, 2012c).

Resource-use pattern

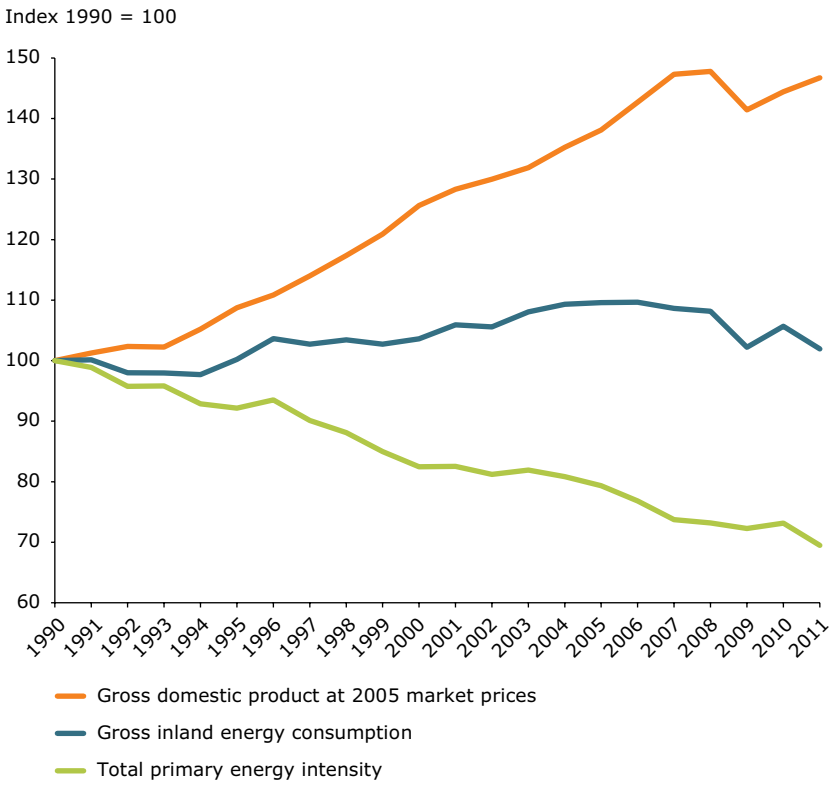
The process of converting natural resources into energy has always played a central role in human development — from providing the means to keep warm and forge tools, to powering the economic and social systems of production, transport and communication that today provide for much of our material well-being.

Although energy is unquestionably central to the functioning of EU-27 economies and societies, the relationship between energy use and economic growth is certainly not linear. Historically, economic development has brought with it major changes in terms of the fuels and conversion technologies employed, and in terms of the types and efficiency of end uses of those fuels. The result has been tremendous increases in aggregate energy efficiency — i.e. the energy resources consumed to produce economic output. Maddison (2003 and 2006), for example, estimates that US energy consumption per person only tripled in the long period from 1820 to 1998, despite a more than 20-fold increase in per capita gross domestic product (GDP).

The same forces are equally apparent over shorter time scales. As illustrated in Figure 6.1, EU-27 energy consumption has remained fairly stable since 1990, despite steady GDP growth up until 2008.

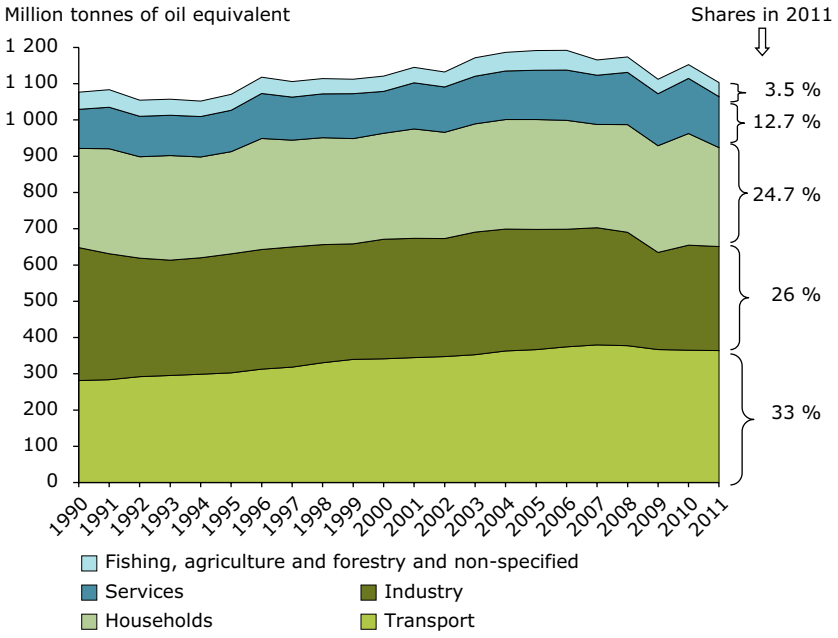
While aggregate energy consumption remained fairly steady in the period 1990–2010, there were shifts in the relative energy consumption of different sectors (Figure 6.2). The transport and service sectors increased their consumption by about 30 %. Meanwhile, industry recorded a 30 % decline, although the recent economic crisis played a significant role in this reduction, with industry's energy consumption falling by almost 15 % between 2008 and 2009. That drop contributed to a 5.2 % reduction in EU-27 final energy consumption between 2008 and 2009.

Figure 6.1 EU-27 energy intensity, 1990–2011



Source: EEA (CSI 028).

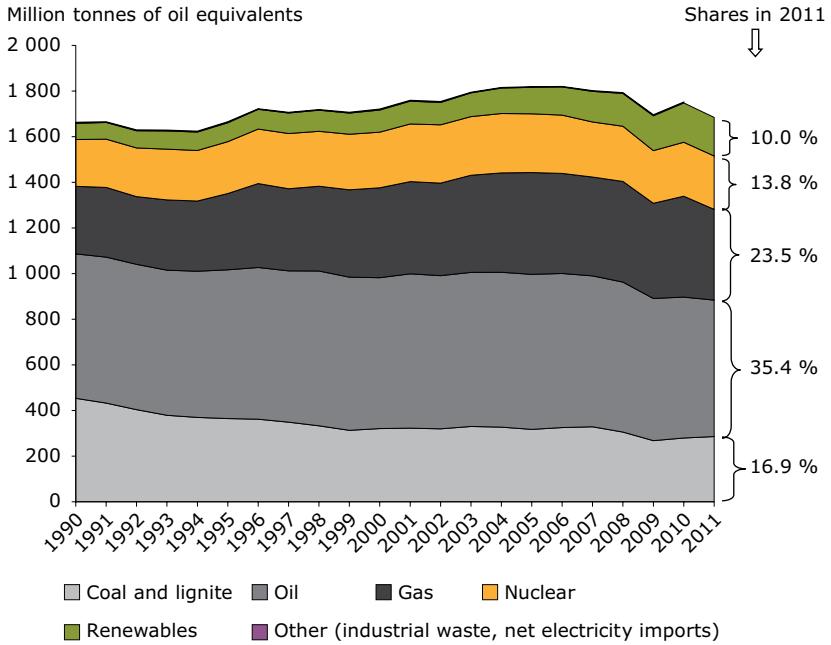
Figure 6.2 EU-27 final energy consumption by sector, 1990–2011



Source: EEA (CSI 027).

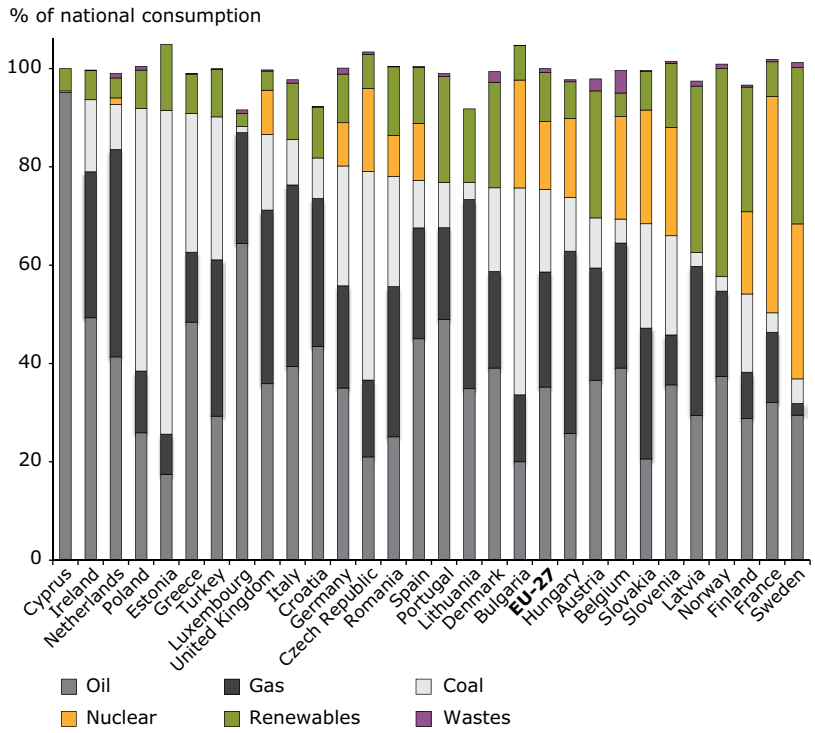
The relative stability in energy output since 1990 has also masked some substantial changes on the production side (Figure 6.3). Coal's contribution to aggregate energy consumption declined in the period 1990–2011 (from 27 % to 17 %), the contribution of gas increased (18 % to 24 %), and the contribution of oil remained broadly unchanged. As a result, the EU-27 remains heavily dependent on fossil fuels, which accounted for 76 % of primary energy consumption in 2011 compared to 83 % in 1990. The slight decline in the contribution of fossil fuels was largely offset by increased use of renewable energy, which provided 10 % of EU energy needs in 2011, up from 4 % in 1990. Nuclear energy retained a fairly steady share of the EU-27 energy mix, rising from 12 % in 1990 to 14 % in 2011.

Figure 6.3 EU-27 primary energy consumption by fuel, 1990–2011



Source: EEA (CSI 029).

Figure 6.4 National energy consumption by fuel, 2011



Note: Covers EEA-33 countries for which data are available.

Countries are ordered from left to right according to the contribution that fossil fuels (oil, gas and coal) make to total energy consumption. Where national totals exceed 100 (e.g. Estonia), it is because those countries are net exporters of electricity. Conversely, where the totals are less than 100 (e.g. Luxembourg), it is because a portion of national consumption is met through imports of electricity.

The 'wastes' category comprises industrial wastes and non-renewable wastes (energy from other waste categories falls under 'renewables').

Source: EEA (CSI 029).

Within Europe, there is substantial variation in the mixture of fuels and technologies employed to generate energy (Figure 6.4). Although fossil fuels dominate in almost all countries, their contribution to national energy consumption varies between 96 % in Cyprus and 37 % in Sweden. While coal consumption has generally declined, it continues to account for a substantial proportion of the energy mix in some countries, such as Estonia (66 %), Poland (49 %), the Czech Republic and Bulgaria (both 42 %). Nuclear energy offsets the reliance on fossil fuels in some countries, most notably France, where it accounts for 44 % of energy consumption. Renewables likewise play a minor role in most countries, although countries with substantial hydroelectric capacity are obvious exceptions. Renewables account for 42 % of energy consumption in Norway, 34 % in Latvia and 32 % in Sweden.

A substantial proportion of EU-27 energy output relies on fuels imported from non-EU countries, in particular imports of crude oil. Although dependence on imports of fossil fuels (gas, solid fuels and oil) was very stable between 2005 and 2010, the period 1990–2005 saw a sharp increase in fuel imports, from 45 % of gross inland consumption to 54 %. Almost three-quarters of that increase in import dependency was due to higher gas imports (EEA, 2011d). The EU-27 is also almost entirely dependent on imports of uranium for its nuclear sector.

Global competition has also driven structural changes in the EU economy, with many needs for manufactured goods now met by producers outside Europe. Although data on the amount of energy used to produce Europe's imports of goods are not available, estimates of greenhouse gas emissions embedded in EU imports can serve as a useful proxy. Eurostat (2011a) estimates that in 2007 the CO_2 emissions implicit in EU consumption equalled 8.9 tonnes per capita, whereas the EU production system emitted about 7.2 tonnes per capita. This suggests that EU energy use is also likely to be higher if viewed from a consumption perspective (i.e. including imported goods and excluding exports). Thus, in addition to being heavily dependent on imports of fuels from overseas, the EU is probably a net importer of energy via trade in materials and goods.

Environmental pressures

The energy system consists of a complex web of links between numerous sources, conversion pathways, and end uses. It generates significant environmental burdens at each stage. A large portion of the energy resources exploited in the EU is sourced from overseas, and much of the resulting pollution likewise crosses international borders, generating global impacts.

While all energy sources generate costs of one sort or another, fossil fuels exert the greatest burden on the environment. Impacts potentially occur across the life cycle of a fossil fuel, including during extraction of fuels (e.g. damage to landscapes) and transportation (e.g. oil spillage). However, the most significant and widespread effects result from the emissions released when they are burned. Fossil fuels account for a substantial proportion of EU emissions of a range of pollutants, including carbon dioxide, sulphur oxides, nitrogen oxides, non-methane volatile organic compounds and particulate matter (Figure 6.5). They are also responsible for most greenhouse gas emissions (Figure 6.6).

The environmental impacts of such emissions are highly diverse. As detailed in Table 6.1, some pollutants have direct effects on plants and animals (including humans), such as the lung damage caused by releases of particulate matter. Of even greater concern, however, are the diverse second-order impacts that occur via the myriad linkages and interactions in ecological systems. For example, several different pollutants combine to form ozone, which causes harm to vegetation and human health. Other pollutants cause acidification and eutrophication in soil and water. The gravest impacts potentially arise from greenhouse gases such as CO_2 and SO_X, because climate change alters fundamental environmental conditions, a phenomenon with far-reaching implications for habitats and the diversity and distribution of species.

While fossil fuels undoubtedly generate the greatest environmental harm today, all energy sources carry a mixture of benefits and costs. Nuclear power, for example, appears to offer the considerable advantage of producing energy without emitting greenhouse gases. Yet construction and decommissioning of power stations and processing of nuclear fuel all require energy.

The IPCC estimates that the total life cycle carbon emissions per unit of electricity produced from nuclear power are less than 40 g CO_2/kWh(e) (Sims et al., 2007). While this is about a tenth of the emissions associated with generating energy from natural gas and perhaps a twentieth of the emissions from coal (IEA, 2012), it is not negligible. Moreover, nuclear energy creates other serious environmental challenges. These include long-term issues related to waste management and disposal; the associated risks of radioactive contamination; and impacts on local ecosystems due to the extraction of cooling water and discharge of warmer water. Disasters such as those at Chernobyl and Fukushima illustrate the challenge for decision-makers in balancing the advantages of nuclear power against the 'low probability, high impact' risks that it brings.

Several renewable technologies offer clearer advantages, combining energy that is almost free of greenhouse gases with unlimited and costless fuel. Nevertheless, integrating a growing share of renewable energy sources into our energy grid requires current infrastructure to be modernised to create more flexibility and ensure grid stability.

The renewable technologies themselves are often costly in financial terms and demand substantial resource inputs. They also give rise to environmental impacts across the full life cycle, although these are normally substantially lower than in the case of non-renewable energy technologies. Solar panels, for example, typically offset the GHG emissions generated during manufacture after 1–2 years of use (Fthenakis et al., 2008) but may demand land resources and water during the use phase, depending on the technology deployed. Wind-power technologies can harm wildlife and disrupt landscapes. Hydroelectricity significantly affects aquatic ecosystems, harming riverine species. Geothermal power can cause air and water pollution, as well as land subsidence.

Figure 6.5 EEA-33 emissions of selected air pollutants by main source sectors, 1990–2011

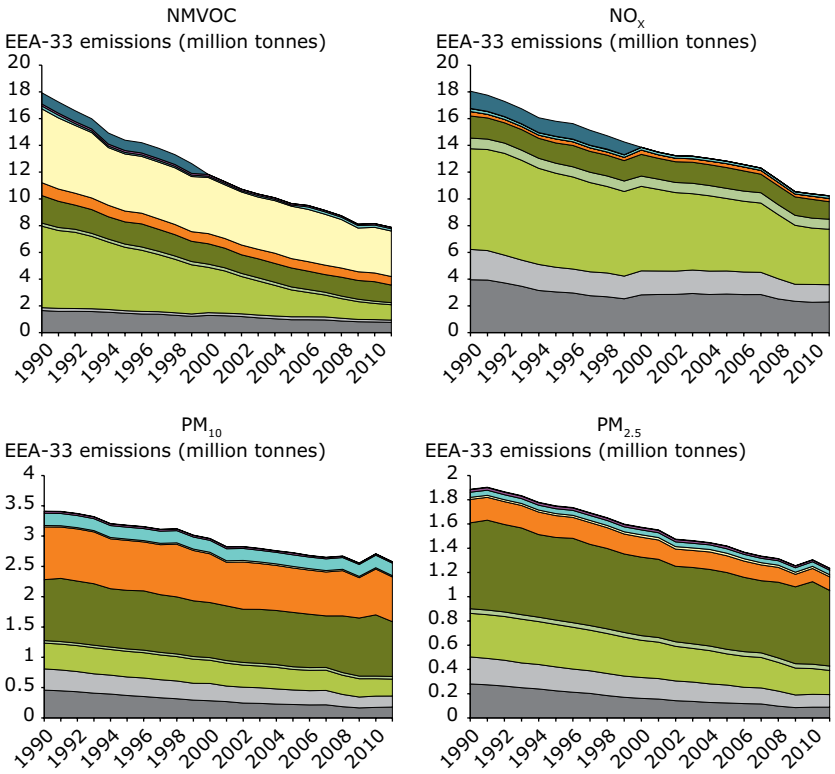
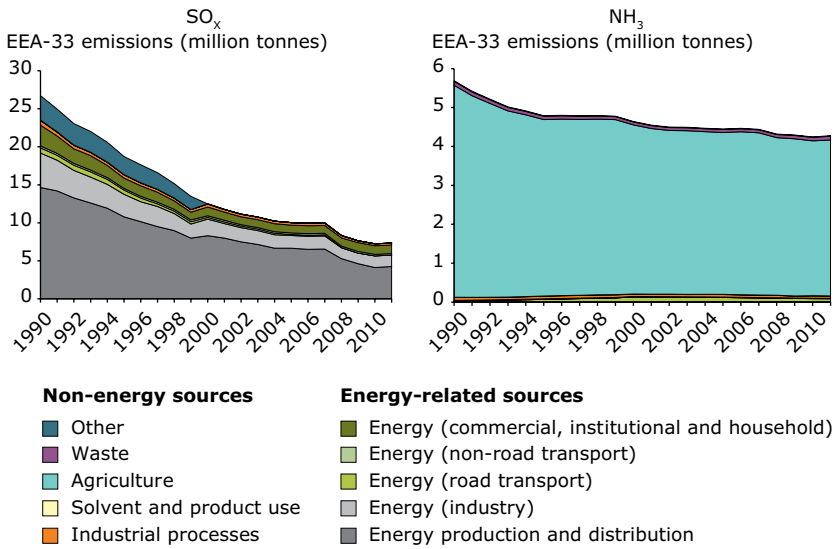


Figure 6.5 EEA-33 emissions of selected air pollutants by main source sectors, 1990–2011 (cont.)

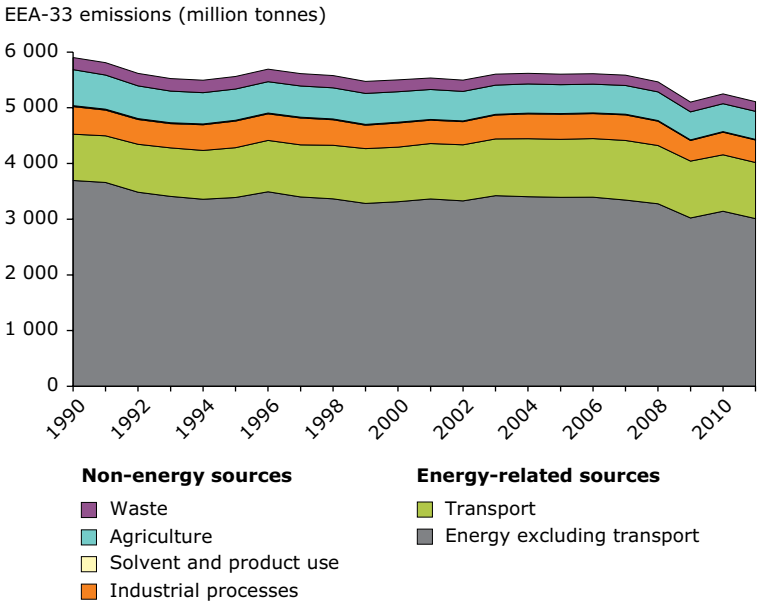


Note: A limited amount of transport air pollutant emissions of $PM_{2.5}$ and PM_{10} result from tyre and brake-wear, and road abrasion. Emissions related to energy production from waste are categorised as 'energy'.

Ammonia (NH_3) emissions are not associated with energy generation but are included here because of their relevance in terms of food system impacts (see Chapter 4).

Source: EEA (CSI 001, 002, 003).

Figure 6.6 EEA-33 emissions of greenhouse gases by main source sectors, 1990–2011

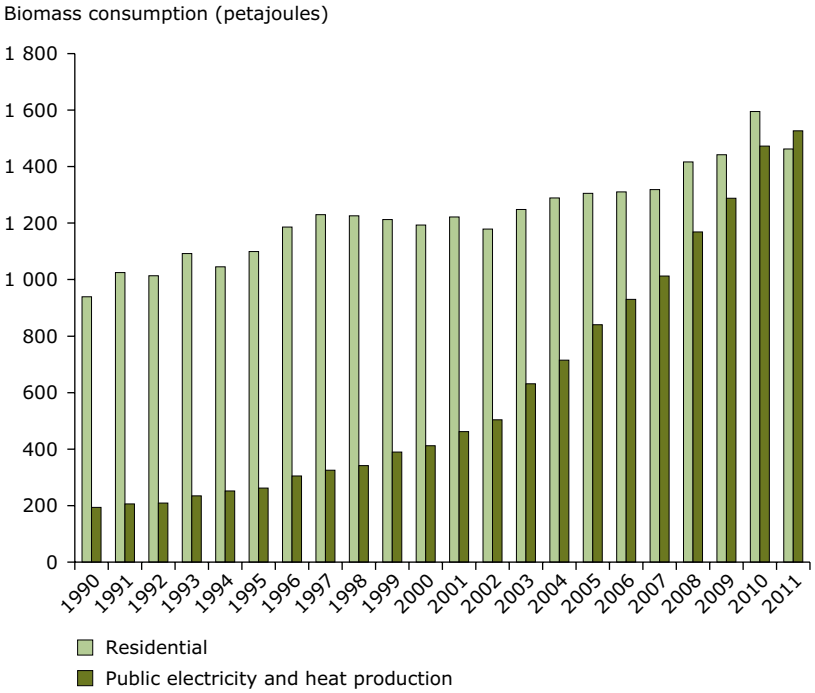


Source: EEA (CSI 011).

Bioenergy can have particularly far-reaching impacts, depending on the type of biomass resources used. Although burning waste and agricultural by-products implies fairly limited upstream environmental risks, cultivating energy crops involves substantial land use. This may result in major impacts on ecosystems, either directly or by displacing farming to previously uncultivated areas, including forests (EEA, 2013f). Similarly, increased use of forest biomass is a concern because it may take decades for regrowth to offset the initial release of carbon from wood and soils.

Burning all forms of biomass results in greenhouse gas and air pollutant emissions. This means that in the absence of adequate safeguards, some forms of biomass may offer few environmental benefits relative to fossil fuels (EEA, 2013f). This is particularly important because biomass combustion has increased markedly in recent years, driven by renewable energy policy targets and the combined effects of higher fuel prices and economic recession. As illustrated in Figure 6.7, the burning of biomass in thermal power stations (power stations that generate electricity by combusting fuels) has surged since 2000 as EU Member States seek to achieve the commitments they have made in National Renewable Energy Action Plans. According to these plans, biomass will provide for about 10 % of EU energy consumption by 2020 (EEA, 2013f).

Figure 6.7 EU-27 consumption of biomass in residential and public energy generation, 1990–2011



Source: EEA, 2013b.

Table 6.1 Impacts of fossil fuel and bioenergy air emissions on ecosystems, climate and human health

Pollutant	Direct effects on ecosystems	Effects on climate	Direct effects on human health
Particulate matter (PM)	Can affect animals in the same way as humans. Affects plant growth and ecosystem processes. Can damage buildings. Reduced visibility.	Net cooling or warming, depending on particle size and composition. Changed rainfall patterns.	Cardiovascular and lung diseases, cancer, impacts on the central nervous and reproductive systems, premature mortality.
Ozone (O_3) (ground level)	Damages vegetation, impairing reproduction and growth. Alters ecosystem structure, reduces biodiversity and decreases CO_2 uptake of plants.	Ozone is a greenhouse gas contributing to warming of the atmosphere.	Decreased lung function, aggravating asthma and other lung diseases, premature mortality.
Nitrogen oxides (NO_x)	Acidification and eutrophication of soil and water, changing species diversity. A precursor of O_3 and PM. Damage to buildings.	Contributes to the formation of O_3 and PM, with associated climate effects.	Harm to the liver, lung, spleen and blood. Aggravating lung diseases, leading to respiratory problems.
Sulphur oxides (SO_x)	Acidification of soil and surface water. Harms vegetation and species in aquatic and terrestrial systems. Contributes to PM formation. Damages buildings.	Contributes to the formation of sulphate particles, cooling the atmosphere.	Aggravates asthma and can reduce lung function and inflame the respiratory tract. Can cause headache, general discomfort and anxiety.
Carbon monoxide (CO)	May affect animals in the same way as humans.	Contributes to the formation of greenhouse gases such as CO_2 and O_3.	Can lead to heart disease and damage to the nervous system and cause headaches, dizziness and fatigue.
Heavy metals	Most heavy metals are highly persistent and bioaccumulate in the environment (meaning their toxic effects cannot be broken down by natural processes), with highly toxic impacts on aquatic life, birds and land animals.	No specific effects.	Arsenic, cadmium and nickel are carcinogens. Alongside lead and mercury, they also harm multiple internal organs and systems.

Table 6.1 Impacts of fossil fuel and bioenergy air emissions on ecosystems, climate and human health (cont.)

Pollutant	Direct effects on ecosystems	Effects on climate	Direct effects on human health
Benzene (C_6H_6)	Acute toxic effects on aquatic life. Bioaccumulates and causes reproductive problems and changes in appearance or behaviour. Damages and kills plants.	Greenhouse gas causing atmospheric warming directly and by forming O_3 and secondary organic aerosols.	A human carcinogen, which can cause leukaemia and birth defects. Can affect the central nervous system, blood production and the immune system.
Benzo-a-pyrene (BaP)	Toxic to aquatic life and birds. Bioaccumulates, especially in invertebrates.	No specific effects.	Carcinogenic. Other effects include irritation of the eyes, nose, throat and bronchial tubes.
CO_2	Enhances photosynthesis. No direct harm but multiple impacts on plants and fauna due to changes in conditions such as temperature, precipitation, etc.	CO_2 is the most significant greenhouse gas influencing climate change.	No direct harm but multiple impacts as a result of the influence of climate change on environmental, social and economic systems.

Source: EEA, 2012b.

Although less dramatic, the 56 % growth in the amount of biomass burnt by households in the period 1990–2011 is also a major concern. The lack of filters on domestic burners means that households are now the main source of fine particulate matter emissions in the EU and are also directly exposed to these emissions (Figure 6.5). Increased household use of biomass also raises concerns about whether the fuel used is being sourced sustainably.

In general, renewable technologies cause much less environmental harm than the alternatives that currently dominate the energy system. Nevertheless, they do create costs (including often comparatively large financial expenses) that need to be reflected in decisions about the optimal energy mix.

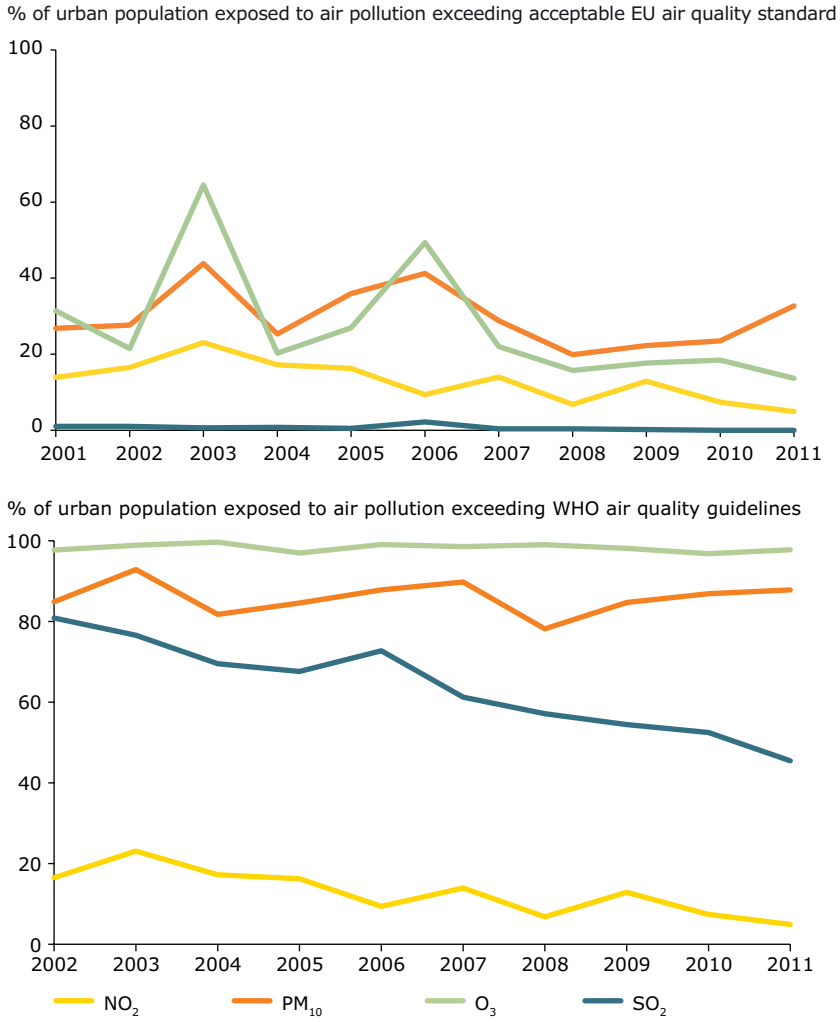
Human exposure and well-being implications

As noted above, the energy system plays an essential role supporting most aspects of modern lifestyles — providing for our basic needs, while driving key systems such as transport, commerce, communication and entertainment. It thereby contributes in innumerable ways to human well-being.

At the same time, the current system of sourcing and generating energy can cause much harm or discomfort to humans. This can occur directly, for example via pollution or noise (the latter being a major issue for the transport system). Or it can occur indirectly through impacts on ecosystems that alter their capacity to deliver vital services such as provisioning other essential resources (water, food and materials), regulating a healthy environment, and sustaining precious cultural and recreational values.

Fossil fuels account for much of the harm caused by the energy system to human well-being. Despite a decline in recent years, human exposure to energy-related air pollutants in Europe remains considerable (Figure 6.8), causing diverse direct impacts on human health (Table 6.1). In the period 2001–2010, between 15 % and 61 % of the EU urban population was exposed to O_3 concentrations above the EU target value for protecting human health, and substantial

Figure 6.8 Percentage of the EU urban population living in areas where air pollution exceeds acceptable EU air quality standards (top) and WHO air quality guidelines (bottom)



Note: The values for the EU air quality standards and WHO air quality guidelines are available in EEA, 2012b.

Source: EEA (CSI 004).

proportions of the EU population were also exposed to excessive NO_X and PM_{10} levels. The percentages exposed to pollution exceeding the stricter World Health Organization guidelines were much higher (EEA, 2012b).

Geographical variance in emission sources and complex interactions of air pollutants mean that it is impossible to determine exactly what proportion of exposure to these pollutants is related to the energy system but it is clearly substantial. As illustrated in Figure 6.5, energy generation (including in the transport, industry and household sectors) accounts for more than 90 % of the EU's NO_X and SO_X emissions and for the great majority of PM. It is also responsible for a large amount of ozone precursor emissions.

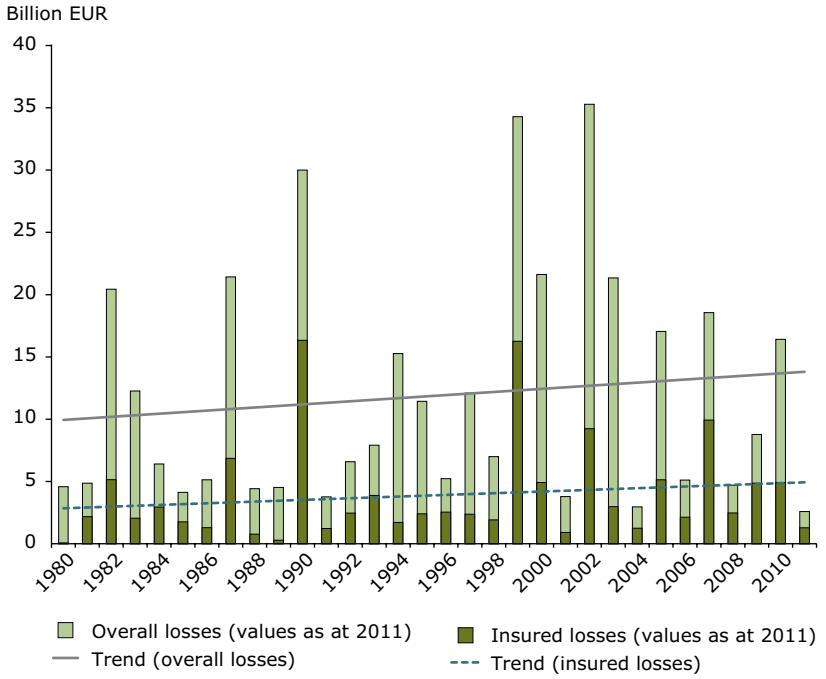
Looking beyond direct health impacts, the links between the energy system and human health are highly complex, mediated via multiple pathways, including social and economic systems.

The energy system's impacts on the climate have potentially the greatest implications for human well-being. While it is impossible to link individual events to climate change (EEA, 2013c), the expected changes in the frequency and intensity of extreme events — such as drought in southern Europe and floods in the north — are likely to create diverse direct risks to human health and infrastructure (EEA, 2012c).

Evidently, the impacts of weather and climate-related events on human well-being depend not only on environmental change but also on social and economic developments, for example urban sprawl. In monetary terms, inflation-adjusted average annual losses from extreme weather events have increased from EUR 9 billion in the 1980s to more than EUR 13 billion in the 2000s (Figure 6.9), primarily as a result of increases in population, economic wealth and human activities in hazard-prone areas, as well as because of better reporting of those losses (EEA, 2012e).

Together with other drivers, including socio-economic conditions, globalisation of travel and trade, and shifts in land use and biodiversity, climate change also contributes to the transmission of certain diseases. It has, for example, allowed the tick species *Ixodes ricinus* to thrive further north and made parts of Europe more suitable

Figure 6.9 Annual damages from weather and climate-related events in EEA member countries



Source: EEA (CLIM 039).

for disease-carrying mosquitos and sandflies. The duration and spatial distribution of the pollen season has also expanded, today arriving 10 days earlier than 50 years ago, with impacts on allergic diseases (EEA/JRC, 2013).

Heat waves are projected to be more frequent and intense in some regions of Europe. Their health impacts, especially in vulnerable groups, may be further exacerbated by air pollution, especially through increased formation of ground-level ozone (EEA, 2012c; EEA/JRC, 2013). In addition to direct health impacts, climate change also has the potential to spark conflict or migration by altering access to essential resources. This is a particular concern in parts of the world that are set to face harsher environmental change and are ill-equipped to adapt.

The energy system has important links with the water and food systems — a fact reflected in the prominence of the 'water-energy-food' nexus in current policy debate, for example the Bonn Nexus Process (Federal Government of Germany, 2013). Europe's largely carbon-based energy system accounts for 37 % of water abstraction in Europe (EEA, 2010h), which is more than any other sector. Although much of the water used in energy generation is returned to local water systems, it can impact ecosystems because of the higher temperature or the rate at which it is released.

The interdependence of energy, water and food raises particular concerns in relation to the fast-growing bioenergy sector, with the allocation of land between competing uses having potentially far-reaching impacts on human well-being. Where agricultural land is used to cultivate energy crops, it often results in both direct and indirect changes to land use, including necessitating expanded or intensified agricultural production at other locations. This can have significant implications for the natural environment, such as biodiversity, and for the water, nutrient and carbon cycles. This in turn affects ecosystem functioning and resilience in many ways.

Societies also feel the effects of land allocation decisions via markets. Biofuels production is recognised as a key cause of the world food price shock of 2007–2008 (Mitchell, 2008). Since food accounts for a relatively large proportion of the spending of poorer people, especially those in developing countries, it was the poor that endured the harshest impacts from the surge in prices. This illustrates the complex feedbacks that arise in interdependent environmental, social and economic systems.

In sum, renewable energy sources generally offer a means to generate energy at much lower costs to the environment and to human well-being. Renewable energy also boosts energy security and potentially creates skilled jobs (for example in establishing and maintaining installations). Nevertheless, they can also produce negative impacts. For example, in addition to influencing the availability of other resources, the energy system has major implications for the well-being that humans derive from living in and experiencing the natural environment. While cultural values of this sort can seem abstract, they can have a major influence on decision-making — a reality reflected in the intense debate in some countries over the desirability of wind farms.

Governance aspects and levers for action

Historically, Europe's choices about how much energy to consume and how to generate it have largely been shaped by market forces — and in particular by the relative costs of extracting fuels and converting them into energy. Since market prices for energy seldom reflect the full environmental and social costs, they result in an energy system dominated by fossil fuels, resulting in substantial harm to humans and the environment.

Although there are very significant uncertainties in estimating the financial value of such non-market costs, available analysis indicates that the sums are very large. For example, the EEA (2011e) estimates that air pollution by large power plants in 2009 caused damage to humans and the environment worth EUR 66–112 billion. The Stern Review likewise estimated that 'the overall costs and risks of climate change will be equivalent to losing at least 5 % of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20 % of GDP or more' (Stern, 2006).

The dominance of fossil fuels in the global energy system is also partly due to the dispersed character of the harms it causes. Whereas wind turbines have an immediate effect on landscapes and local people, impacts resulting from emissions of greenhouse gases and long-range air pollutants spread across international borders and across generations, greatly weakening the incentives for an effective response. A focused group of local people affected by wind farm development may have strong incentives to organise and influence planning decisions; in contrast, the vaguely defined victims of climate change have little recourse — especially if they number among future generations.

Furthermore, the transboundary characteristics of the problem can create incentives for individual countries to act in a self-interested way, rather than engaging in the coordination needed for good governance. A country is less likely to reduce pollution where the impacts are felt elsewhere and its own situation depends on reciprocal actions from other countries. After all, one country's actions may have little impact on global emissions and could even incentivise other countries to emit even more, 'free-riding' on the efforts of others. The prospects of

international agreement are further undermined by difficult questions about how to share the burden of emissions abatement, in particular the balance between industrialised and developing countries.

Despite the challenges, governments are increasingly intervening to reshape the global energy system so that it delivers better environmental and social outcomes. In Europe, national governments have taken steps to correct market forces for a century or more, imposing regulatory limits on air pollution and taxing fuel consumption ([3]). More recently, growing recognition of the need for an international response to pollution and climate change has manifested in a variety of intergovernmental measures. At the EU level, these include the Euro standards for vehicle emissions and the Large Combustion Plant Directive, which aims to reduce acidification, ground level ozone and particles emitted by large industrial and energy facilities. At the global scale, agreements include the United Nations Framework Convention on Climate Change and its Kyoto Protocol, and the UNECE Convention on Long-range Transboundary Air Pollution.

To complement international efforts, the EU has established a range of legislative targets that provide the framework within which regulatory, market-based and informational tools can be deployed. The most prominent of these are the '20-20-20' objectives (EC, 2007), targeting a 20 % cut in EU greenhouse gas emissions between 1990 and 2020, alongside a 20 % share of renewable energy in total energy output by 2020, and a 20 % increase in energy efficiency by 2020 (which the Energy Efficiency Plan (EC, 2011c) translates into a 20 % reduction in consumption of primary energy compared to projected 'business-as-usual' consumption of 1 842 Mtoe in that year). Further ahead, the EU is targeting an 80–95 % cut in greenhouse emissions by 2050 (EC, 2011b), which is regarded as the level of reduction needed from developed countries to prevent global average temperatures rising by more than 2 ˚C compared to pre-industrial levels (IPCC, 1995).

([3]) It is interesting to note that, whereas governments increasingly seek to reshape many aspects of the energy system (e.g. choice of fuels, conversion technologies and overall consumption levels) by intervening to constrain market forces, they are also acting to liberalise other aspects of the energy market. Electricity grids remain largely fragmented in Europe (partly reflecting historic concerns about energy security) and government and EU efforts in this area focus on establishing an integrated energy distribution infrastructure and market.

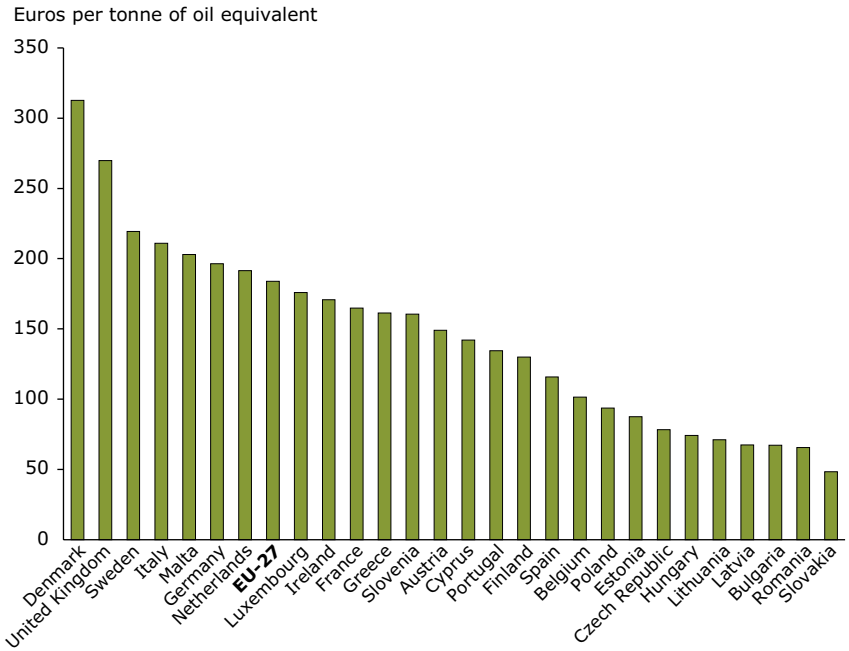
To achieve these targets, governments have at their disposal multiple mechanisms for shaping the production and consumption aspects of the energy system. These include regulatory standards such as limits on emissions of pollutants and greenhouse gases from point sources and vehicles, energy efficiency standards for buildings and household appliances, and the promotion of renewables. Measures targeted at enhancing efficiency (including product standards and subsidies for the development and adoption of new technologies) have some appeal as they offer producers and consumers the chance to reduce their expenses at the same time as mitigating environmental impacts.

The mechanisms available to governments also include market-based tools such as the EU Emissions Trading System, which sets the aggregate permissible emissions for a substantial proportion of European industry (together accounting for about 40 % of the EU's total greenhouse gas emissions) and enables individual companies to trade their emissions entitlements. As a result, the reductions are made at installations where they can be achieved most cheaply.

Measures to correct market prices (e.g. imposing environmental taxes) have theoretical appeal, since they potentially create the incentives for reducing pollution to a socially desirable level at the least cost. EEA analysis (2011a, 2011b) suggests that there are significant opportunities to design taxes that combat carbon emissions while boosting both innovation, employment and earnings. Moreover, as illustrated in Figure 6.10, there is substantial variation in the tax rates on energy across Europe, suggesting much scope for a reorientation of the tax burden away from economically desirable activities such as labour and onto harmful pollution.

Nevertheless, market-based measures face barriers to their design and implementation. Besides the technical difficulty of assessing the appropriate tax rate to offset externalities, there are concerns regarding the social equity and political viability of such approaches. Pricing measures are likely to hit the poorest hardest because the inelasticity of demand for necessary goods like energy implies a regressive impact (EEA, 2011a). Although such impacts can be offset through welfare payments, it can be hard to overcome public opposition to fuel price rises, particularly as businesses also tend to oppose such increases due to concerns about competitiveness.

Figure 6.10 Implicit tax rate on energy, 2011



Note: The implicit tax rate on energy is defined as the ratio between annual energy tax revenues and final energy consumption. Energy tax revenues are measured in Euros (deflated with the final demand deflator) and final energy consumption in tonnes of oil equivalent.

Source: Eurostat.

Producers are also likely to object to measures that increase energy prices. Such costs make up a portion of the total expenses of producing tradable goods, putting domestic producers at a disadvantage relative to international competitors. These concerns do not make market-based approaches unworkable but they do highlight the need for careful analysis of the problem. Ultimately, all changes to the energy system are likely to involve trade-offs. Even if society as a whole stands to gain, the distribution of benefits and costs is unlikely to be even. As such, policies must be designed carefully to ensure equitable and achievable results.

7 Housing

Adequate housing is a fundamental human demand, accounting for a substantial share of total human use of natural resources — predominantly construction materials, fuels and land. The environmental pressures associated with housing are not only construction-related (e.g. mining, energy and water use, waste generation), but also include the use phase, with heating and transport being the main sources of energy demand. The land use associated with housing and related infrastructure development results in loss and fragmentation of natural habitats. The health and well-being impacts of housing include comfort (floor space and heating) as well as the attractiveness of the living environment (both socially and environmentally) in which the housing is located.

Access to construction materials and energy is to a large extent shaped by markets, but the construction itself is often strictly regulated, both in terms of technical requirements and spatial restrictions (urban planning). Socio-economic and environmental considerations interact and result in widely varying spatial development models for housing.

This chapter describes resource use based on Eurostat data on population growth, household size, and the composition of the housing stock. Resulting environmental pressures are exemplified using Corine Land Cover data (CSI 014) to convey urban sprawl patterns. Human well-being issues are illustrated with Eurostat data on overcrowding and adequacy of heating, and with CSI 014 data on access to green spaces.

Other related EEA indicators (see Annex) and reports include:

- Indicators and indicator sets: transport (TERM)
- *Consumption and the environment — 2012 update* (EEA, 2012d)
- *Environmental pressures from European consumption and production.*

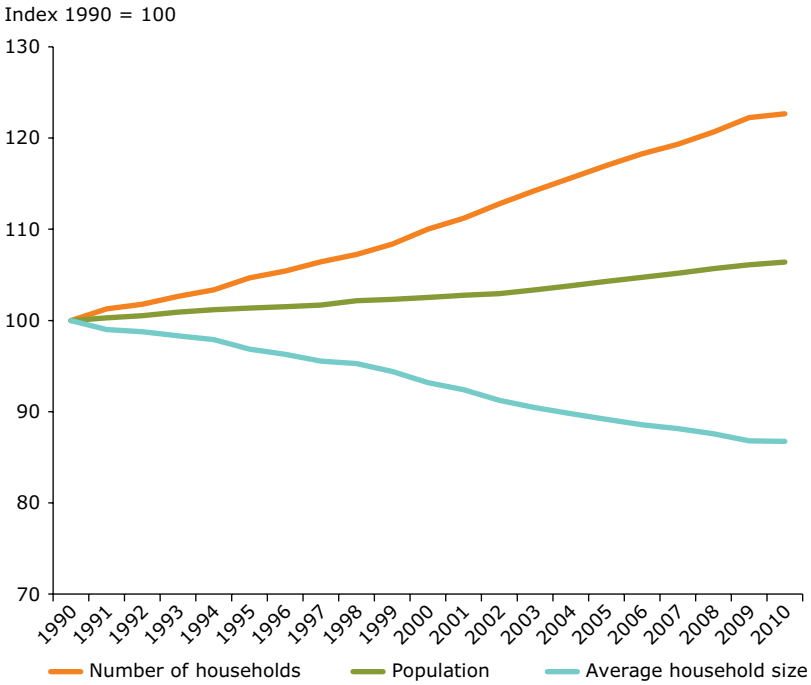
Resource-use pattern

Housing accounts for a substantial proportion of the material flows required to meet basic human needs. Unfortunately, available data do not allow a distinction between material use for houses and industrial purposes, nor do they allow for a full break-down into material categories, such as construction materials used (wood, concrete, metals) and types of energy carriers (fossil fuels). This

analysis therefore focuses on the general patterns regarding demand for housing, and on some characteristics of the housing stock and urbanisation patterns across Europe.

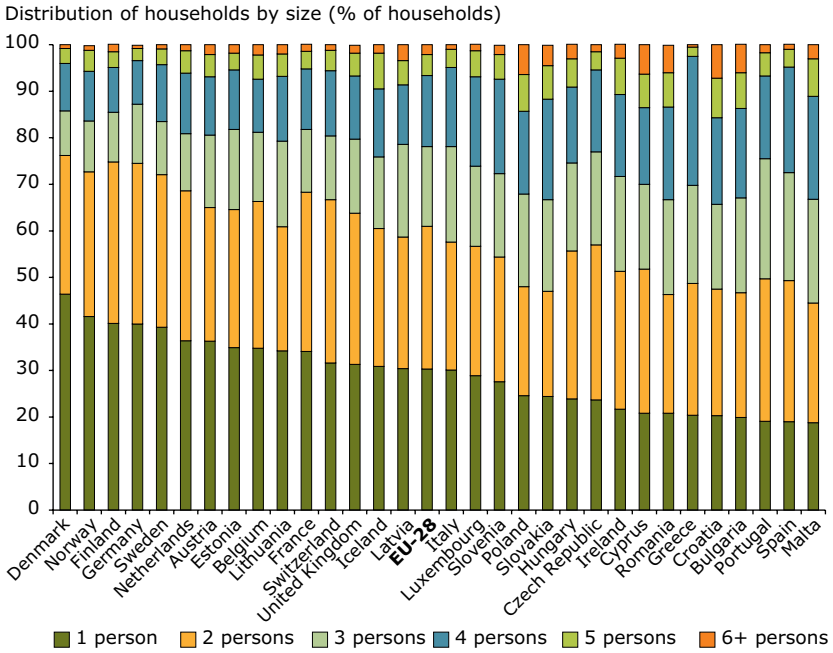
Housing demand is largely driven by total population growth and average household size, as well as generally increasing wealth. The European population is projected to increase from around 500 million people now to 526 million people in 2040, with a significant decrease in average household size (ETC/SCP, 2013). This trend is already apparent: the number of households in the EU-28 grew from some 170 million in 1990 to 209 million in 2010, a 23 % increase, while the EU-28 population grew by only 6 % in the same period (Figure 7.1). There is significant variation in the EU in terms of household size (Figure 7.2).

Figure 7.1 Development of population, household size and total number of households in the EU-28, 1990–2010



Source: Enerdata, 2013.

Figure 7.2 Household size, 2011



Source: Eurostat.

The underlying trends — increasing wealth, changing lifestyles, and the ageing of the European population — can be assumed to have negative consequences for the overall efficiency of material and energy use. This is because the frequency of single persons living in houses intended and suitable for larger households is likely to increase. Increasing wealth and growing personal demands for floor space and living conditions may add to this.

As for the supply of housing, it is important to note that housing is long-lasting and annual material flows are small compared to the material embedded in the existing housing stock. Construction activity is very sensitive to general economic performance and fluctuates accordingly. During the current economic and financial crisis, construction activity has dropped markedly, particularly in terms of new houses (ETC/SCP, 2013).

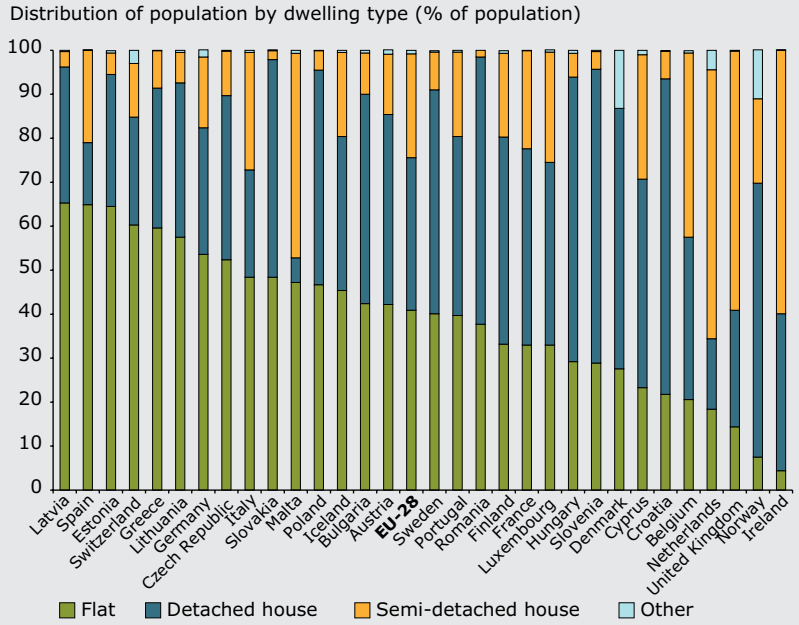
Box 7.1 Diverse housing patterns across Europe

The housing pattern shows large variation across Europe, with the ratio between detached houses and flats being very high in Norway, Sweden, Denmark, Croatia and Romania, and very low in Spain, Switzerland and Italy. Semi-detached houses are prevalent in the UK, and the Netherlands (Figure 7.3).

These housing patterns have obvious implications for the efficiency of material and energy use, but they are largely obscured by inter-country variation in building traditions and climatic conditions, the lack of sufficiently differentiated datasets, and the fact that the material embedded in the existing housing stock does not enter the material flow accounts (ETC/SCP, 2013).

The composition of the housing stock also affects the use of land as a resource. Belgium, for example, has a much higher share of detached houses than the otherwise rather comparable Netherlands, which is reflected in a higher degree of urban sprawl (see also next section).

Figure 7.3 Distribution of population by dwelling type, 2011



Note: Covers EEA-33 countries for which data are available.

Source: Eurostat, 2013b.

The raw materials required for constructing houses originate to a large extent from mining activities, with relatively small contributions from forestry. Metal ore mining and quarrying represents 62 % of total raw material use measured in tonnes; the rest consists of biomass and fuels (EEA, 2013e). Just 3 % of construction materials used in the EU are imported. This is due to their low value, wide availability, and high transportation costs. The use of renewable construction material (wood) remains limited overall, although in certain regions (notably in parts of the Nordic region) wood is abundant and the preferred construction material for domestic housing.

Much of the waste generated in construction and demolition can be recycled. Most countries show increasing recycling rates, with countries such as the Netherlands, Denmark and Croatia reaching percentages of more than 90 % ([4]) (Eurostat data cited in ETC/SCP, 2013).

Environmental pressures

Housing is one of the household consumption categories with the highest embedded environmental pressures. Such pressures originate throughout the life cycle of the housing stock, extending from extraction of raw materials (e.g. land use, energy use); to fabrication of products (e.g. energy use and generation of solid and liquid waste); through to construction (e.g. water, energy and material inputs); use (e.g. heating, water use and maintenance); and finally demolition and recycling of materials.

Across the full life cycle, housing accounts for more than one third of consumption-related greenhouse gas emissions, and the sector also accounts for one fifth of acidifying and ground ozone precursor emissions (EEA, 2012d). Energy use during the use phase (notably heating) accounts for a large proportion of these emissions. This suggests that the energy efficiency of dwellings and settlements has a major influence on the environmental burden that results from meeting society's housing needs.

([4]) These figures include industrial construction.

Construction is responsible for only a relatively low share of total emissions (1.2 % of greenhouse gases, 1 % of acidifying gases and 4.8% of ground-level ozone precursors). Wood has been suggested as an environmentally friendly alternative to stone, metal and concrete that could increase the sustainability of buildings in all life-cycle phases (ETC/SCP, 2013). However, the available data do not allow a differentiated analysis of the pressures embedded in these different construction materials. The potential for shifting to wood-based construction would in any case appear rather limited, considering that European forestry is already intensive, with harvest levels in many forests approaching the net annual increment (EEA, 2007).

A potentially important environmental pressure related to housing results from the generation of hazardous demolition and construction waste. The available data show considerable differences between countries in the amounts generated, with relatively high figures for the Benelux countries and Germany. Such variation may, however, reflect differences in accuracy of reporting rather than real differences in waste generation (ETC/SCP, 2012). The actual pressures from hazardous demolition and construction waste therefore remain largely unknown.

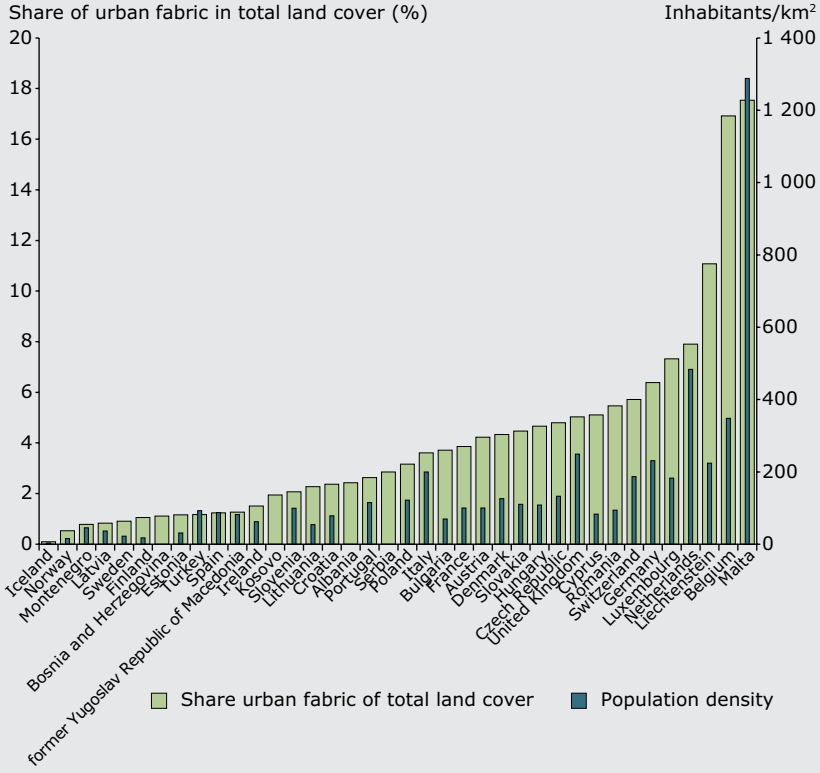
As for impacts on natural capital, urban development necessarily leads to land take and loss of natural habitats. Between 1990 and 2006 urban areas sprawled faster than population growth. Industrial areas and infrastructure expanded fastest with 45 % growth, while residential areas grew by 23 %. During the same period, the population increased just 6 % (EEA, 2013d). Urban development is less compact than before, which would seem consistent with the trend towards increasing per capita demand for floor space, as signalled earlier.

The increased fragmentation of natural habitats that results from urbanisation and the construction of infrastructure may lead to biodiversity loss. This is not only because of the immediate land conversion, but also because species dispersion in an increasingly fragmented landscape can be hampered, leading to an increased risk of local extinctions. In addition, fragmented habitats are more vulnerable to external pressures, such as noise and pollution from urban and agricultural sources. The knock-on effects on energy use for transport add to the environmental pressures of urban sprawl.

Box 7.2 Contrasting patterns of urbanisation and landscape fragmentation

Urbanisation patterns across Europe are strikingly different (Figure 7.4). The share of urban land in Belgium, for example, is almost twice as high as in the Netherlands, despite a population density that is one third lower. These figures reflect differences in spatial planning, with more restrictions in the Netherlands, and a lower share of detached houses and more compact urban settlements than in Belgium. Similar outliers are Malta (with a relatively small share of urban area) and Cyprus (with a relatively high share).

Figure 7.4 Urbanisation patterns across Europe



Note: All countries for which Corine Land Cover data were available in 2006 are shown; data for the United Kingdom and Greece are not available.

Source: EEA, 2011b, for land cover data. Eurostat, 2011a, for population data.

Human exposure and well-being implications

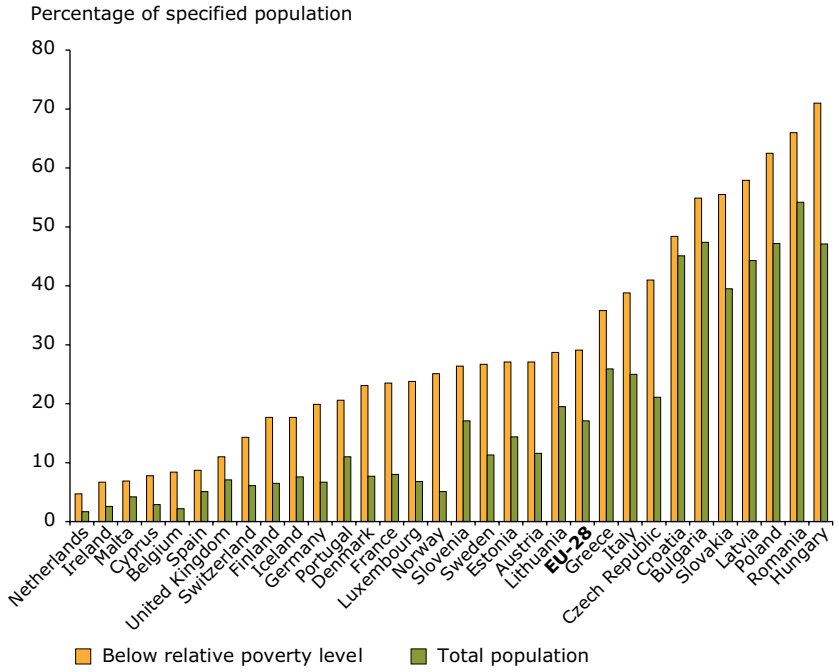
A society's choices about how to meet its housing needs have diverse impacts on human well-being, shaping general living conditions and personal comfort; access to green spaces and areas for outdoor recreation; the quality of the indoor climate; and related exposure to chemicals and air pollutants ([5]).

Available floor space and adequate heating are among the most basic determinants of human well-being related to the housing stock. In these respects, large variations exist across and within the EU Member States. On average, the 10 % rate of overcrowding in the EU-15, Malta and Cyprus is much lower than the rates of 40 % or more in central and eastern European countries. There are also large differences linked to socio-economic conditions (Figure 7.5). In households with children, the prevalence of overcrowding is generally higher in single-parent households.

Large contrasts also exist with regard to the ability of European households to warm their homes (Figure 7.6). The percentage of the population unable to keep their homes warm is generally lower in western and northern European countries than in southern and eastern countries. Bulgaria is a notable outlier with an average prevalence of insufficient heating capacity of around 70 %. The available data also point at considerable social inequality tied to heating. This appears to be a consistent phenomenon in all countries. The proportion of low-income population groups that have difficulty maintaining comfortable indoor temperatures is on average twice the proportion of high income groups.

([5]) The indoor climate and exposure to chemicals, which partly relates to building materials and ventilation, receives increasing policy attention but goes beyond the scope of this report (EEA/JRC, 2013; WHO, 2010d).

Figure 7.5 Overcrowding rates (percentage of specified population), 2011

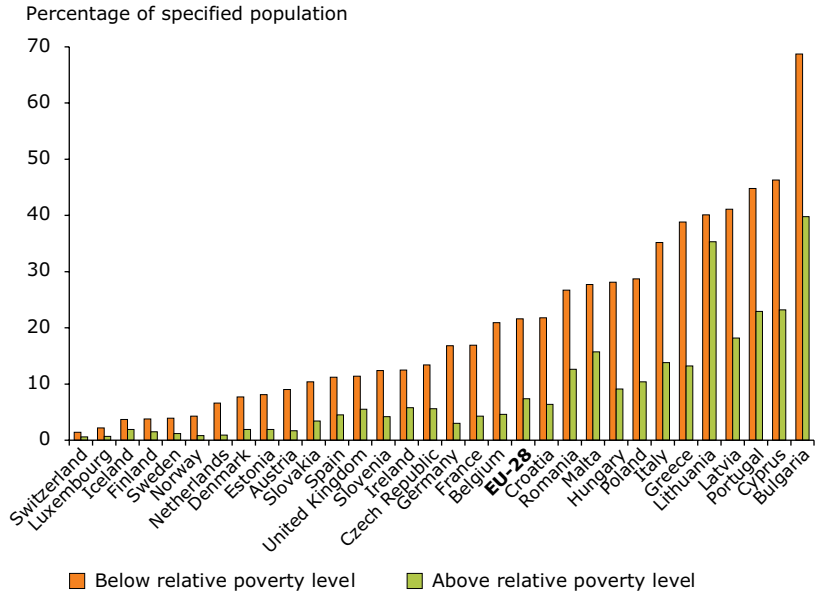


Note: Covers EEA-33 countries for which data are available.

A person is considered as living in an overcrowded household if the household does not have at its disposal a minimum number of rooms equal to: one room for the household; one room per couple in the household; one room for each single person aged 18 or more; one room per pair of single people of the same gender between 12 and 17 years of age; one room for each single person between 12 and 17 years of age and not included in the previous category; one room per pair of children under 12 years of age (ESTAT).

Source: Eurostat.

Figure 7.6 Percentage of population unable to keep their homes warm (percentage of specified population), 2011



Note: Covers EEA-33 countries for which data are available.

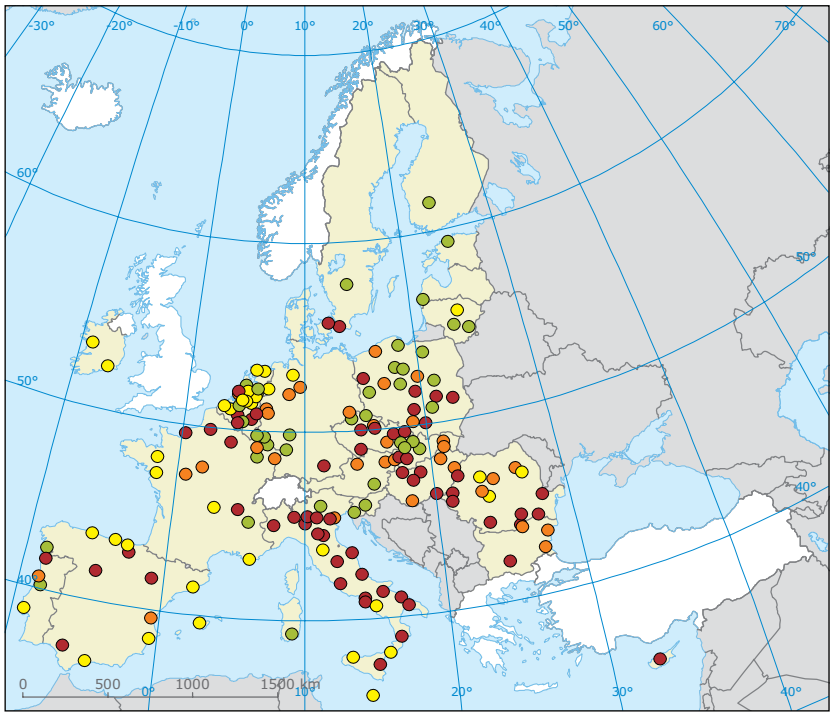
Source: Eurostat.

Well-being is not solely related to the internal features of housing. The way in which housing is situated in relation to the rest of the landscape is also important. Access to natural, green environments offers multiple benefits to physical health, mental and social well-being and improved quality of life. Although the precise nature of these interactions are not fully understood, there is some evidence that people with better access to a green environment are more likely to be physically active, with a lower risk of becoming obese (EEA/JRC, 2013). Other positive factors for human health and well-being associated with green infrastructure in the urban environment are reduced exposure to air pollution and noise.

Social inequalities are also apparent in this context. The fragmentary evidence from European countries indicates that low-income populations often live in areas with high pollution and poor-quality housing. These areas are often near waste dumping sites and noisy roads, and typically have limited access to good-quality green space. Poor environmental conditions tend to be spatially correlated with social stressors, although little is known about the combined and potentially synergistic health effects of stress and pollution (Clougherty et al., 2007, 2009; EEA/JRC, 2013).

Map 7.1 shows the results of an analysis for a selection of European cities, where the availability of green spaces in and around urban areas is compared. Conclusions on combined health effects cannot be drawn from such a general picture but some regional differences in spatial planning approaches and urban development patterns emerge. Compact urban development with strict spatial restrictions, as for example practised in the Netherlands, may preserve a relatively green landscape matrix. However, it has also resulted in a relatively low share of green spaces within the urban fabric itself.

Map 7.1 Green areas inside and around cities



Note: The map compares the green areas in and around cities to the average values. Thus, a 'brown city' in a 'green background' is one where the proportion of green areas in the city is below average but the proportion of green areas in the city's surroundings is above average.

Source: EEA, 2010k.

Governance aspects and levers for action

Decisions about how to meet society's housing needs — addressing the types of housing structures developed nationally and locally, the materials used, the compactness of urban settlements and access to green spaces — result in diverse environmental and social impacts. In part, such choices are shaped by market forces, for example the cost of purchasing and transporting construction materials, or the relative financial returns from using land for agricultural production or urban development. In part, they are determined by government interventions, such as building standards and restrictions on spatial planning.

While most Europeans today have access to adequate housing, the approach to governance of housing has shortcomings. There are clear opportunities to meet Europe's housing needs in ways that alleviate pressures on the environment and enhance human well-being. These opportunities mainly reside in using more resource-efficient construction techniques and materials, and in ensuring compact urban development.

Primarily in the context of its climate change mitigation efforts, the EU has taken specific actions to regulate construction, most notably via its Energy Performance of Buildings Directive. This directive requires all new buildings to be 'nearly zero energy buildings' by 2020 (new public buildings must achieve this objective by 2018). Similarly, the Directive on the Promotion of the Use of Energy from Renewable Sources requires that Member States set minimum levels of energy from renewable sources to be used in new buildings and in existing buildings that are subject to major renovation. To complement these requirements, the Commission provides financial support for improving energy efficiency in buildings (EC, 2013c).

Better spatial planning has the potential to incentivise more resource-efficient housing approaches, reducing energy use for commuting and heating in well laid-out settlements, and avoiding the intrusion of urban infrastructure into natural areas. Improved spatial planning would involve both increased restrictions on urban sprawl, and the alleviation of restrictions on development within urban areas.

This is undoubtedly an area characterised by complex trade-offs. Some people prefer living close to nature, rather than in a compact

urban setting. Equally, governments often impose restrictions on the height of new buildings to preserve a city's cultural identity and urban environment — and these are undoubtedly characteristics that are valued by inhabitants and contribute to well-being. At the same time, it is important to recognise that such restrictions can also greatly increase the cost of housing in city centres (particularly impacting poorer households) and drive urban sprawl.

Spatial planning must be truly integrated, aiming at optimising economic development opportunities and ecosystem services, reducing human exposure to multiple environmental pressures, and reducing social inequities. The challenge is to design a future urban environment with broad public appeal, meeting the evolving needs of the population.

In the current EU governance model, spatial planning is the remit of the Member States, not the EU institutions. Nevertheless, more and more building blocks for spatial planning (and 'boundary conditions' that limit what can be done) arise from European environmental legislation, such as the Habitats Directive and the Water Framework Directive. The European Commission's recently adopted strategy on green infrastructure (EC, 2013e) provides opportunities to integrate them into a common approach.

Regarding the construction materials used for housing, there is some scope for increasing the share of renewables (primarily wood) in the EU as a whole, but the resource base poses limits. Given the high harvest rates in important European wood-producing countries such as Sweden and Finland (EEA, 2009a), a substantial intensification of production appears unrealistic. Increased reliance on imports is likely to pose problems as well, given global deforestation rates.

The potential for increasing recycling rates of construction materials, on the other hand, appears considerable judging by the highly variable recycling rates in European countries. The Waste Framework Directive (EU, 2008b) sets an EU recycling target for construction and demolition waste of 70 % by 2020. Although these national datasets are not necessarily complete and comparable, they point at differences in governance and market regulation, with market-based incentives — such as taxation of construction and demolition waste — probably playing a major role.

3

REFLECTIONS

Part 3 Reflections

Chapter 8 Resource use patterns and well-being impacts

- Land-use patterns are at the heart of the food-water-energy nexus
- Environmental pressures related to resource use are generally declining, but diverse well-being impacts persist

Chapter 9 Meeting our future needs

- Integrated responses are needed, recognising land as a key resource
- Global consumption trends necessitate greater resource efficiency

8 Resource use patterns and well-being impacts

Land-use patterns are at the heart of the food-water-energy nexus

The analysis in Part 2 of this report illustrates the complex interdependence of Europe's systems for meeting its food, water, energy and housing needs.

Agriculture, for example, may affect water security in both quantitative and qualitative terms. Pesticides and excessive nutrients pollute surface water and groundwater bodies, threatening drinking water quality (EEA, 2010a). Irrigation may add to water stress (EEA, 2010b). Cultivation and drainage patterns affect the 'run-off' characteristics of water basins (the way in which water dissipates into rivers, lakes and drain systems), with considerable effects on regional flooding risks. In addition, agricultural production, related land conversion, and the distribution of commodities and food products all affect greenhouse gas emissions, which in turn drive climate change.

Water is a crucial resource for human well-being in view of humanity's need for drinking water and sanitation. It plays a central role in a wide variety of production processes, including agriculture and energy, and supports multiple ecosystem functions. Different types of water use may conflict with each other, causing water stress at the river-basin level. The way water is sourced, from both ground water and surface water, has implications for the environment and for pollution abatement, and thus for other resource use categories, such as agriculture.

Energy use is related to all other resource use categories in multiple ways. The energy sector is a major source of air pollution and greenhouse gas emissions, causing wide-ranging environmental and human health impacts. The related shift towards renewable energy sits at the heart of the 'food-water-energy' nexus, with energy and

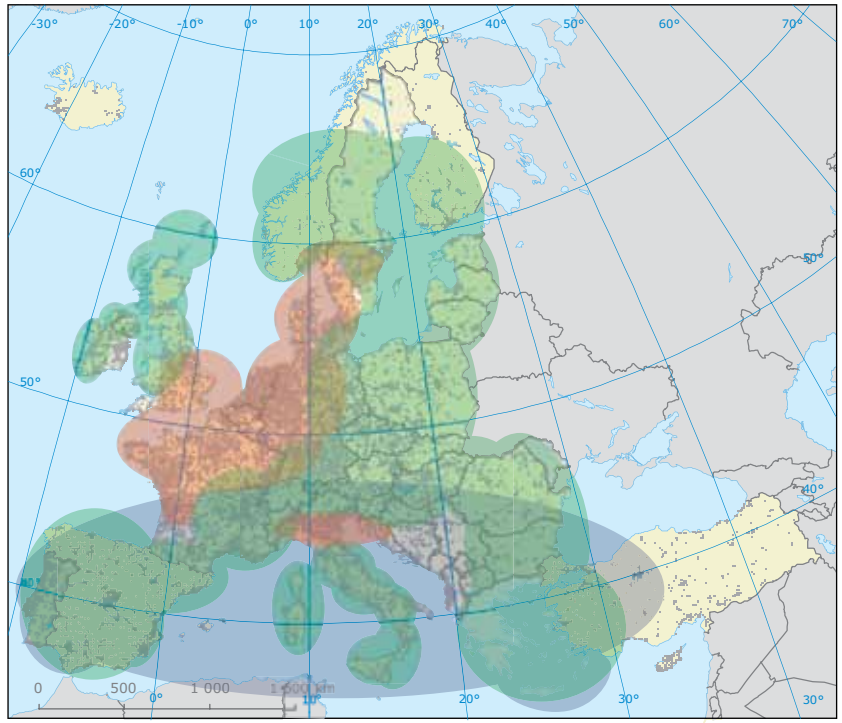
food crops potentially competing for land and water resources. Where bioenergy cropping replaces extensive farming systems, it can also produce negative side-effects on biodiversity and landscape amenity values.

Resource demands for housing complicate matters further. The urbanisation pattern itself has implications for habitat fragmentation and biodiversity loss, as well as for vulnerability to climate change (flooding risks). Construction methods and settlement patterns have an immediate impact on the environment and considerable implications for energy and water use. With most environmental pressures from housing resulting from the use phase (heating and transport to and from housing), the links with energy use are obvious. As for construction materials, a shift to renewables (notably wood) would increase pressures on forests.

The combined environmental pressures from resource use are apparent at the landscape scale — directly though land-cover change and indirectly via impacts on the ecological status of water bodies, habitats and biodiversity. Human exposure to these pressures may be very unevenly distributed, with some areas and societal groups being much more affected than others. This accentuates the spatial dimension of resource use and impacts, with land as a crucial integrating factor.

Map 8.1 captures some of the complexity of the multiple demands on land resources, with urban sprawl, agricultural intensification and land abandonment exerting pressures on biodiversity and water resources. These pressures can result in spatially differentiated impacts on human well-being.

Map 8.1 Synthesis map of urban land take and agricultural challenges



Indicative map of combined environmental challenges related to land use

Marginal agricultural areas

Challenges: maintain on-field biodiversity, stimulate favourable practices, increase profitability without intensifying

Prime agricultural areas

Challenges: reduce pressures on air, soil and natural habitats, nature reserve approach to remaining high nature value agri patches

Main irrigated areas

Challenges: reduce water stress

Urbanising areas

Urban land take 2000–2006
Challenges: minimising and mitigating habitat loss and fragmentation

Outside coverage

Source: Corine Land Cover and EEA.

Environmental pressures related to resource use are generally declining, but diverse well-being impacts persist

Assessing the human well-being impacts of these combined environmental pressures is challenging — both conceptually and empirically. As the WHO and others acknowledge, human health and well-being are by definition the result of many factors, and not easily captured in measurable parameters.

Suitable health and well-being indicators — if available — are often attributable to multiple environmental conditions, which can themselves be influenced by many factors. Although the causal relationships between individual resource use and health parameters are often obscure, exposure to environmental pressures can nevertheless be analysed as a useful proxy for well-being outcomes.

The summary analysis presented in Tables 8.1 and 8.2 thus interprets the available indicators per resource use category in terms of multiple environmental pressures and related impacts on human health and well-being. The data suggest that, overall, the environmental pressures from resource use in Europe are declining (most notably for water and energy). However, these overall trends mask large regional differences.

Food demand and meat consumption appear relatively stable, and the average increase in cereal yields points towards increasing resource productivity. At the same time, however, agricultural diversity appears to be diminishing, with high-nature-value farming losing ground to more intensive farming systems or to land abandonment. Both of these trends diminish the biodiversity and amenity values of farmland. As for possible health and well-being impacts of the current food system, the available data (for example on exposure to food and water contaminated with pesticides) are limited and inconclusive. The obesity incidence raises concerns about access to food of good nutritional value, but also points at systemic challenges related to lifestyles and inequalities.

In the case of water, the overall abstraction rate is falling but there is considerable regional variation. Data on temporary breaches in drinking water supply are lacking, but acute water stress remains an issue in some (particularly southern European) regions, a situation likely to be exacerbated by climate change. Water quality is generally improving, but again regional problems remain, particularly in the intensively farmed regions of lowland western Europe with high nutrient and pesticide loads. In addition, emerging chemicals used in industry and domestic settings pose a considerable but insufficiently understood risk for water quality.

For energy, the indicators all point at a reduction of environmental pressures: energy efficiency and the use of renewable energy sources are increasing, and emissions are declining. This is reflected in a general decrease in exceedances of exposure limits for air pollutants, a trend that also has clear health benefits. Regional variation is also considerable in this case, however, and exposure to harmful pollution levels in urban areas remains high in absolute terms and continues to impact human health. This is of concern in view of the continuing trends of urbanisation and ageing of the European population, which together increase both exposure and vulnerability. Climate change is an additional long-term stress factor that can only be partially mitigated by the current emission cuts.

As for housing, decreasing household sizes and urban sprawl are of concern, mainly because of their effects on landscape infrastructure, biodiversity and energy demand for housing and transport. Access to green spaces is a relevant factor for health and well-being, for which unfortunately no trend information is available.

Table 8.1 Selected 'pressure' indicators (related to resource use)

Aspect	Indicator	Trend	Rationale (efficiency)
Food			
Food demand	Meat consumption per capita	→	Higher values imply greater resource needs
Agricultural productivity	Cereal yield	↗	Higher values imply smaller land footprint
Chemical inputs	Pesticide/fertiliser use	→	Higher values indicate increased environmental pressure
Water			
Water demand	Water use	↘	Lower values imply decoupling from population/ GDP
Exploitation intensity of river basins	Water exploitation index	□	Lower values imply more sustainable water use/greater regional differentiation indicates local water stress
Ecological status of water bodies	Concentration of selected pollutants in water	↘	Lower values imply increased ecological quality of water bodies
Energy			
Energy demand	Total consumption/ energy intensity	↘	Higher values imply increased pressure on air quality
Sustainability of supply	Renewable energy share	↗	Higher values imply greater sustainability
Air emissions	Greenhouse gas emissions	↘	Higher values indicate increased pressure on the environment
Housing			
Housing demand	Average household size	↘	Lower values indicate increased pressure on the environment
Material use	Recycling rate construction material	↗	Higher values indicate reduced resource needs
Land take	Urban land take	↗	Higher values indicate habitat loss/landscape fragmentation

Legend

Positive developments	Neutral developments	Negative developments
↘ — Decreasing trend	→ — Stable	↘ — Decreasing trend
↗ — Increasing trend	□ — Mixed progress (but overall problem remains)	↗ — Increasing trend

Table 8.2 Selected 'impact' indicators (related to exposure/ human health and well-being)

Aspect	Indicator (exposure)	Trend	Rationale (health/ well-being impacts)
Food			
Nutritional quality	Obesity incidence	↗	Higher values indicate health risks
Biodiversity/amenity value of the farmed landscape	HNV farmland conservation status	↘	Lower values Indicate decreasing biodiversity/ amenity value
Water			
Water availability	Breaches in drinking water supply	*No data. Increasing risk due to climate change*	—
Water safety	Bathing water compliance	↗	Higher values indicate lower human exposure
Energy			
Air quality	Exposure exceedance for selected pollutants	↘	Higher values indicate greater human exposure
Climate change	Heat waves/flooding risk	↗	Higher values indicate greater human exposure
Housing			
Housing quality	Floor space per person	↗	Higher values indicate more comfort
Living environment	Access to green spaces	*No trend data*	—

Legend

Positive developments	Neutral developments	Negative developments
↘ — Decreasing trend	→ — Stable	↘ — Decreasing trend
↗ — Increasing trend	□ — Mixed progress (but overall problem remains)	↗ — Increasing trend

9 Meeting our future needs

Integrated responses are needed, recognising land as a key resource

Looking at each of the natural resource categories addressed in this report, it is apparent that society's mechanisms for managing food, water, energy and material resources differ significantly. Market failure is common to each of the four categories, however, and governments have therefore put in place a mixture of market-based and regulatory policy instruments in order to achieve the best outcome for society, balancing resource use against related environmental pressures.

Market forces have normally played only a limited role in water resource management, with price setting and allocation often determined by government rules and choices. At the European level, the EU Water Framework Directive today provides a comprehensive legislative framework to ensure water security in terms of quantity and quality. In contrast, market forces have played a much larger role in shaping modern energy systems, particularly in terms of the types of fuels used and the overall levels of energy consumption. The security of fuel supplies is highly reliant on the functioning of global markets, although governments are increasingly intervening to correct market incentives via taxation, emissions trading and incentives for renewable energy.

Food provisioning and resource use for housing take intermediate positions in the continuum between state-managed resource and fully free market. In the case of food provision, market mechanisms are modified by instruments such as the EU's Common Agricultural Policy. Nevertheless, negotiations in the World Trade Organization tend towards liberalisation, breaking down trade barriers, and reducing protectionism. As for housing, access to construction materials and fuels is largely subject to free market forces, whereas urban development and the construction itself are usually heavily regulated.

These different governance mechanisms are all partly successful in reducing overall pressures from resource use. However, they fail to address in a consistent way the human health impacts of exposure to multiple environmental pressures and the regional and social inequalities. Thematic policies in the environment and health domain (for example those regarding air quality, water quality or chemicals) tend to be fragmented, addressing individual substances and issues separately. This predominantly hazard-focused and compartmentalised approach is insufficient to address interconnected and interdependent challenges such as depletion of natural resources, climate change, ecosystem degradation, unequal distribution of impacts across society, and major public health problems, such as cardiovascular and respiratory diseases, obesity and cancer (Morris, 2010).

New concepts have emerged to facilitate more integrated analyses and policy design, linking human, environmental and social aspects in different spatial settings. Some researchers have proposed a 'social-ecological systems' (SES) approach, focusing on 'a set of people, their natural and human-made resources, and the relationships among them', and enabling integrated analysis of ecological, technological, social, economic and political factors (Confalonieri and Schuster-Wallace, 2011). Recognition of mutual interactions between humans and ecosystems is also the core of the 'ecological health' concept (Parkes et al., 2010; Morris, 2010), which argues for an interrelated, multi-dimensional approach to address the complex causality of human health.

The need for such integrated policy approaches at the European level is increasingly recognised. The EU's green infrastructure strategy (EC, 2013e), for example, aims to secure ecosystem resilience and multiple ecosystem services to society. Other applications of integrated approaches can be found in the area of climate change adaptation, for example regarding the reduction of exposure to flooding risks or the exposure of humans to emerging infectious diseases (EEA/JRC, 2013; Bogich et al., 2012; Zinsstag et al., 2011; Coker et al., 2011).

The notion of 'landscapes' — embracing not merely an area's physical characteristics but also its social, cultural and economic attributes — provides a useful focus for fostering sectoral integration. Indeed, the usefulness of adopting a landscape perspective to manage land use trade-offs is today reflected in international deliberations bringing together forestry, agriculture and climate change (CIFOR, 2012; Foley et al., 2011).

Using scarce land resources in different ways (such as forestry, pasture, biodiversity conservation or urban sprawl) provides contrasting packages of benefits and costs to land owners, local people and society as a whole. Understanding the scale and distribution of these impacts on human well-being is essential for identifying the drivers of current land management choices and the ways in which land use can be steered to the benefit of society.

In this regard, striking a balance between agricultural and biodiversity concerns appears particularly challenging, with the strategic choice between 'land sparing' and 'land sharing' posing a key dilemma (EEA, 2012a; POST, 2012). 'Land sharing' favours multifunctional land use, more extensive farming and on-field biodiversity, whereas 'land sparing' favours spatial separation of functions, with more intensive farming in some areas and totally uncultivated spaces left to nature in others.

The diverse local and regional realities across Europe necessitate that policy objectives and implementation be carefully designed and differentiated. Special attention should also be given to reducing inequalities with respect to human exposure to environmental pressures. Evidence is growing that environment-related inequalities and their potential impacts on health and well-being are strongly related to socio-economic and demographic factors, including unequal opportunities for certain population groups to influence decisions concerning their close environment. However, the implications of these complex relationships for policy need to be clarified (WHO, 2012a).

To protect and sustain human health and well-being, future efforts to improve the quality of the environment will need to be complemented by other measures, including significant changes in lifestyles, human behaviour and consumption. This also implies a stronger need for a multidisciplinary and multi-stakeholder dialogue to take account of often conflicting knowledge, values and attitudes — especially in the human health context. For example, tensions could occur between the available evidence on potential impacts, societal values, perceptions of relevant environmental challenges, and possible technological solutions.

Global consumption trends necessitate greater resource efficiency

The analysis in Part 2 of this report suggests that environmental pressures in Europe may be diminishing in some areas. In international terms, however, European lifestyles remain very resource intensive, imposing a disproportionate burden on the Earth's finite resources and systems (EEA, 2012d). Moreover, they persist in the context of rapidly growing world consumption, which is projected to continue in the decades ahead, fuelled by a considerable expansion of the global middle class (EEA, 2010g).

A range of factors suggest that the Earth's food, water and energy systems are becoming increasingly vulnerable. Based on resilience theory and ecosystem analysis, Rockström et al. (2009) have identified nine 'planetary boundaries' and argue that crossing any of them could lead to irreversible ecosystem shifts with potentially disastrous consequences for humanity. In their view, three of the biophysical boundaries identified — relating to climate change, biodiversity loss and nitrogen cycling — have already been crossed, while human impact on phosphorus flows is close to the biophysical limit. Each of these parameters is intrinsically linked to food production, energy use and water demands.

World demand for energy and water are both projected to rise by 40 % over the next 20 years (EEA, 2010d), which is disconcerting in the face of concerns about 'peak oil' and the potential repercussions of projected climate change on regional water availability.

The global food system is probably even more vulnerable. Demand for food, feed and fibres is projected to grow by 70 % between now and 2050, whilst the area of arable land per person may decrease (FAO, 2009, 2012). The productivity increases needed to respond to this demand contrast sharply with projections of increased risk of soil erosion due to improper management and other adverse impacts due to climate change. If agricultural productivity is not substantially improved in a sustainable manner, the growing demand for agricultural produce is likely to lead to further land conversion and deforestation. This would in turn lead to biodiversity loss, increases in greenhouse gas emissions, and reductions in ecosystem resilience, including the ability of soils to sequester carbon (EEA, 2010g; Foley et al., 2011).

Improved waste management also has an important role to play in reconciling growing demand for resource with the finite limits of natural systems. In addition to reducing the need to extract virgin resources from the environment, better resource management (via reduced waste generation and increased reuse and recycling) offers a means of mitigating emissions of chemical and greenhouse gases from waste, and related impacts on the environment and human health (EEA, 2011f). Reducing food waste could clearly lessen the burden on ecosystems — both in terms of resource extraction and pollution reduction. Awareness raising and education can play a major role in changing diets and food waste habits.

In the context of rapidly growing global environmental pressures, it seems likely that maintaining human well-being in coming decades will depend heavily on finding ways to meet resource needs at much lower environmental costs. This notion is reflected in the EU's Europe 2020 agenda (EC, 2010) and its Roadmap to a resource efficient Europe (EC, 2011a), as well as in current discussions on the elaboration of global sustainable development goals (UN, 2013). As noted in the proposal for a General Union Environment Action Programme to 2020 (EC, 2012d), the overarching goal of maximising the benefits that we derive from nature while preserving ecosystem resilience is central to the transition to an inclusive green economy:

'To live well in the future, urgent, concerted action should be taken now to improve ecological resilience and maximise the benefits environment policy can deliver for the economy and society, while respecting the planet's ecological limits. This programme reflects the EU's commitment to transforming itself into an inclusive green economy that secures growth and development, safeguards human health and well-being, provides decent jobs, reduces inequalities and invests in and preserves biodiversity and the ecosystem services it provides — natural capital — for its intrinsic value and for its essential contribution to human wellbeing and economic prosperity.'

Broader application of the established EU policy principles of precaution, prevention and polluter-pays will have an important role in effecting a transition to an inclusive green economy in Europe. However, promoting widespread public engagement can also assist in making the choices that this transition will require. Such choices include selecting which resource innovation pathways to follow and how best to build greater adaptability into governance systems to deal with systemic challenges (EEA, 2013h; O'Riordan, 2013). In such discussions, spatial planning and optimising use of land resources will play a central role in reconciling potentially conflicting demands for food, energy, water and material resources.

Annex Overview of the EEA's environmental indicators as of 1 October 2013

The EEA aims to deliver timely, targeted, relevant and reliable information to policymakers and the public. Environmental indicators play a key role in achieving this goal.

This annex provides an overview of the 146 environmental indicators maintained by the EEA. In addition indicator names and codes, it also includes information on the role of the indicator within the DPSIR model and on the type of indicators following the EEA's indicator typology (see Chapter 3).

EEA indicators are accessible at: www.eea.europa.eu/data-and-maps/indicators.

Indicator focus (within DPSIR model) — see Chapter 3 for more details						
	D	**P**	**S**	**I**	**R**	**Total**
Number of EEA indicators in category	20	44	23	40	19	146

D — Driving force indicators

P — Pressure indicators

S — State indicators

I — Impact indicators

R — Response indicators

Indicator type — see Chapter 3 for more details						
	A	**B**	**C**	**D**	**E**	**Total**
Number of EEA indicators by type	117	16	9	4	0	146

A — Descriptive indicators: 'What's happening?'

B — Performance indicators: 'Does it matter?', 'Are we reaching targets?'

C — Efficiency indicators: 'Are we improving?'

D — Policy effectiveness indicators: 'Are the measures working?'

E — Total welfare indicators: 'Are we on the whole better off?'

Indicator name	**Indicator code**	**Indicator focus**	**Indicator type**
Agriculture indicators — 2 (including 2 CSI indicators)			
Gross nutrient balance	CSI 025	P	A
Area under organic farming	CSI 026	R	A
Air pollution indicators — 11 (including 5 CSI indicators)			
Emission od acidifying substances	CSI 001	P	B
Emissions of ozone precursors	CSI 002	P	B
Emissions of primary particulate matter and secondary particulate matter precursors	CSI 003	P	B
Exceedance of air quality limit values in urban areas	CSI 004	S	A
Exposure of ecosystems to acidification, eutrophication and ozone	CSI 005	S	B
Sulphur dioxide (SO_2) emissions	APE 001	P	B
Nitrogen oxides (NO_X) emissions	APE 002	P	B
Ammonia (NH_3) emissions	APE 003	P	B
Non-methane volatile organic compounds (NMVOC) emissions	APE 004	P	B
Heavy metal (HM) emissions	APE 005	P	B
Persistent organic pollutant (POP) emissions	APE 006	P	B
Biodiversity indicators — 27 (including 3 CSI indicators)			
Species of European interest	CSI 007	S	A
Designated areas	CSI 008	R	A
Species diversity	CSI 009	S	A
Abundance and distribution of selected species	SEBI 001	S	A
Red List Index for European species	SEBI 002	S	A
Ecosystem coverage	SEBI 004	S	A
Habitats of European interest	SEBI 005	S	A
Livestock genetic diversity	SEBI 006	S	A
Nationally designated protected areas	SEBI 007	R	A
Sites designated under the EU Habitats and Birds Directives	SEBI 008	R	A
Critical load exceedance for nitrogen	SEBI 009	P	B
Invasive alien species in Europe	SEBI 010	P	A
Impact of climate change on bird population	SEBI 011	P	A
Marine trophic index of European seas	SEBI 012	S	A
Fragmentation of natural and semi-natural areas	SEBI 013	P	A
Nutrients in transitional, coastal and marine waters	SEBI 015	P	A
Freshwater quality	SEBI 016	P	A
Forest: growing stock, increment and fellings	SEBI 017	P	A
Forest: deadwood	SEBI 018	S	A
Agriculture: nitrogen balance	SEBI 019	P	A

Indicator name	Indicator code	Indicator focus	Indicator type
Agriculture: area under management practices potentially supporting biodiversity	SEBI 020	S	A
Fisheries: European commercial fish stocks	SEBI 021	P	A
Aquaculture: effluent water quality from finfish farms	SEBI 022	P	A
Ecological Footprint of European countries	SEBI 023	P	A
Patent applications based on genetic resources	SEBI 024	R	A
Financing biodiversity management	SEBI 025	R	A
Public awareness	SEBI 026	R	A
Climate change indicators — 46 (including 5 CSI indicators)			
Production and consumption of ozone depleting substances	CSI 006	D	D
Greenhouse gas emission trends	CSI 010	P	B
Progress to greenhouse gas emission targets	CSI 011	P	A
Global and European temperature	CSI 012	S	B
Atmospheric greenhouse gas concentrations	CSI 013	S	A
Mean precipitation	CLIM 002	I	A
Precipitation extremes	CLIM 004	I	A
Storms	CLIM 005	I	A
Air pollution by ozone and heath	CLIM 006	I	A
Glaciers	CLIM 007	I	A
Snow cover	CLIM 008	I	A
Greenland ice sheet	CLIM 009	I	A
Arctic and Baltic Sea ice	CLIM 010	I	A
Permafrost	CLIM 011	I	A
Global and European sea-level rise	CLIM 012	I	A
Sea surface temperature	CLIM 013	I	A
Phenology of marine species	CLIM 014	I	A
Distribution of marine species	CLIM 015	I	A
River flow	CLIM 016	I	A
River floods	CLIM 017	I	A
River flow drought	CLIM 018	I	A
Water temperature	CLIM 019	I	A
Lake and river ice cover	CLIM 020	I	A
Distribution of plant species	CLIM 022	I	A
Plant and fungi phenology	CLIM 023	I	A
Distribution and abundance of animal species	CLIM 024	I	A
Animal phenology	CLIM 025	I	A
Species interactions	CLIM 026	I	A
Soil organic carbon	CLIM 027	I	A
Soil erosion	CLIM 028	I	A
Soil moisture	CLIM 029	I	A

Indicator name	Indicator code	Indicator focus	Indicator type
Glowing season for agricultural crops	CLIM 030	I	A
Agrophenology	CLIM 031	I	A
Water-limited crop productivity	CLIM 032	I	A
Irrigation water requirement	CLIM 033	I	A
Forest growth	CLIM 034	I	A
Forest fires	CLIM 035	I	A
Extreme temperatures and health	CLIM 036	I	A
Vector-borne disease	CLIM 037	I	A
Damages from weather and climate-related events	CLIM 039	I	A
Ocean acidification	CLIM 043	S	A
Ocean heat content	CLIM 044	S	A
Storm surges	CLIM 045	I	A
Floods and health	CLIM 046	I	A
Heating degree days	CLIM 047	I	A
Production, sales and emissions of fluorinated greenhouse gases (F-gases)	CLIM 048	D	D
Energy indicators — 19 (including 5 CSI indicators)			
Final energy consumption by sector	CSI 027	D	A
Total primary energy intensity	CSI 028	R	B
Primary energy consumption by fuel	CSI 029	D	A
Renewable primary energy consumption	CSI 030	R	B
Renewable electricity consumption	CSI 031	R	B
Energy and non-energy related greenhouse gas emissions	ENER 001	P	A
Energy-related emissions of ozone precursors	ENER 005	P	A
Energy-related emissions of acidifying substances	ENER 006	P	A
Energy-related emissions of particulate matter	ENER 007	P	A
Emission intensity of public conventional thermal power electricity	ENER 008	I	C
Emissions from public electricity and heat production	ENER 009	P	C
Nuclear energy and waste production	ENER 013	P	A
Efficiency of conventional thermal electricity generation	ENER 019	D	C
Combined heat and power (CHP)	ENER 020	R	C
Final energy consumption intensity	ENER 021	D	A
Share of renewable energy in final energy consumption	ENER 028	I	C
Overview of the European energy system	ENER 036	D	C
Progress on energy efficiency in Europe	ENER 037	R	C
Overview of the electricity production and use in Europe	ENER 038	D	C

Indicator name	Indicator code	Indicator focus	Indicator type
Transport indicators — 23 (including 3 CSI indicators)			
Passenger transport demand	CSI 035	D	A
Freight transport demand	CSI 036	D	A
Use of cleaner and alternative fuels	CSI 037	R	D
Transport final energy consumption by mode	TERM 001	P	A
Transport emissions of greenhouse gases	TERM 002	P	A
Transport emissions of air pollutants	TERM 003	P	A
Exceedances of air quality objectives due to traffic	TERM 004	S	A
Transport accident fatalities	TERM 009	P	A
Capacity of infrastructure networks	TERM 018	D	A
Transport infrastructure investments	TERM 019	D	A
Real change in transport prices by mode	TERM 020	D	A
Fuel prices	TERM 021	D	A
Transport taxes and charges	TERM 022	R	A
Expenditures on personal mobility	TERM 024	D	A
External costs and charges per vehicle type	TERM 025	P	A
Internalisation of external costs	TERM 026	R	D
Energy efficiency and specific CO_2 emissions	TERM 027	P	A
Specific air pollutant emissions	TERM 028	P	A
Occupancy rates of passenger vehicles	TERM 029	D	A
Load factors for freight transport	TERM 030	D	A
Size of the vehicle fleet	TERM 032	P	C
Average age of the vehicle fleet	TERM 033	D	A
Proportion of vehicle fleet meeting certain emission standards	TERM 034	D	A
Waste indicators — 3 (including 2 CSI indicators)			
Municipal waste generation	CSI 016	P	A
Generation and recycling of packaging waste	CSI 017	P	A
Waste electrical and electronic equipment	WAS 003	R	A
Water indicators — 8 (including 7 CSI indicators)			
Use of freshwater resources	CSI 018	P	A
Oxygen consuming substances in rivers	CSI 019	S	A
Nutrients in freshwater	CSI 020	S	A
Nutrients in transitional, coastal and marine waters	CSI 021	S	A
Bathing water quality	CSI 022	S	A
Chlorophyll in transitional, coastal and marine waters	CSI 023	S	A
Urban waste water treatment	CSI 024	R	A
Hazardous substances in marine organisms	MAR 001	P	A

Indicator name	Indicator code	Indicator focus	Indicator type
Other indicators (green economy) — 1			
Number of organisations with registered environment management systems according to EMAS and ISO 14001	SCP 033	R	A
Other indicators (household consumption) — 1			
Household expenditure on consumption categories with different environmental pressure intensities	SCP 013	D	A
Other indicators (fisheries) — 3 (including 3 CSI indicators)			
Status of marine fish stocks	CSI 032	S	A
Aquaculture production	CSI 033	P	A
Fishing fleet capacity	CSI 034	P	A
Other indicators (land and soil) — 2 (including 2 CSI indicators)			
Land take	CSI 014	P	A
Progress in management of contaminated sites	CSI 015	R	A

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