THE EUROPEAN ENVIRONMENT

STATE AND OUTLOOK 2010

LAND USE

European Environment Agency

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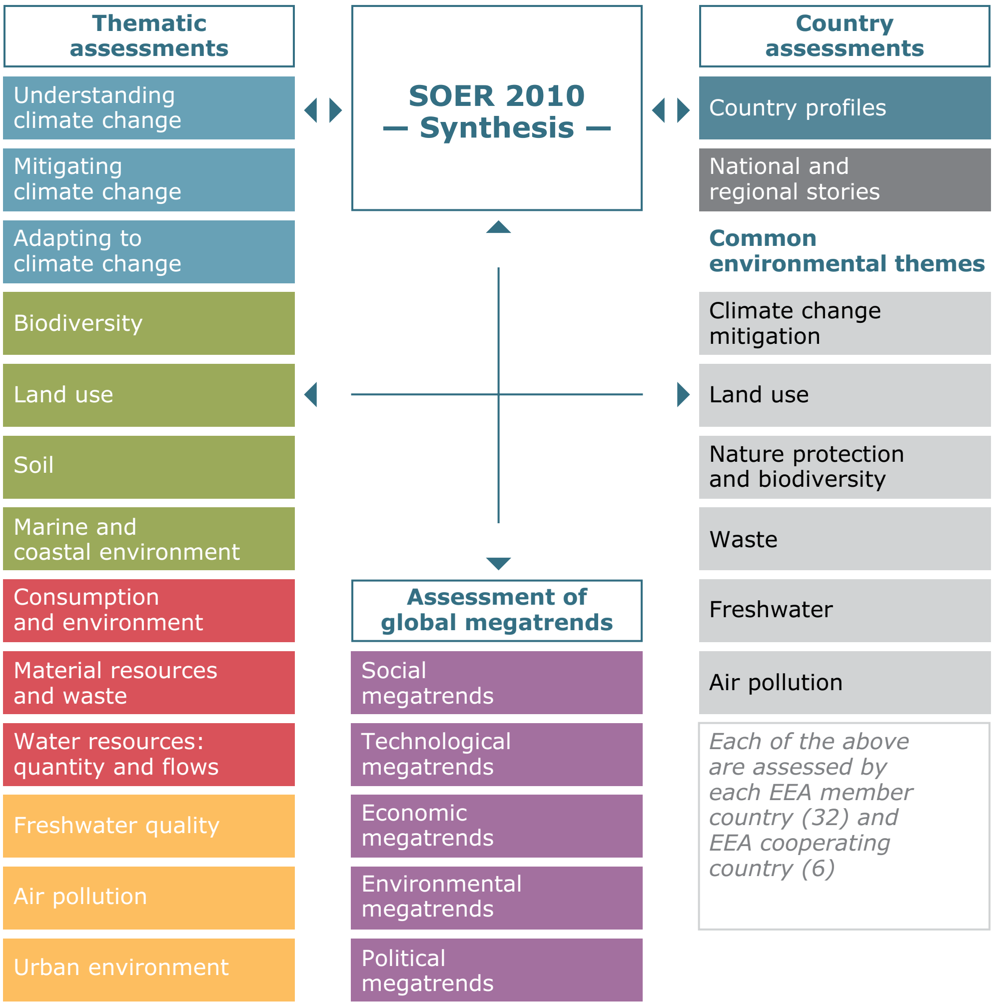
2. an exploratory assessment of **global megatrends** relevant for the European environment;
3. a set of 38 **country assessments** of the environment in individual European countries;
4. a **synthesis** — an integrated assessment based on the above assessments and other EEA activities.

SOER 2010 assessments



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Land use

Summary

Land use shapes our environment in positive and negative ways. Productive land is a critical resource for food and biomass production and land use strongly influences soil erosion and soil functions such as carbon storage. Land management largely determines the beauty of Europe's landscapes. It is important therefore to monitor land cover and land-use change through tools such as Corine land cover. Data on land-cover change in Europe from 2000–2006 show that growth in built-up areas and forest land leads to a continued loss of agricultural land. In turn, global economic and environmental change will increasingly influence the way Europeans use land (e.g. as communities work to mitigate and adapt to climate change). Policy responses are needed to help resolve conflicting land-use demands and to guide land-use intensity to support environmental land management.

Land-cover change in Europe

EEA analysis of land-cover change across 36 European countries shows a change in land-cover type for 1.3 % of the total land stock (68 353 km^2 of 5.42 million km^2) from 2000–2006. The annual rate of these changes has slowed compared to the period 1990–2000. However, land-use specialisation (urbanisation, agricultural intensification and abandonment plus natural afforestation) is still a very strong trend and is expected to continue in the future, depending on many interacting drivers.

While the overall land-change rate has slowed since the 1990s, there were considerable differences between countries: the highest density of land-cover change took place in Portugal, Cyprus, Hungary, the Czech Republic and Ireland, but also in Finland and Sweden (forest conversions) and Spain (agricultural transitions). There were also differences between land-use categories. Artificial surfaces increased most in terms of percentage change from 2000 to 2006 (3.4 %), but this masked a deceleration in conversions for residential purposes and an increase in conversions for the purposes of economic sites and infrastructures. The formation of new artificial surfaces was greater than the formation of new agricultural land.

Forest creation and management was the largest land-cover change in absolute terms, due mainly to internal conversions (i.e. forest felling and regeneration) in the boundaries of forest areas. However, total forest area increased only slightly (by 0.1 %). Arable land and permanent crops decreased by 0.2 % and pastures and mosaics by 0.3 %. Semi-natural vegetation, open spaces and wetlands continued the downward trend observed from 1990–2000. Water surfaces increased due to new artificial lakes and reservoirs taking more land than the consumption of water bodies by other economic activities.

Environmental impacts of land-use change

The way land is used affects human health and wellbeing. Land use has impacts on climate, biodiversity and ecosystem services. It can also cause degradation and pollution of water, soil and air. Although the land change rate in Europe has slowed since the 1990s, biodiversity-rich natural and semi-natural areas continue to decline, partly through intensification in agriculture but mostly through conversion to forest. Land-use/land-cover change similarly plays a major role in climate change at the global, regional and local scales, by increasing the release of carbon dioxide to the atmosphere when soils and natural vegetation are disturbed. Changes in land use and land cover are also behind major changes in terrestrial emissions of other greenhouse gases, especially methane (through altered surface hydrology and elimination of forest cover) and nitrous oxide (through agriculture).

Responses

Policy decisions that shape land-use involve trade-offs between many sectoral interests, including industry, transport, energy, mining, agriculture and forestry. In particular, agriculture and forestry represent the largest share of land use by economic sectors. These trade-offs can be tackled through integrated programmes for land use and territorial planning, sectoral policies as well as targeted policy instruments, such as protected area networks. Integrated programmes include the EU objective for Territorial Cohesion and the Water Framework Directive. Future directions of the EU Common Agricultural Policy (CAP) and implementation of renewable energy targets will have a significant impact on forest and agricultural land use and its intensity. The role of green infrastructure and site protection under Natura 2000 as well as the re-use of land are also important aspects of land resource management. In addition, Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) are the important tools for evaluating programmes and projects that have impacts on land resources.

The essential source of European land monitoring data is the Corine land cover inventory, carried out in 1990, 2000 and most recently in 2006. In combination with land statistics, the Global Monitoring for Environment and Security Initiative (GMES) will strengthen the European capacity for earth observation and facilitate more frequent analysis of land-use changes in Europe as a basis for future policymaking.

1 Introduction

1.1 Overview

Land and the use of land provide a key link between human activities and the natural environment. The way land is used is one of the principal drivers of environmental change, and, in turn, environmental change, particularly climate change, will increasingly influence the way we use land as communities strive to adapt to and mitigate the effects of a changing climate (Lobley and Winter, 2009).

European economies depend on natural resources, including raw materials and the land resource. Land is needed for production (extracting minerals, harvesting timber, growing food) and various socio-economic activities (construction, infrastructure, recreation, services). These activities often compete for land. The share of Europe's land used for production is one of the highest on the globe, and it is becoming clearer and clearer that land is a finite resource: conflicting demands will require land-use decisions that involve hard trade-offs. Increasing designation of land for nature protection, driven by EU policy, and various soil, water and civil protection objectives, have to be combined with demands for food and non-food biomass production, infrastructure and settlements.

Different levels and characteristics of economic development within Europe determine regional differences in land-use patterns and intensity. Urban and rural land uses are at opposite ends of human settlement systems and each has distinctive spatial patterns across the continent, but this diversity is gradually being erased by look-alike peri-urban growth. In mountain areas, islands and coasts, land-use practices have specific aspects, and regional historical and cultural backgrounds also add to the diverse picture of land use. Integrated assessment of land use in Europe has to address these differences with appropriate detail to remain relevant to the governance of land resources.

1.2 Drivers of land-use change

Land use in Europe has a number of important drivers. Settlement and infrastructure patterns are primarily influenced the increasing demand for living space per person, the link between economic activity and transport demand and the resulting growth of transport infrastructure. Rural land use is shaped by increasing global food consumption that stimulates production, and the shift to biomass resources to replace fossil fuels in energy generation and for the chemical industry (PBL, 2009).

The increasing demand for food, animal feed, fibre and bio-energy is likely to require improvements in productivity — intensification — or conversion of additional land to agricultural use. At the same time Europe already relies on imports for 25 % of its biomass requirements, using land elsewhere in the world to satisfy its needs (Sleen 2009).

1.3 Land use and the environment

The environmental impact of land use is at the root of our relationship with nature. Activities such as agriculture, forestry, transport, manufacturing and housing alter the natural state and functions of land as they involve land-cover conversion or land-use intensification. Different types of land use have different impacts on climate change, biodiversity and ecosystem services, and can result in degradation and pollution of water, soil and air, all of which may affect human health and well-being. On the other hand traditional land uses have shaped the diversity of European landscapes and extensive farming systems help manage valuable semi-natural grasslands, for example.

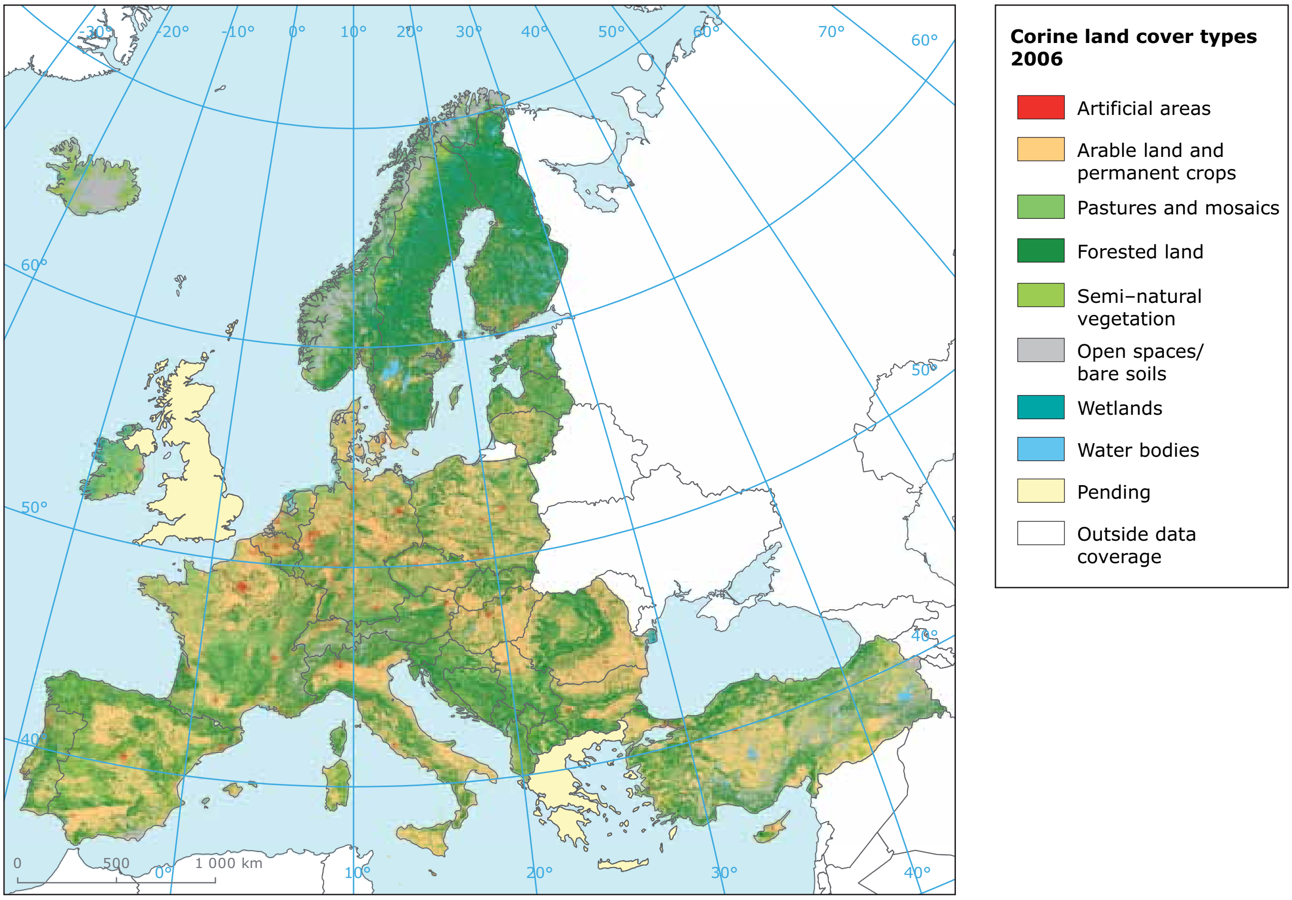
Changes in the type and intensity of land use in Europe have never been greater than during recent decades (Turner et al., 2007). The following land-use trends are critical to the environmental impacts of the exploitation of our land resource:

1. changes between major land-cover/use categories, for example, from forest to arable farming or agriculture to urban;

2. changes in land-use intensity within a given category, for example agricultural intensification.

The fastest land-cover change in Europe is associated with the covering of land by artificial surfaces, which increased by 6 258 km^2 — 3.4 % of the continent's land

Map 1.1 **European land cover 2006 (main land-cover categories in European countries with Corine land cover 2006 data available)**



Source: EEA/ETC-LUSI, 2010.

area — between 2000 and 2006. Most of this is related to the expansion of residential areas and industrial and commercial sites. New arable land and permanent crops in 2000–2006 required an additional 5 410 km^2 of land. During the same period 8 326 km^2 of these lands were lost to other land uses and the overall stock of arable land and permanent crops decreased. Part of agricultural land decline happened when marginal farmlands were abandoned and some forested. The European land area covered by forests increased by 1 114 km^2 in 2000–2006.

Growth of urban population and even faster growth of urban areas results in intensification of land use. Land occupied by man-made surfaces and dense infrastructure connects human settlements and fragments landscapes. New transport routes are often followed by urban sprawl which requires even more technical infrastructure, which further increases fragmentation.

The intensity of land use in forests depends on the level of forest management. Overall, the annual ratio of wood harvesting to forest increment in Europe is now about 60 % and the growing stock of forests is gradually increasing (EEA, 2009a).

However, demand for wood is also rising because of the demand for bio-energy (Eurostat, 2010d). Forest ecosystems can be fragmented by forestry activities, in particular final felling including clear cutting. This has impacts on the connectivity of forest species, which is a measure of landscape integrity. Highly fragmented landscapes support less biodiversity (EEA, 2009a and EEA, 2009d).

Agricultural intensification affects biodiversity, water resources and soil quality, and contributes to greenhouse gas (GHG) emissions (EEA, 2006c; Ramankutty, 2010). It is characterised by increased inputs to farming systems — fuel, fertiliser, water, chemicals — and conversion from forest, (semi-) natural vegetation and predominantly non-arable uses — pasture and agricultural mosaics.

While some areas are experiencing intensification, for the period 2000–2006 the area of semi-natural extensively-managed land across European countries declined by 1 681 km^2. The main reason for the decline was natural forest regeneration, afforestation and, in some cases, fire. With these areas an important component of high nature-value farmland and its associated biodiversity of farmland birds, butterflies and many plant species is being lost.

Current land-use practices, dominated by concentration and specialisation, and abandonment of land, both result in landscape polarisation that often leads to a reduction in landscape diversity and its multi-functionality — its capacity to support multiple uses (Selman, 2009). Over-specialised lands that optimise one function, such as crop production, at the expense of others are stable only in a narrow span of conditions and can become more vulnerable to diseases, climatic extremes, invasive species and other factors (Foley et al., 2005).

1.4 Policy response

There are a number of different spatial scales that are relevant to land-use management. In addition, there is a wide range of potential policy areas through which the environmental dimension of land use can be addressed. For the purpose of this assessment, policy actions to manage land use are grouped into three approaches:

1) integrated programmes for land-use planning/regional development and management;

2) sectoral policies that focus on economic drivers for certain land-use types;

3) targeted policy instruments that focus on specific locations or land-use types.

Integrated approaches at EU level include the Territorial Agenda, Regional policy and the Water Framework Directive.

The long-term sustainability of Europe's land use was a focus of the European Spatial Development Perspective (1999). Its vision has been carried forward and supplemented with new priorities by the Territorial Agenda of the EU and the Action Programme for its implementation (COPTA, 2007) which defined an intergovernmental programme of work up to 2011. The main focus of this initiative is on adding the territorial dimension to Community and national sectoral policies and reinforcing territorial governance in the EU and the Member States.

The coordinated use of land resources is the basis of balanced spatial organisation of society, where a compromise between competing stakeholders is normal practice. EU Regional policy contributed to this by organising a debate on territorial cohesion in 2008–2009 (European Commission, 2008). A high degree of territorial cohesion makes the best use of the diversity of Europe's territories and harnesses territorial capital — the localised set of common goods. Territorial cohesion supports the coordination of sectoral policies and can be regarded as a spatial representation of sustainability.

Integrated river basin management plans as mandated by the Water Framework Directive need to include land use in the catchments. In addition, the directive that regulates nitrate content in groundwater directly addresses land-use activities, and the EU Floods Directive requires flood risk mapping and affects land use through flood management plans for affected floodplain areas.

Via the on-going reform discussions and further integration of environmental and rural development objectives the Common Agricultural Policy (CAP) can contribute to a reduction in environmental pressures from agricultural land use. Agri-environment schemes, organic farming and land management in river catchment planning all continue to figure strongly in European rural policy (EEA, 2009c). However, in the context of the climate-change agenda, the current debate on a multi-functional agri-environment, with an emphasis on biodiversity and landscapes rather than food and non-food crop production for food security and bio-energy, is increasingly challenging land-use policies at all levels (Lobley and Winter, 2009).

Responsibility for forest policy lies primarily with Member States, though the EU can add value by various coordination activities. The EU Forest Strategy (1999) builds on the sustainable forest management principles of the pan-European Ministerial conference on the Protection of Forests in Europe (now called FOREST EUROPE) and sees multi-functionality as a core approach (MCPFE, 1993). The EU Forest Action Plan (COM(2006) 302) follows the Forest Strategy and serves as a coordination tool for forest-related activities and policies at the EU level. Among other objectives, it aims to maintain and enhance biodiversity, carbon sequestration, and the integrity, health and resilience of forest ecosystems at multiple geographical scales, and confirms that the productive capacity of forests is based on well-functioning forest ecosystems (European Commission, 2010a).

Policy decisions that shape land use involve trade-offs between many sectoral interests, including industry, transport, energy, mining, agriculture and forestry. These trade-offs can be implemented through spatial planning and land management practice in the Member States. In particular, effective implementation of the Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) Directives is important with regard to programmes and projects that have impacts on land resources.

Targeted policy instruments can help to develop a European green infrastructure. Relevant examples are the EU-27 designated sites of Natura 2000 and the Pan-European Ecological Network (PEEN), which aim to reconcile conflicting demands by integrating biodiversity conservation into the sustainable exploitation of natural resources. Areas designated under Natura 2000 provide space for species to perform ecosystem functions and are becoming increasingly important in securing space for adaptation to climate change. Around 26 000 Natura 2000 sites have been established for the preservation of protected habitats and species on 17.6 % of the EU-27 territory (EEA, 2010d). In the context of land use it is relevant to mention the role of the European Landscape Convention (Council of Europe, 2000) which deals with the protection, management and planning of all landscapes in Europe.

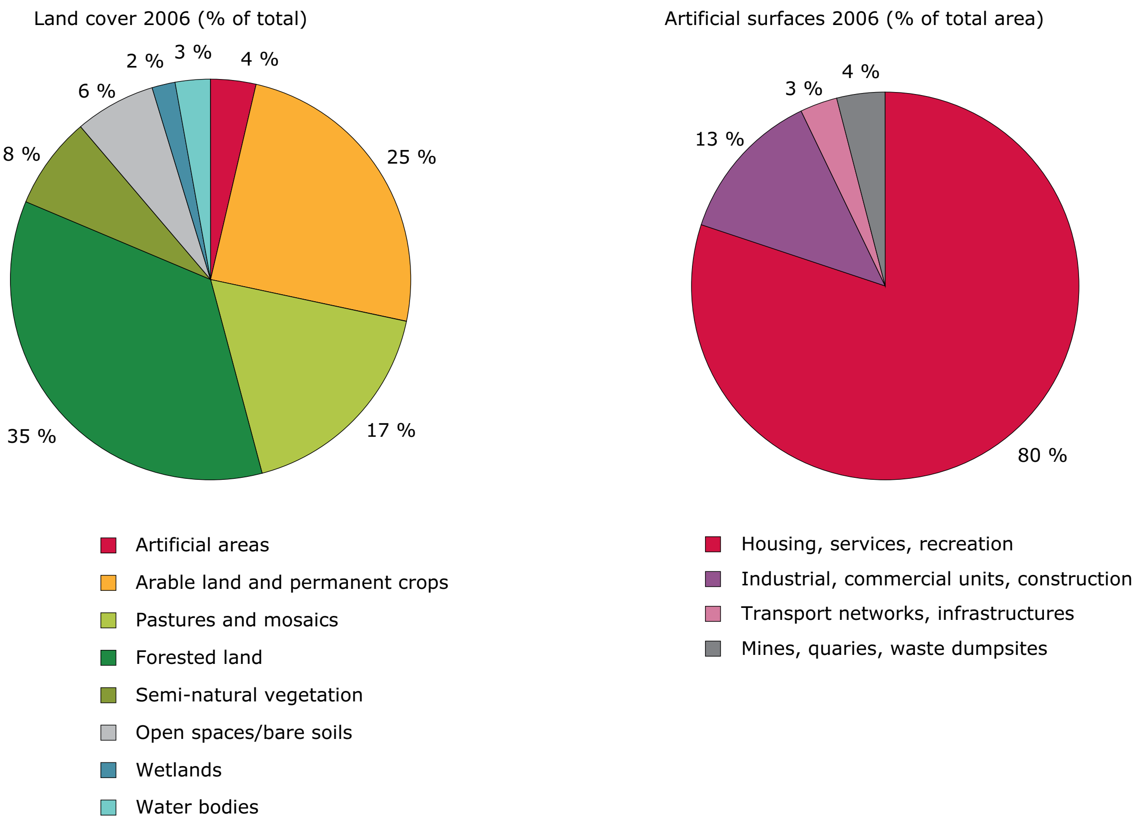
2 State and trends

2.1 Land cover 2006

Land can be seen as a renewable resource in that its productive potential, if it is managed sustainably, can be renewed rather than exhausted. However, reporting on land-use change benefits from a view of land as a fixed and finite resource. The main source of European land-monitoring data is the Corine land cover inventory (CLC), performed in 1990, 2000, and most recently in 2006 (EEA, 2007a). The Corine 2006 data set used for land-cover change analysis in this assessment covers the 38 EEA member and collaborating countries, plus Kosovo under UNSCR 1244/99, but excluding Greece, Switzerland and United Kingdom. For the territory of the EU, an important source of information is the largest harmonised land survey, the Land Use/Cover Area frame Survey (LUCAS) conducted in 2009 (Eurostat, 2010a). Based on different methodologies, both report comparable shares of the main land-cover categories.

Thirty-five per cent of Europe's land is covered by forests, 25 % by arable land and permanent crops, and 17 % by pastures and mixed mosaics (Figure 2.1). About 4 % is covered by artificial surfaces — mostly in cities, including green urban areas. Although a relatively small proportion, the urban areas represent spatial hot-spots — they accommodate the majority of Europe's population and host the vast majority of economic activity. This requires the constant exchange of resources and emissions with surrounding areas and results in environmental impacts.

Figure 2.1 Share of land-cover types in Europe: total area (left); artificial surfaces (right) (results for 36 countries in Corine land cover 2006 data set)



Source: EEA/ETC-LUSI, 2010.

Map 1.1 (in the introduction) showing the eight main land-cover categories mapped in 2006, illustrates the broad-brush categories of landscape features, such as boreal forests in the north, the densely populated area stretching from Amsterdam to Milan, open spaces related to mountain massif mosaics, and the mixed landscapes of South-East Europe and Iberia. Areas of arable land concentration are also clearly visible.

2.2 Land-cover changes 2000–2006

Table 2.1 shows land-cover changes in Europe from 2000 to 2006 for the eight aggregate land-cover types.

Analysed land stock across the 36 European countries was 5.42 million km^2 and 1.3 % of this, (68 353 km^2) changed land-cover type during 2000–2006. Overall land-cover change was less than in the previous assessment period, 1990–2000, when 23 countries were assessed. Annual land-cover change slowed from 0.2 % in 1990–2000 to 0.1 % in 2000–2006 (or when all recent felling and transitions inside forest area were included, from 0.27 % to 0.21 %, respectively) (calculation by EEA/ETC-LUSI, 2010). Artificial surfaces increased the most in terms of both net area and percentage change since 2000, by 3.4 %. Formation of new artificial surfaces was larger than formation of new agricultural land — arable plus pastures/mosaics. Forest creation and management was the largest land-cover change in absolute terms, due mainly to internal conversions within the boundaries of forest areas — forest felling and regeneration: overall, the total forest area increased by 0.1 %. Arable land and permanent crops decreased by 0.2 % and pastures and mosaics by 0.3 %. Land with semi-natural vegetation, open spaces and wetlands continued the downward trend of 1990–2000 while the total area covered by water increased because new artificial lakes and reservoirs exceeded the loss of water bodies as a result of infrastructure development and mineral extraction activities (Figure 2.2).

Trends in land-cover change in EEA member and collaborating countries for the two periods 1990–2000 and 2000–2006 bring out the differences of land-cover change between countries (Table 2.2).

Regional analysis of land-cover change can identify trends that are obscured by the general picture for Europe (Box 2.1). For example, regional land accounts for European mountain massifs provide specific information on land-use trends, land stocks and impacts of land-cover change in these areas (Box 2.2).

Historic demand for land, timber products and energy has removed a large part of Europe's original forest cover, and their composition has long been influenced by humans. The total forest area began increasing again in the 19th or 20th century, and EU forests have been expanding continuously for more than 60 years, although recently at a slower rate (European Commission, 2010a). EU forest

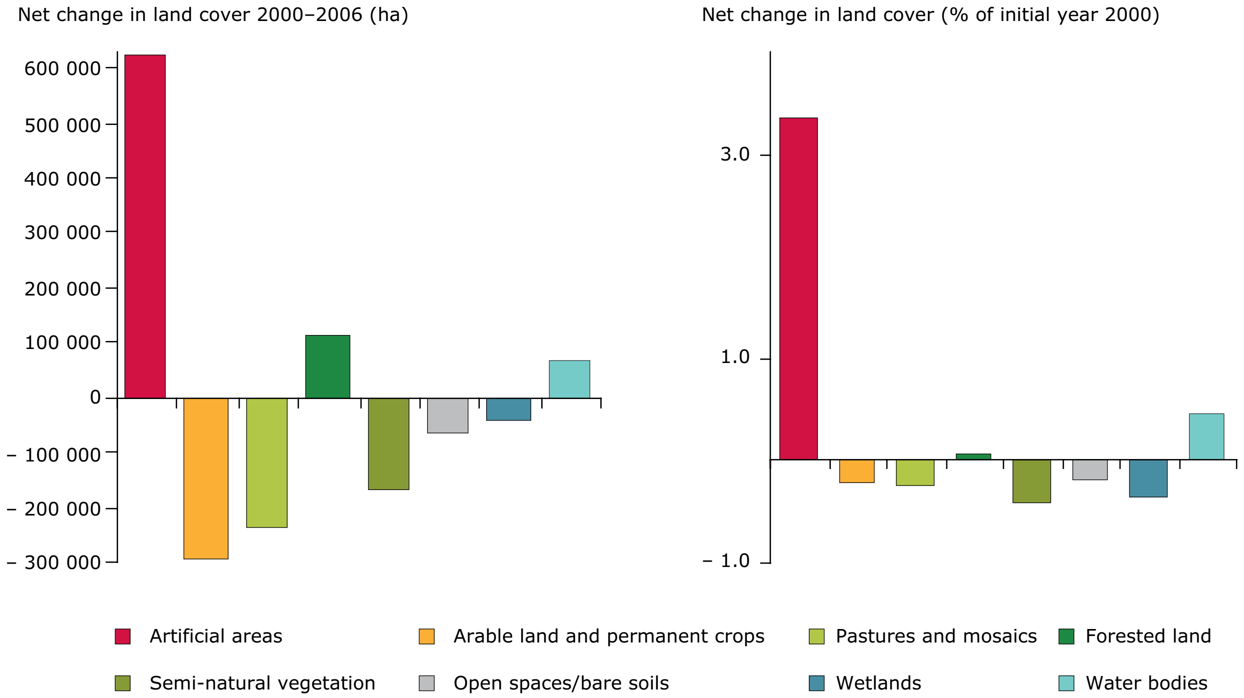
Table 2.1 Land accounts 2000–2006 for the European 36 countries in the Corine land cover 2006 data set

	Artificial areas	Arable land and permanent crops	Pastures and mosaics	Forested land	Semi– natural vegetation	Open spaces/ bare soils	Wetlands	Water bodies	Total (km^2)
Land cover 2000	186 528	1 350 193	942 015	1 929 507	410 883	342 072	119 968	143 004	5 424 171
Consumption of initial LC	1 853	8 326	4 855	47243	2 693	2 408	645	330	68 353
Formation of new LC	8 111	5 410	2 493	48357	1 012	1763	211	997	68 353
Net Formation of LC	6 258	– 2 916	– 2 362	1114	– 1 681	– 645	– 434	667	0
Net formation as % of initial year	3.4	– 0.2	– 0.3	0.1	– 0.4	– 0.2	– 0.4	0.5	
Total turnover of LC	9 965	13 735	7 348	95 599	3 704	4 171	856	1327	136 707
Total turnover as % of initial year	5.3	1.0	0.8	5.0	0.9	1.2	0.7	0.9	2.5
Land cover 2006	192 786	1 347 278	939 653	1 930 622	409 202	341 427	119 533	143 671	5 424 171

Note: This land accounting matrix for the eight main land-cover categories shows stocks in 2000 and 2006 and the changes.

Source: EEA/ETC-LUSI, 2010.

Figure 2.2 Net land-cover changes 2000–2006 in Europe: total area in hectares (left) and percentage change from 2000 (right)



Note: Results for the 36 European countries in the Corine land cover 2006 data set.

Source: EEA/ETC-LUSI, 2010.

utilisation, measured as the ratio of felling to increment, also declined until early this century, since when increases in demand of wood products have been supplemented by demand from bio-energy developments. Most EU forests, including those under continuous management, have also grown in terms of wood volume and carbon stock.

The majority of EU forests now consist of semi-natural stands and plantations of indigenous or introduced species. A recent BioSoil study of forest biodiversity at the EU level concluded that most of the forests surveyed were 40–80 years old and mainly composed of only one to three tree species (Hiederer and Durrant, 2010). Nevertheless, forests are a key component of European nature and home to the largest number of vertebrates on the continent.

Forest land cover increased during 2000–2006 across Europe by 0.1 %. This trend is most significant in some countries where deforestation has been widespread in the past. In spite of general forest expansion a negative forest land balance can be found at regional level within certain countries (CLC 2006 results). Internal conversions — felling and transitions within the forest land cover — provide information about the intensity of forest use, but also tell us about damage to the forest by, for example, storms. It is difficult to compare intensity of forest-land management between the 1990–2000 and 2000–2006 periods, because many countries with significant forest activities (e.g. Sweden, Finland) were included only in the analysis of the latter period.

Forest area has increased partly as a result of the creation of forests on former farmland. Converting non-forest land to forests has clear environmental benefits in situations where it contributes to combating desertification, protecting soil and water, and in some countries where reforestation is needed to compensate widespread deforestation. At the same time, the afforestation of farmland has contributed to a loss of pasture and other extensively-managed open areas that have long been in decline for economic reasons, in many instances, this leads to a loss of biodiversity and landscape features associated with such land use.

The EU Common Agricultural Policy (CAP) for 2007–2013 provides support to a range of forestry measures (see Box 2.3). This encourages farmers to maintain agricultural land in good condition and supports afforestation of abandoned open lands. In some countries there is also a trend to buy up and afforest agricultural land in order to get afforestation support, because the price of agricultural land is low (National contribution from Latvia to SOER 2010). In general, afforestation of farmland is less likely to occur in the future because of increasing demand for food and increasing commodity prices.

Table 2.2 Land-cover change in EEA member and collaborating countries: total changes for 1990–2000 and 2000–2006, and examples of specific trends for 2000–2006

Country	Annual land-cover change, % of total area		Characteristic land-cover changes, 2000–2006		
	1990–2000	2000–2006	Artificial areas	Agricultural areas	Forest and nature
Albania	-	0.18	Very high rate of residential sprawl	Loss of agricultural land	Forest — gains from agriculture, losses to urbanisation
Austria	0.03	0.08	Expansion of sport, leisure and recreation sites	Agricultural land uptake by artificial areas	Accelerated decrease of alpine glacier area
Belgium	0.17	0.10	Slow-down of land uptake	Slow-down of change dynamics, land uptake by artificial areas	Internal forest conversions, formation of water bodies
Bosnia and Herzegovina	-	0.12	Diffuse residential sprawl	Loss of pasture/mosaics, vineyards and orchards	Semi-natural land transitions, fires
Bulgaria	0.11	0.09	Urban sprawl accelerates	Overall stabilisation, loss of pasture/mosaics, vineyards and orchards	Forest management has replaced forest expansion
Croatia	0.19	0.17	Accelerated artificial sprawl driven by highway construction	Uptake of pasture by arable and complex cultivation land	Forest management, loss of open spaces, re-growth of burnt areas
Cyprus	-	0.49	Diffuse sprawl of residential areas, sport and, leisure facilities	Consumption of agricultural land	Transitional woodland formation over burnt areas
Czech Republic	0.81	0.33	Urban sprawl accelerates, driven by construction	Slow-down, continued conversion from arable land to pasture	Stabilisation in natural landscapes, some loss of natural grasslands
Denmark	0.13	0.13	Diffuse residential sprawl accelerated	Consumption of arable land	Forest creation, changes in wetlands and water bodies
Estonia	0.44	0.38	Doubled sprawl of artificial areas: mines and construction	Slow-down of changes, conversion from pasture to arable land	Exchange between mineral extraction sites and forested land
Finland	-	0.35	Sprawl of housing and recreation	Conversion from forest and wetlands to arable land	Forest management, net loss of forest and wetlands
France	0.20	0.11	Continued urban expansion	Reduced agricultural transitions, loss of different farmland types	Slowed changes of natural areas, forest management, fires
Former Yoguslav Republic of Macedonia	-	0.14	Residential sprawl, development of mineral extraction	Transitions of different land types, loss of vineyards and orchards	Forest management, new water bodies, loss of natural grasslands
Germany	0.24	0.10	Land uptake slows down	Decreased change dynamics, conversion of pasture to arable land	Forest and water bodies created on open spaces and former mining areas
Greece	-	-	-	-	-
Hungary	0.56	0.48	Expansion of construction and mineral extraction	Withdrawal of farming, some conversion of pasture to arable land	Transitional woodland creation over former farmland and grasslands
Iceland	-	0.10	Land take driven by construction	Loss of pastures to artificial land uptake	Decrease of permanent snow and glaciers, new transitional woodlands
Ireland	0.79	0.38	Continued expansion of artificial areas on agricultural land	Rapidly reduced agriculture dynamics, withdrawal of farming	Transitional woodland over open natural and farmed areas
Italy	0.13	0.10	Growth of economic sites and recycling of urban land	Loss of farmland, less farming withdrawal and arable/pasture transition	Reduced expansion on to farmland, transitions of natural land cover
Kosovo under UNSCR 1244/99	-	0.16	Dominance of residential sprawl	Loss of farmland and conversion from pasture to arable/crop land	Forest transitions, re-vegetation of burnt areas
Latvia	0.78	0.38	Faster artificial sprawl in surroundings of capital city	Slowed agricultural transitions, accelerated loss of farmland	Recent forest transitions, loss of pastures/mosaics to transitional woodland

Table 2.2 Land-cover change in EEA member and collaborating countries: total changes for 1990–2000 and 2000–2006, and examples of specific trends for 2000–2006 (cont.)

Country	Annual land-cover change, % of total area		Characteristic land-cover changes, 2000–2006		
	1990–2000	2000–2006	Artificial areas	Agricultural areas	Forest and nature
Liechtenstein *	-	-	Steady increase of artificial areas	Continued decrease of agricultural land	Observed impacts of natural disturbances
Lithuania	0.48	0.25	Faster sprawl, driven by development of construction sites	Rapid slowdown of internal agriculture conversions	Natural land transitions, loss of pastures/mosaics to transitional woodland
Luxembourg	0.15	0.23	Slow-down of sprawl of housing and recreation facilities	Accelerated consumption of pasture, formation of arable land	Transitional woodland becoming forest, some loss to economic sites
Malta	0.07	0.00	No change in urban areas	No change in agricultural land cover	Natural areas almost without change
Montenegro	0.02	0.04	Extension of construction sites and residential areas	Loss of pastures and mosaics to artificial surfaces	Forest transitions, loss of natural areas to economic sites, fires
Netherlands	0.30	0.27	Increased construction and urban land management	Agricultural land uptake by development of artificial areas	Growth of natural areas, e.g. grasslands, withdrawal of farming
Norway	-	0.10	Extension of sport and leisure facilities, residential sprawl	Low intensity of agricultural changes	Forest transitions, some loss of natural areas, fires, decrease of glaciers
Poland	0.10	0.10	Increased sprawl of economic sites, highway construction	Loss of agricultural land (mostly arable)	Transitional woodland on former farmland, new water bodies
Portugal	0.78	1.43	Development driven by construction around key areas	Slow-down of agricultural transitions, farmland abandonment	Forest transitions, new forested land and water bodies, fires
Romania	0.16	0.05	Residential sprawl accelerates around main cities	Slow-down of agricultural transitions, loss of pastures	Recent felling and land transition, some loss of natural open areas.
Serbia	0.11	0.07	Slower residential sprawl, doubled extension of mines	New formation of arable land, loss of pasture/ mosaics, fruit and berry	Low forest formation, loss of grasslands, new water bodies
Slovakia	0.51	0.25	Slow-down of residential land take	Slow-down of changes, loss of agricultural land	Forest creation after withdrawal of farming
Slovenia	0.02	0.03	New construction sites drive future land take	Limited changes, loss of agricultural land	Limited changes, forest felling and loss of land, new water bodies
Spain	0.34	0.29	Urban extension, faster sprawl of construction and transport land	Loss of arable land to, olive groves, vineyards, orchards, construction	Forest transitions, afforestation of dry semi-natural land, fires
Sweden	-	0.49	Dynamic development of artificial land cover	Loss of arable land	Forest transitions, some uptake of forested areas by economic sites
Switzerland **	-	-	Slower urban and infrastructure extension	Decline in arable land, increase in pasture, withdrawal of farming	Remote area reverting to wild vegetation, glacier retreat
Turkey	-	0.08	Development mostly driven by construction and mining	Increased arable land e.g. irrigated lands, loss of pasture/mosaics	Loss of natural open land to transitional woodland/shrub
United Kingdom	-	-	-	-	-

Notes: * Land-cover changes in Liechtenstein remained below the detection level of the Corine land-cover change methodology; land-cover trends are assessed from the national contribution to SOER 2010.
** Land-cover trends for Switzerland are assessed from the national contribution to SOER 2010.

Source: EEA/ETC-LUSI, 2010, based on Corine land-cover data.

Box 2.1 Assessments of 2000–2006 key land-cover changes: geographical distribution

Examining the geographical distribution of **all land-cover changes**, the highest density of change is in Portugal, Cyprus, Hungary, Czech Republic and Ireland, but also in northern Europe. In contrast, the most stable landscape is represented by mountainous areas of the Alps, Pyrenees, Romania and Norway.

Changes in forested landscape are concentrated mostly in the woodland landscapes of northern Europe, especially in Finland and Sweden. There are also significant concentrations of land-cover change related to forest areas in Ireland, Portugal, Hungary, in south-western France and northern Spain, in Italy (Tuscany), Baltic countries and in the surroundings of the Bosporus strait in Turkey.

Agricultural conversions occur, for example, in Spain, especially in the southern half of the country — conversion of arable land to olive groves, vineyards, plantations — and in Finland — conversion from natural land-cover types to agriculture. There are several areas across Europe with concentrations of internal agricultural conversion — in northern Germany; Central Europe, especially the Czech Republic and Hungary. Land-cover change in the southern parts of Turkey is mainly linked to the increase of permanently irrigated areas. Cessation of farming still occurs in many countries, for example in the southern half of Portugal, in Ireland and in Hungary.

Growth of commercial and industrial sites and infrastructures is mainly concentrated in western Europe. There are dense concentrations of commercial/industrial growth covering the whole of the Netherlands and the Po lowland in northern Italy, along the Mediterranean coast in Spain and also in the surroundings of major western European cities such as Madrid, Paris, Dublin, Toulouse and Rome, and also in Portugal. In Turkey, sprawl of commercial and industrial sites and infrastructures is situated around the Bosporus strait and around the city of Ankara. Significant linear features of artificial sprawl representing highway construction occur in Spain, Poland and Croatia.

Residential area growth is typical for France, where new residential areas are situated mostly in the western part of the country, especially in Brittany; along the Mediterranean coast in the south, the Côte d'Azur, around Marseille; and around Lyon in the eastern part of the country. In Germany, areas of residential growth are scattered over the whole western part of the country. There is also very dense concentration of residential sprawl in Albania, especially along the Adriatic coast.

Changes of land cover due to **natural and multiple causes** are represented by glacier areas decreasing in the Alps and also in the mountains of Iceland. There are also large concentrations of changes connected with changes in the natural landscape, which are caused by forest and shrub fires, mostly in the Mediterranean area — in Portugal, Spain, Sardinia, Corsica, Croatia and southern Bosnia.

Source: EEA/ETC-LUSI, 2010, based on CLC 2006 data.

Box 2.2 European mountain areas — main land-use trends and impact on biodiversity

On average, the **population density** (inh./km^2) in European mountain areas increased by 10.6 % between 1990 and 2006, compared with 7.5 % in the rest of Europe. The increases were in the Alps, British mountains, French/Swiss low mountains, Nordic mountains, Turkey and the western Mediterranean island massifs. However, the population density decreased in the Apennines, the Atlantic islands and the two Central European low mountain massifs. The changes within the mountain massifs were not homogeneous, for example the population density in the Iberian mountains increased in Spain but decreased in Portugal.

The largest **land-cover changes** in the European mountain massifs between 1990 and 2006 are related to forestry and agriculture, and range from intensification to land abandonment. Agricultural internal conversions were larger in the EU-12 than in the EU-15, forest creation and management were larger in the EU-15. The largest changes were in the Iberian and central European low mountain massifs. Urban residential sprawl caused the largest change in the Atlantic islands massif — the mountains in the Azores, Madeira and Canary islands — because of strong pressure from tourist activities.

European mountains play a key role in conserving **biodiversity**, as shown by 43 % of the total area occupied by Natura 2000 sites in the EU-27 being in mountain areas, and 29 out of 33 habitat types being found in some mountain massifs such as the Iberian mountains, Balkan/southeast Europe, Alps and Apennines.

The observed land-use transitions, including agricultural intensification or abandonment, urbanisation, and agricultural development, and the population density changes mentioned above, indicate **increasing human pressures** on mountain ecosystems in the past 16 years. Together with climate change impacts, these may have a serious impact on biodiversity.

Source: EEA, 2010a.

Box 2.3 Sustainable use of forest land in the EU Rural Development Policy 2007–2013

Forestry is one part of EU rural development policy, and support for sustainable land use encompasses the sustainable management of forests and their multi-functional role. In this context, measures under Axis 2 of EU rural development policy provide support for *first afforestation of agricultural land*, *first establishment of agro-forestry systems* on agricultural land, *first afforestation of non-agricultural land*, *Natura 2000 payments* to private forest owners to compensate for costs incurred and income foregone resulting from the implementation of the Natura 2000 network, *forest-environment payments*, *actions to restore forestry potential and preventative actions* and support for *non-productive investments* linked to forest-environment payments.

Source: European Commission, 2005a.

2.3 Urban land-take

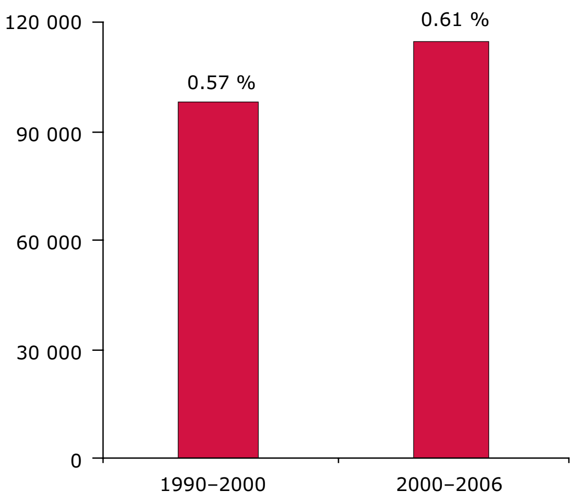
Urban land use deserves special attention as most human activities are concentrated in cities, and demand for the urban land-use patterns have a particular impact on the environment e.g. through soil sealing or whole sale change of landscapes. Understanding urbanisation trends and their impacts across the continent is therefore crucial for sustainable development.

Urbanisation in Europe is generally high but has large regional variations (EEA, 2009b). Around 35 % of Europeans live in cities and towns of more than 100 000 inhabitants, and 40 % in smaller urban agglomerations ([1]). Cities are concentrated in a core area stretching from the United Kingdom to Italy, but big cities are also found in all the other countries.

In 2000–2006 about 1 000 km² of land was covered every year by artificial surfaces. Land take for urban area and infrastructure use increased between 1990 and 2000 by 5.7 % across Europe, but with unequal distribution. This trend accelerated during 2000–2006 — annual land take increased from 0.57 % for 1990–2000 to 0.61 % for 2000–2006 (Figure 2.3).

Urban growth differs strongly between countries (Table 2.3 and Figure 2.4): between 2000 and 2006 annual growth ranged from an average of 0.1 % to 3.2 %, with an exceptional rate of 5.0 % for Albania. In general, urban land take is increasingly happening due to expansion of economic rather than residential areas (CLC 2006 analysis). During 2000–2006 the growth rate per year of economic areas — all non-residential artificial land take including infrastructures, mines and construction sites — was more than twice the residential urban growth rate and it had also accelerated compared to 1990–2000.

Figure 2.3 Annual land take by artificial surfaces in the 36 European countries in the Corine land cover 2006 data set



Note: CSI-014 Land-take indicator — increase in the amount of agricultural, forest and other semi-natural and natural land taken by urban and other artificial land development. It includes areas sealed by construction and urban infrastructure as well as urban green areas and sport and leisure facilities. The main activities that result in land take are the extension of housing, services and recreation, industrial and commercial sites, transport networks and infrastructures, mines, quarries and waste dumpsites.

Source: EEA/ETC-LUSI, 2010.

([1]) Population from UMZ2000.

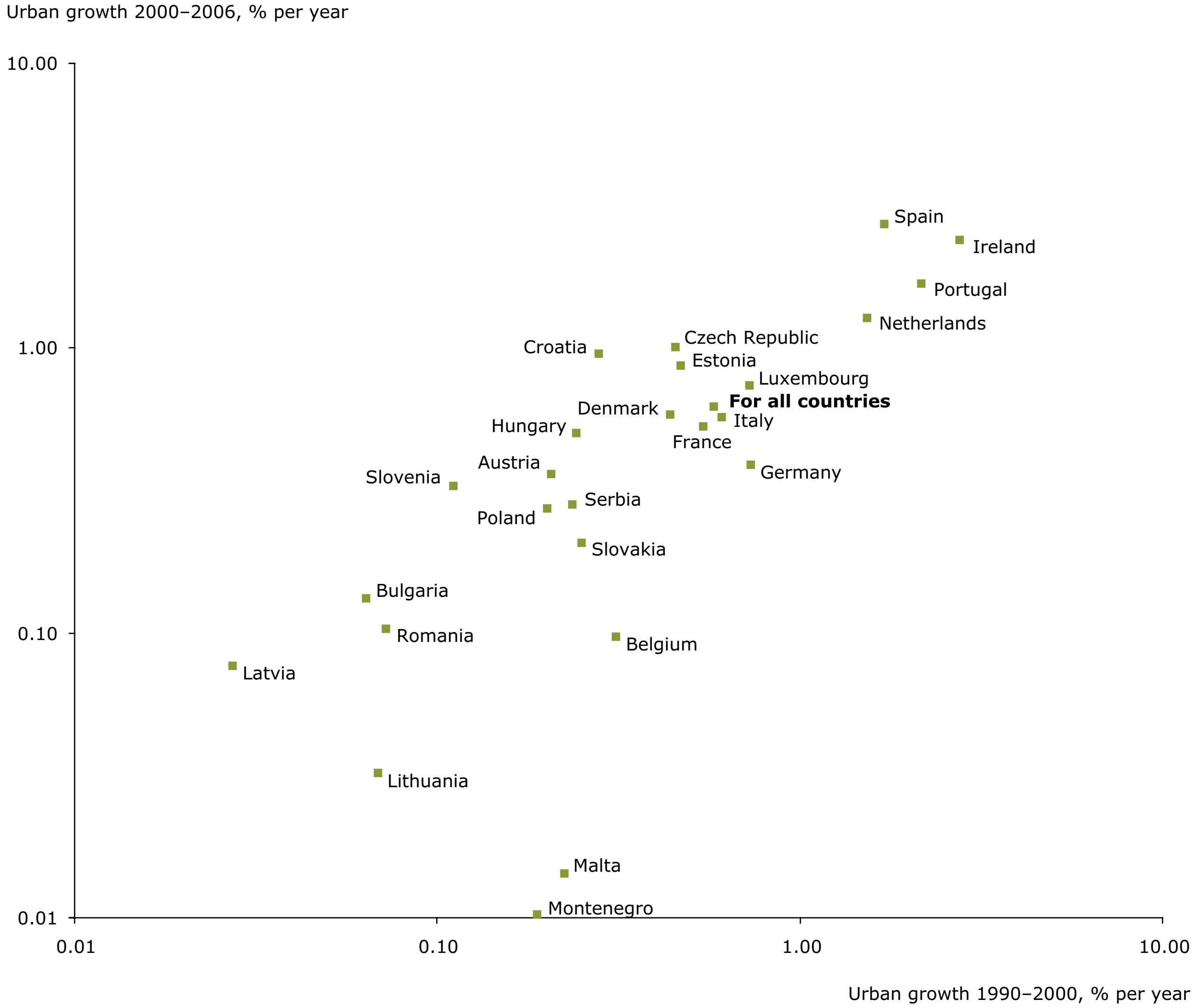
Table 2.3 Growth of artificial area in selected European countries 1990–2000 and 2000–2006

Country	Change 1990–2000, percent per year			Change 2000–2006, percent per year		
	Urban residential land take	Land take of economic sites	Land take: residential + economic sites	Urban residential land take	Land take of economic sites	Land take: residential + economic sites
Albania	-	-	-	4.7	0.3	5.0
Austria	0.1	0.2	0.2	0.1	0.3	0.4
Belgium	0.1	0.2	0.3	0.0	0.1	0.1
Bosnia and Herzegovina	-	-	-	1.1	0.4	1.5
Bulgaria	0.0	0.1	0.1	0.0	0.1	0.1
Croatia	0.1	0.1	0.3	0.1	0.9	1.0
Cyprus	-	-	-	1.5	1.1	2.6
Czech Republic	0.1	0.2	0.3	0.1	0.4	0.5
Denmark	0.1	0.3	0.4	0.2	0.3	0.6
Estonia	0.3	0.2	0.5	0.3	0.6	0.9
Finland	-	-	-	0.1	0.3	0.4
France	0.2	0.3	0.5	0.2	0.3	0.5
Former Yugoslav Republic of Macedonia	-	-	-	0.3	0.4	0.7
Germany	0.3	0.4	0.7	0.1	0.2	0.4
Greece	0.2	1.2	1.4	--	-	-
Hungary	0.0	0.2	0.2	0.0	0.5	0.5
Iceland	-	-	-	0.3	2.9	3.2
Ireland	1.4	1.4	2.8	1.2	1.2	2.4
Italy	0.4	0.2	0.6	0.2	0.4	0.6
Kosovo under UNSCR 1244/99	-	-	-	0.6	0.1	0.7
Latvia	0.0	0.0	0.0	0.0	0.1	0.1
Liechtenstein	-	-	-	0.0	0.0	0.0
Lithuania	0.0	0.1	0.1	0.0	0.0	0.0
Luxembourg	0.4	0.3	0.7	0.1	0.6	0.7
Malta	0.1	0.2	0.2	0.0	0.0	0.0
Montenegro	0.0	0.2	0.2	0.0	0.0	0.0
Netherlands	0.7	0.8	1.5	0.2	1.0	1.3
Norway	-	-	-	0.2	0.5	0.7
Poland	0.0	0.2	0.2	0.0	0.2	0.3
Portugal	1.2	0.9	2.2	0.4	1.3	1.7
Romania	0.0	0.0	0.1	0.1	0.0	0.1
Serbia	0.1	0.1	0.2	0.1	0.2	0.3
Slovakia	0.1	0.1	0.3	0.0	0.2	0.2
Slovenia	0.0	0.1	0.1	0.0	0.3	0.3
Spain	0.7	1.0	1.7	0.4	2.3	2.7
Sweden	-	-	-	0.1	0.4	0.5
Turkey	-	-	-	0.1	0.6	0.6
United Kingdom	0.1	0.1	0.2	-	-	-
For all countries	**0.2**	**0.3**	**0.5**	**0.2**	**0.4**	**0.6**

Note: Due to the methodology used, the 1990–2000 change rates may be slightly exaggerated for Austria, the Netherlands, Portugal and Spain but underestimated for Estonia, Latvia and Lithuania.

Source: EEA and ETC/LUSI based on data from CLC 1990, 2000 and 2006.

Figure 2.4 Growth of urban residential and economic areas in selected European countries, 1990–2000 and 2000–2006



Note: Results for 25 countries where EEA has data for both periods. For note related to methodology, see Table 2.3. Logarithmic scale.

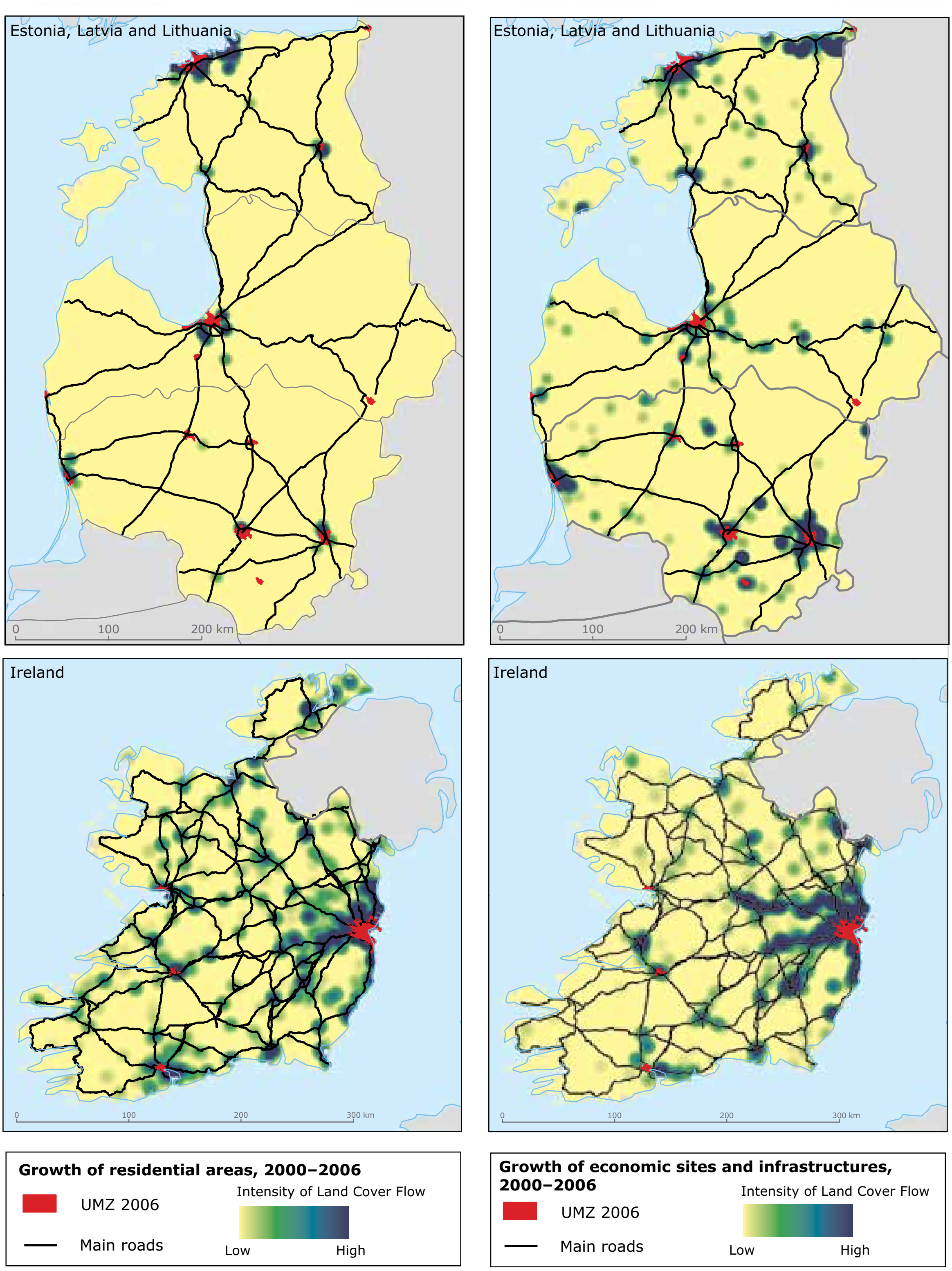
Source: EEA/ETC-LUSI 2010, based on CLC data.

Different patterns of urban development based on urban area growth rates and spatial character are seen across Europe. Small to medium rate of growth, < 20 %, and aggregation of existing settlements is seen mainly in central and eastern Europe. Same growth rates combined with increase of new built-up areas are scattered all over Europe, but not in Spain and Portugal where high rate of growth, > 20 %, occurred in both spatial patterns — as aggregation of existing settlements and increase of new built-up areas. Similar character of urban development was observed also in the Netherlands.

Transport infrastructure and thus accessibility to other areas are major drivers of urban development. As shown by the examples of the Baltic States and Ireland (Map 2.1), residential and in particular economic sites stretch along major transport routes and intersections.

The impact of urbanisation depends on the area of land taken and on the intensity of land use, for example the degree of soil sealing and the population density. Soil sealing within the Urban Morphological Zones (UMZ) of European capitals varies between 23 % and 78 %. Eastern

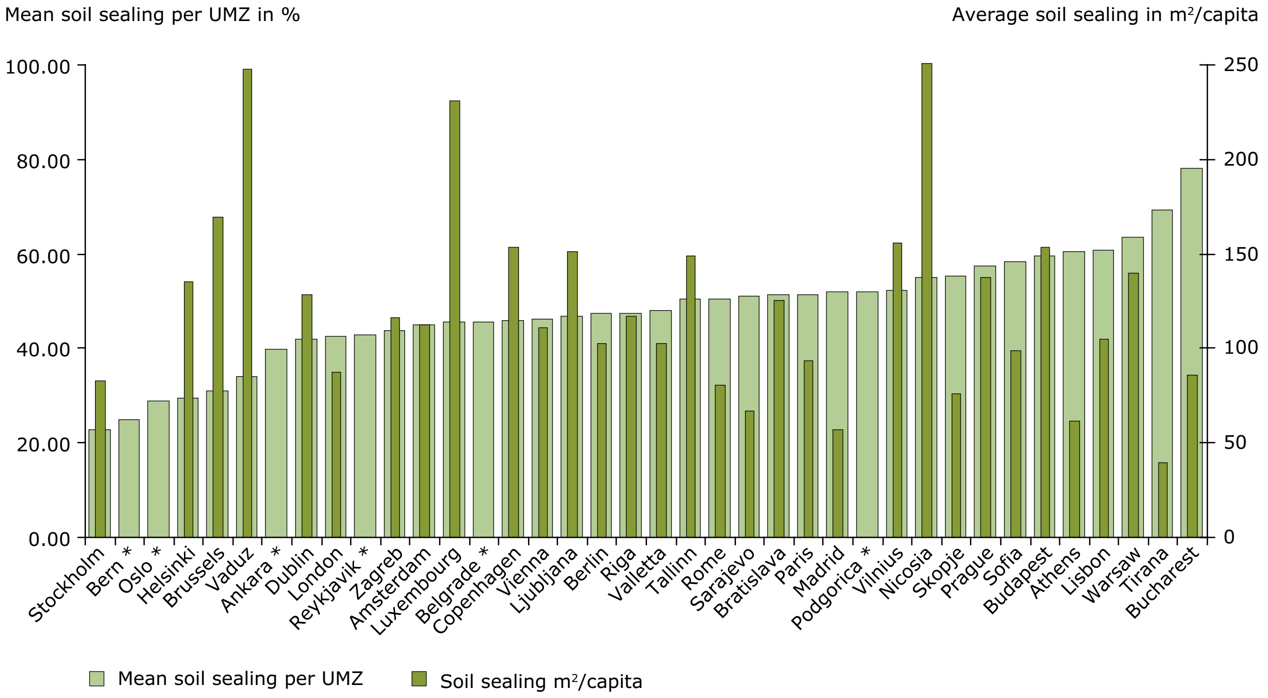
Map 2.1 Intensity of urban sprawl 2000–2006 in Estonia, Latvia and Lithuania (above) and Ireland (below)



Note: The areas surrounding the main road transport links were analysed for increase in urban land cover. The intensity of urban sprawl is the percentage of the total area changed that is transformed to points and estimated as density within a search radius of 10 km. The map also shows the main road axes and urban areas (based on Urban Morphological Zones — UMZ 2006 data).

Source: EEA/ETC-LUSI 2009.

Figure 2.5 Mean soil sealing in European capitals (UMZ) and soil sealing per inhabitant



Note: * Population data for Urban Morphological Zone (UMZ) unavailable.

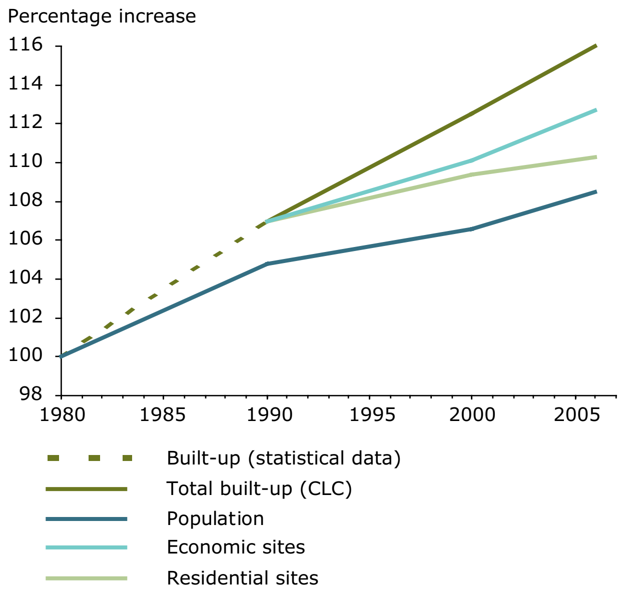
Source: EEA, 2010.

and southern cities tend to have more soil sealed than northern cities (Figure 2.5). However, this can reverse when mean soil sealing per capita is considered — highly-sealed cities like Sofia or Athens can have low soil sealing per inhabitant and thus be very efficient in use of urban land and protection of open space (Map 2.2).

Large variations in urban soil sealing rates emphasise the importance of brown-field development — the infilling and recycling of already-developed urban land — instead of using rural land. Land-cover analysis for 2000–2006 shows that there was more diffuse residential sprawl than brown-field development during that period. The comparison would be even worse if sprawl of commercial and industrial sites were included. The area where recycling of artificial surfaces occurred i.e. brown-field development, was only 18.2 % of the total area of land taken, suggesting sprawl, and in 17 countries it remained below 10 %.

Furthermore, the intensity of urban land use has changed in relation to population. Europe's population — in particular the urban population — has increased over recent decades, but built-up areas increased even more, in particular commercial and industrial areas (Figure 2.6). Thus, overall population densities in built-up areas decreased further. In terms of regional trends, residential

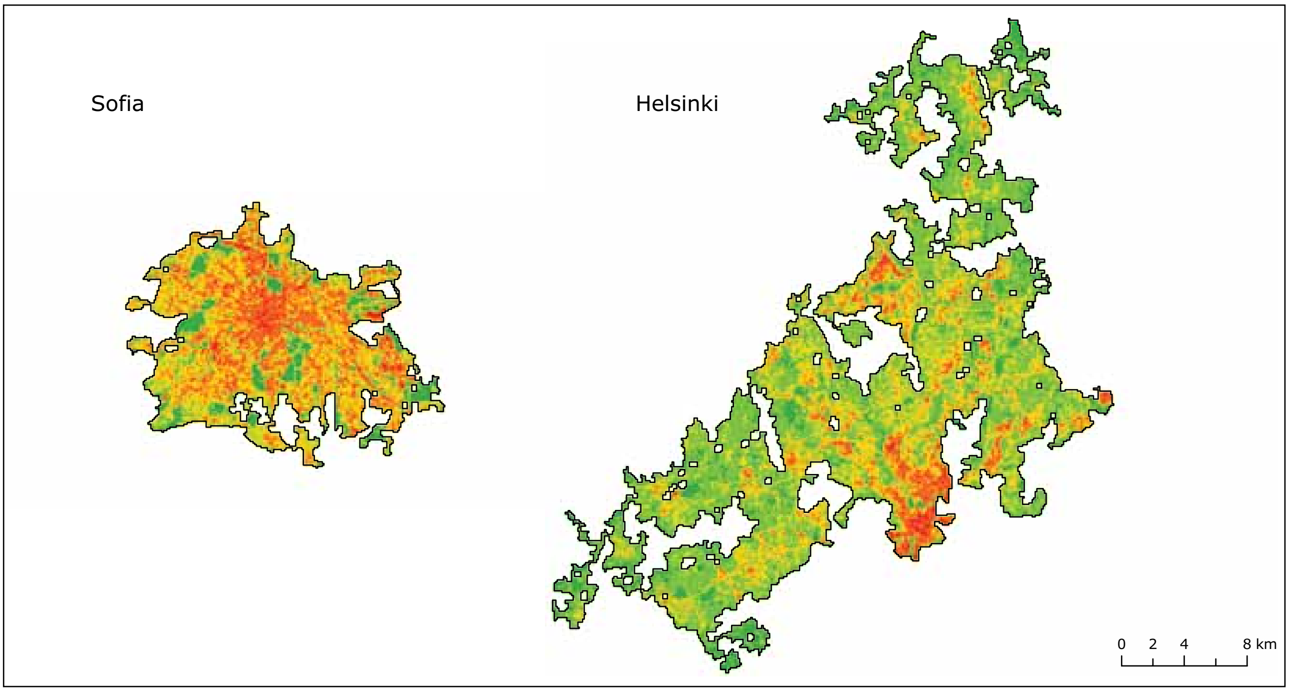
Figure 2.6 Built-up area and population increase in selected countries



Notes: Source for built-up area for the period 1980–1990 is OECD (statistical data). Built-up area for 1990–2006 calculated from Corine land cover. Population data from Eurostat. Graph includes 25 EEA member and collaborating countries.

Source: EEA/ETC-LUSI, 2010.

Map 2.2 **Degree of soil sealing (impermeability) in the UMZ in Sofia with 1.0 million inhabitants and Helsinki with 0.9 million inhabitants**



Degree of soil sealing (impermeability) in the Urban Morphological Zone (UMZ) of Sofia and Helsinki

Degree of soil sealing (%)

0 30 50 80 100

	Sofia	Helsinki
Population:	1 013 249	895 738
Area of UMZ (km^2):	172	413
Population density (inhabitants per km^2):	5 889	2 170
Average soil sealing degree (%):	58.4	29.4
Sealed surface per inhabitant (m^2):	99	135

Source: EEA/ETC-LUSI 2009.

urban land take in the EU-15 Member States has slowed in recent years, moving closer to the population trend. However, economic sites have sprawled, creating a mixed signal regarding the sustainability of land use (CLC 2006 analysis).

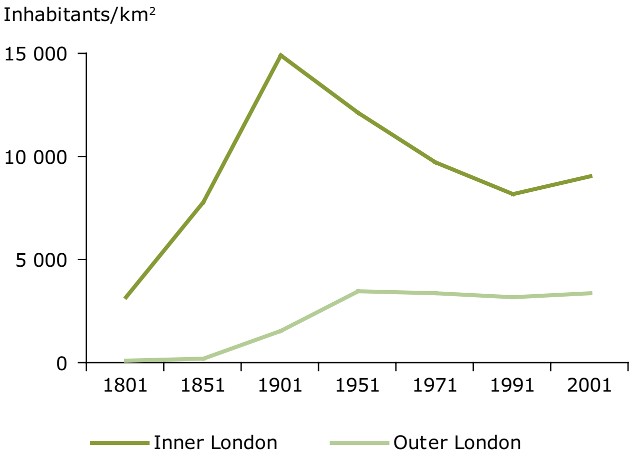
The share of Europe's metropolitan regions in terms of population and gross domestic product (GDP) has not increased substantially since 2000. In central and eastern EU Member States, mono-centric development is still more common than in western Europe, where the main economic growth during 2000–2006 happened outside the largest urban centres (ESPON, 2008; Dijkstra, 2009).

Between 2001 and 2004, the population in the 258 largest European city regions grew overall by around 2 %, and more than 70 % of this increase was in city cores (Urban Audit database) suggesting that people are starting to rediscover the cores of cities as attractive places to live.

Recent studies (Clifton et al., 2008) also suggest that population densities in central city cores and density gradients from city centres to their peripheries have fallen in nearly every city. This is demonstrated by the example of London in the second half of the 20th century: population densities increased strongly in inner London during the 19th century, then, after some delay, they increased slowly in outer London, but reached much lower levels (Figure 2.7), and then remained nearly stable for 70 years while inner city densities fell dramatically. However, from the early 1990s, population densities, particularly in the centre, have started to increase again.

London is not the only example of a reversing population density trend. Between 2001 and 2004, according to the Urban Audit, populations concentrated in the core cities of 29 % of the city regions studied and the situation was unchanged in a further 31 %. However, population densities in the remaining cities cores are still decreasing (Map 2.3).

Figure 2.7 **Changing population densities in London**



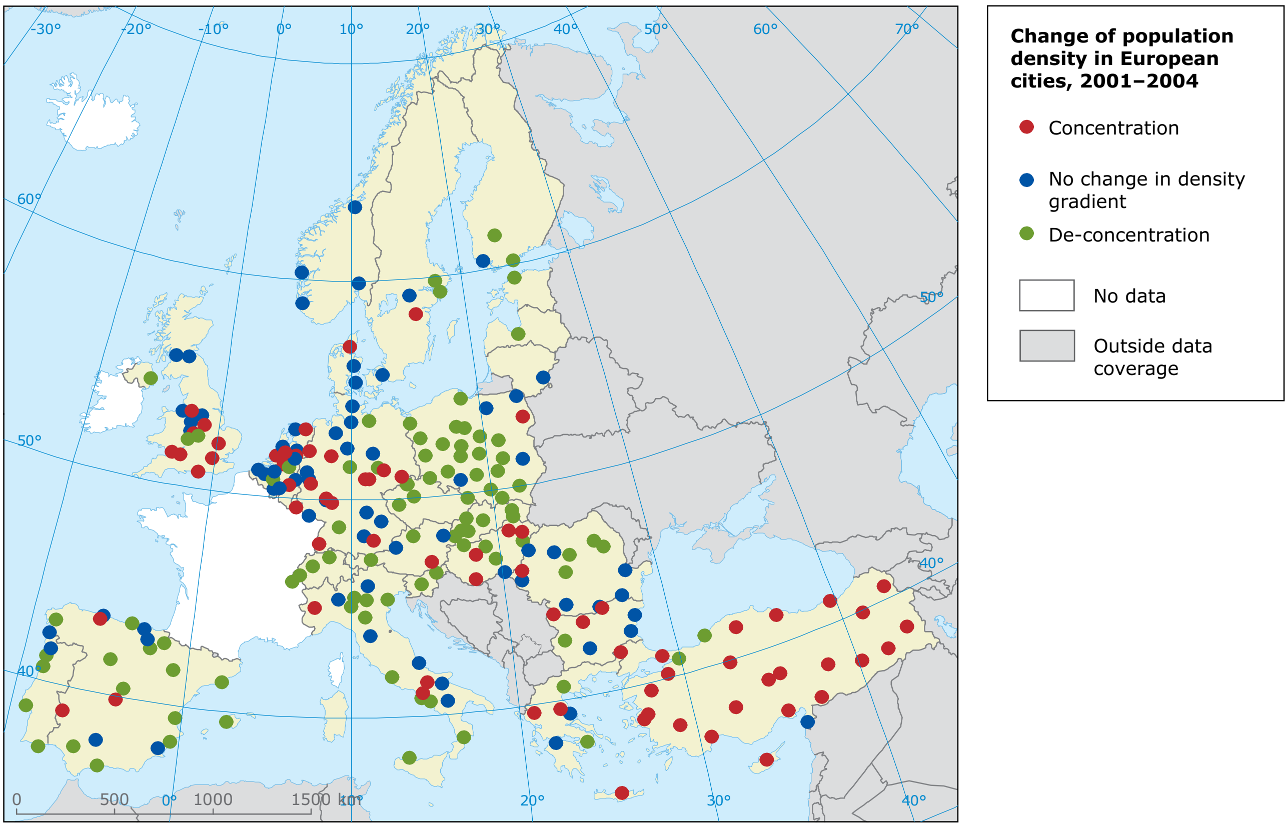
Source: Adapted from Bannister, 2007.

Interestingly, concentration and de-concentration are both happening in growing as well as in declining cities. For example, in the declining or stable city regions of central and eastern Europe in Poland, the Baltic Republics, the Czech Republic, Slovakia, and partially Romania and Germany (East), populations in the city centres are falling even more than at the edge, but in other declining cities, in Hungary and Bulgaria, for example, densities are increasing in the centres.

There are a number of different drivers of urban land take, at all administrative levels (Figure 2.8). Accessibility, for example, plays a major role, as shown by Ireland and the Baltic countries (Map 2.1). The faster increase of economic than residential sites indicates that economic activities can be a strong driver. A growing economy can trigger massive land take — but a weak economy can lead to a wide spread of economic sites when municipalities compete to attract businesses to their area. In some cases this results in partially under-used sites (PBL, 2008).

The population developments recorded in the Urban Audit database show a correlation with the prices of houses and apartments — people tend to move out of inner city areas, where prices are very high or people believe it is difficult to find adequate and affordable houses (European Commission, 2005b). Another important driver is the demographic structure of the population, in particular the increase in the number of smaller households, which

Map 2.3 **Changes in population and population density gradients in European city regions, 2001–2004**



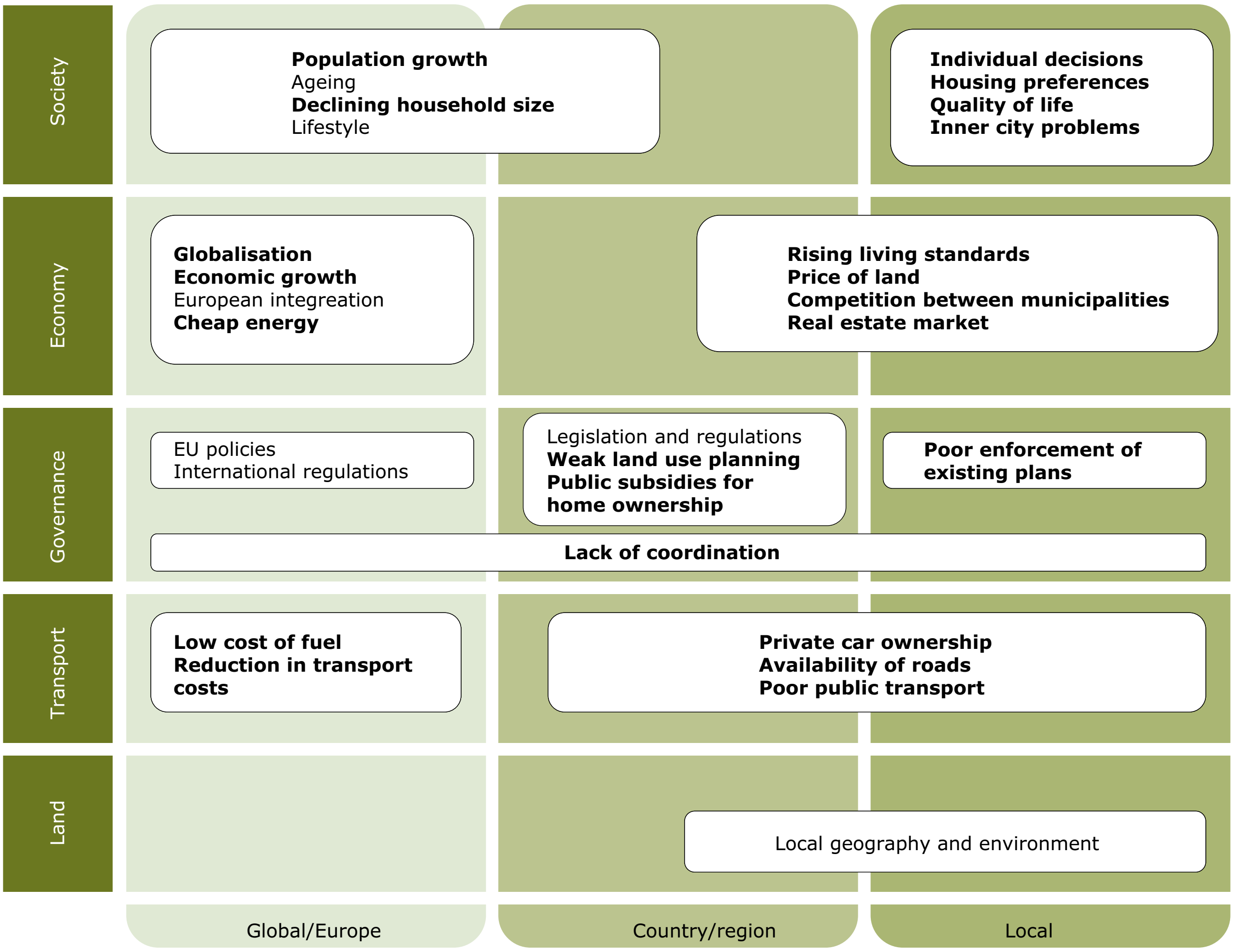
Source: Eurostat, Urban Audit database; EEA, 2009b, analysis by B. Georgi; EEA/ETC-LUSI 2009.

typically require more space per person. Also, weak regional planning, lack of inter-municipal and regional co-operation, and fragmented, sectoral decision-making drive urban sprawl (see further in EEA, 2006a and 2009b). Furthermore, a perceived poor environmental quality in inner cities seems to be another driver of sprawl, encouraging people to move to suburbia (SOER 2010 urban environment assessment, EEA, 2010f).

It is important to note that drivers may interact with each other. Nevertheless, in many cases it is not possible to identify a clear correlation between a driver and urban sprawl. For example the large GDP increases in Spain, Portugal and Ireland over the past 15 years are correlated with high urban sprawl, caused for example by strong development of tourism, sprawl of economic sites, and housing development. In contrast, urban sprawl rates are weakly or not at all correlated with GDP in several EU-12 Member States. Here, a generally low GDP per person may absorb the effect of GDP growth — the new wealth is not yet being converted to new housing. This could mean that urban land-take activities are about to start, but also that spatial planning restrictions in such countries have been more effective. In the case of the Netherlands strong planning policies are likely to lead to the type of concentrated development that would be more noticeable and detectable.

Policies concerning the drivers described above can have an important influence on spatial development. From a European perspective, in particular transport and cohesion policies have major impacts. For example for the period 2007–2013, more than EUR 80 billion has been allocated to transport in the Structural Funds, and two thirds of this is for the EU-12 Member States, mainly for road projects (EEA, 2009b).

Figure 2.8 Main drivers of current urban sprawl in Europe



Note: Drivers have been organised in two dimensions: type (vertical) and spatial scale (horizontal). Demand/supply has not been differentiated. In bold: factors that drive urban sprawl; the remaining factors may become drivers under certain conditions.

Source: Adapted from EEA, 2006a and PBL, 2008.

3 Impacts

3.1 Land-use intensity

Habitat destruction, fragmentation and degradation caused by detrimental land-use change are among the strongest pressures on biodiversity (Council, 2010). Changes in land cover can provide information about pressures on biodiversity (Eurostat, 2010b). Several land-cover changes including land conversion or changes in land-use intensity can affect the status of specific habitat types and species.

High biodiversity characterised by redundant functional relationships between species within an ecosystem is insurance in the face of change. This, in turn, is a key component of system resilience — the capacity to absorb disturbance and reorganise while undergoing change so as to retain essentially the same functions, structure, identity, and feedbacks (Huitric et al., 2009). Both species biodiversity and ecosystem resilience support ecosystem functions and services that benefit human society (MEA, 2005). The adverse effects of land-use specialisation and the resulting landscape polarisation lead to functional simplification of landscapes. Decreased multi-functionality can affect the status of ecosystem services and human well-being (Chapin et al., 2009).

Agriculture is one sector where the intensity of use within individual land-use types has a very important influence on overall environmental impact. The EU has established a set of 28 agri-environment indicators to support the monitoring and evaluation of the environmental impacts of agriculture and to help evaluate the impact of the CAP in this regard. These indicators are presented in a recent publication by Eurostat, with certain agri-environmental trends being in discussed in detail (Eurostat 2010c).

Land take for urban development and infrastructure results in soil sealing — the loss of soil resources due to the covering of land for housing, roads or other construction work, and is generally irreversible. A study (Figure 3.1) has determined soil sealing by urban areas in Europe at 1.81 % of the total land area, which corresponds to other estimates (Schneider et al., 2009). Converted areas become highly specialised in terms of land use. Urban land take is mostly of agricultural land, but also reduces space for habitats and ecosystems that provide important services like regulation of the water balance and protection against floods, particularly if soil is highly sealed (EEA, 2006a).

In addition, lower population densities — a result of urban sprawl — require more energy for transport and heating or cooling. The consequences of urban life styles, such as air pollution, noise, GHG emissions and impacts on ecosystem services, are felt within urban areas as well as in regions far beyond them (SOER 2010 consumption and the environment assessment, EEA, 2010g). On the other hand, a person living in a city consumes only 3.5 tonnes oil equivalent (toe) annually compared with 4.9 toe for a rural dweller (IEA, 2008).

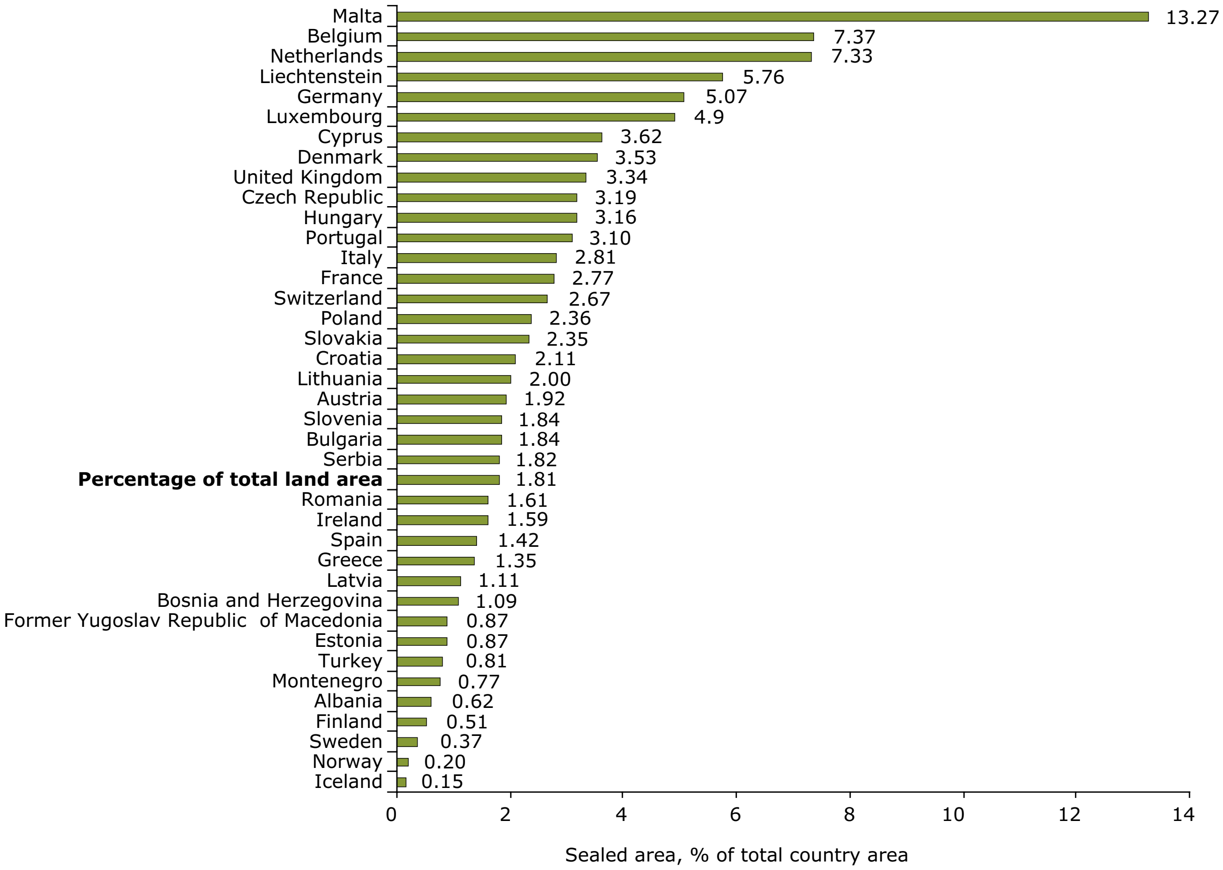
Specialisation is also a norm for other land uses — agriculture aims at higher competitiveness and productivity and has long relied on measures to improve efficiency often leading to simplified crop rotations (or even monoculture), large fields and a high degree of mechanisation. Similar trends can be seen in forestry, where uniform tree plantations are driven by the wish economic returns.

In the context of specialisation and increasing productivity, which generally implies intensification, areas with mixed small-scale land-use patterns tend to be less profitable and may be taken over for more specialist uses. These landscape mosaics are characterised by low inputs and sub-optimal conditions for modern food and fibre production. However, they often support high levels of biodiversity and related ecosystem services (EEA, 2010e).

The dynamics of pasture and mosaic landscapes shows their steady decline in Europe (see Chapter 2). Methods developed in the EEA allow evaluation of the degree of landscape polarisation — land-use specialisation and loss of current or future multi-functionality. The results suggest that European land resources continue to cluster spatially around a few narrowly-focused land uses, while diverse areas are declining. An important step in assessing such areas is establishing the distribution of high nature value (HNV) farmlands in Europe (Paracchini et al., 2008).

In the EEA member countries undisturbed forests account for about 5 % of the total forest area, and are located mainly in east and nordic/Baltic Europe. In most European countries, the share of forests undisturbed by man is very low, ranging up to 1 %, although it has increased

Figure 3.1 Degree of soil sealing, as a percentage of total land area, in European countries, 2006



Source: EEA/ETC-LUSI, 2010 (results from GMES Fast Track Service Soil sealing enhancement project).

slightly since 1990 due to different interpretations of the definitions, including protection when the former semi-natural forests are designated for protected areas and then considered undisturbed forests (MCPFE, 2007).

Generally, a mosaic of different stages of forest development is highly beneficial for biodiversity. In practice, most forests — even protected ones — have been cut during recent tree generations and do not provide enough niches for significant numbers of forest organisms, for example, those related to deadwood (EEA, 2009d).

Some studies show that forest landscapes should contain a minimum of 10 % of relatively natural state, such as old-growth stands, in order to support the continued existence of many species that depend on forest habitats (Lõhmus et al., 2004). In most European countries the deadwood that is essential for forest invertebrate biodiversity is increasing much more slowly than the overall forest area and remains below optimal levels from a biodiversity perspective (EEA, 2009a). For example, deadwood volumes in managed forests range from 2 m^3/ha to 10 m^3/ha but in a study of boreal forests in Fennoscandia, deadwood volumes ranged from 19 m^3/ha up to 145 m^3/ha (Siitonen, 2001).

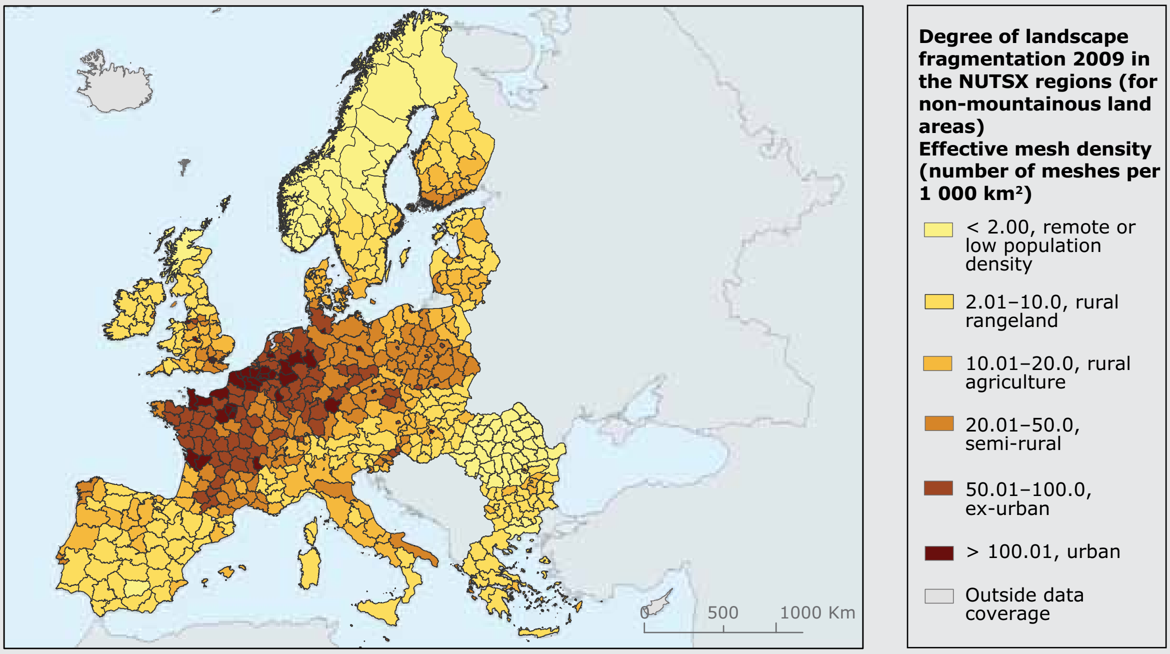
More species are predicted to become extinct as habitat destruction increases (Tilman et al., 2002). Most sensitive are those species that are highly specialised and therefore less able to adapt to environmental change. Moreover, the more fragmented a habitat, the greater the probability of extinctions caused by further destruction. Because such extinctions occur generations after habitat fragmentation, they represent a future ecological cost of current habitat destruction. About 1 000 old-growth boreal forest species have been identified as a so called 'extinction debt', that is ecosystems that support their sustainable existence are increasingly being destroyed and their extinction is only a matter of time (Hanski, 2000).

Fragmentation of natural and semi-natural landscapes is a general threat to terrestrial ecosystems, not only forests. In addition to infrastructure elements, more and more scattered urban land take is fragmenting the countryside and increasing pressures, in particular, on forests and (semi-) natural areas (Box 3.1). Urban sprawl requires more infrastructure like roads and increases fragmentation. Forest ecosystems can be also fragmented by forestry itself, in particular final felling. Connectivity for forest species is another measure of landscape

Box 3.1 Landscape fragmentation levels in Europe (Jaeger, 2000)

Landscape fragmentation caused by transport infrastructure and urban sprawl has a number of detrimental effects such as reduction in size and persistence of wildlife populations, changes in local climate, increase in pollution and noise from traffic. Data on the degree of landscape fragmentation are therefore needed to monitor the sustainability of human land uses. Such data can also be used to identify regions that are particularly fragmented, more than could be explained by human presence or economic activities. Maintaining low fragmentation can result, for example, from making better use of existing road networks instead of building new roads. Low fragmentation does not necessarily mean low GDP or high unemployment rates — areas of low fragmentation can be protected without negative consequences for the economy.

Map 3.1 Effective mesh density (number of meshes per 1 000 km²) for NUTSX (combined NUTS 2 and 3) regions, 2009



Note: The size of meshes is calculated as the Effective Mesh Size (m_{eff}), a geo-statistical measure, which converts the probability that randomly selected points in an area are connected into the size of an un-fragmented patch. Smaller mesh size means less landscape connectivity and higher landscape fragmentation, which is the inverse of connectivity. Effective mesh density (s_{eff}) is the reciprocal value of meff ($s_{eff} = 1/m_{eff}$) (Map 3.1).

Three different groups of regions can be distinguished:
(1) heavily urbanised regions with a population density higher than 100 inhabitants per km²;
(2) ex-urban, generally semi-rural, beyond the suburbs of a city, but experiencing major urban influences such as commuting, and semi-rural regions;
(3) rural and remote regions.

The heavily urbanised regions have an effective mesh density above 100 meshes per 1 000 km². On average, these regions are 40 times more fragmented than ex-urban ones. Ex-urban regions have an effective mesh density between 20 and 100 meshes per 1 000 km². On average, this group is 15 times more fragmented than agricultural (rural) regions. This last group of regions has an effective mesh density ranging from 0.2 to 20 meshes per 1 000 km².

Source: Landscape Fragmentation in Europe, EEA/FOEN joint report 2011, forthcoming.

integrity. Highly fragmented landscapes support less biodiversity (EEA, 2009a, 2009d).

3.2 Land use and greenhouse gas sinks

Land-use/land-cover change (LULCC) plays a major role in climate change at global, regional and local scales (Ellis and Pontius, 2007). At the global scale, LULCC results in the release of GHGs to the atmosphere, thereby driving global warming (UNFCCC 2010). LULCC can increase the release of carbon dioxide (CO_2) by disturbing soils and vegetation, and the main driver of this is deforestation, especially when followed by agriculture, which causes further release of soil carbon as a result of disturbance by tillage and drainage of (peat) soils. LULCC is also associated with major changes in terrestrial emissions of other GHGs, especially methane from altered surface hydrology — wetland drainage and rice paddies, cattle grazing; and nitrous oxide from agriculture — the input of inorganic nitrogen fertilisers, irrigation, cultivation of nitrogen-fixing plants, biomass combustion.

European terrestrial ecosystems store significant amounts of carbon. About one third of terrestrial carbon is sequestered by above-ground biomass and two thirds in soil where parts of organic components are stored for decades or centuries. Carbon storage in arable land is less than in other land systems, but its potential to act as a carbon sink is still significant (Ellis and Pontius, 2007).

When grasslands, forests and wetlands are converted to other types of use, the level of organic matter and organisms in soil, as well as CO_2 sequestration capacity, generally decreases. This is particularly relevant for permanent grasslands such as pastures (European Commission, 2010d).

A meta-analysis of 74 publications (Guo and Gifford, 2002) indicated that soil carbon stocks *decline* after land-use change from pasture to plantation by 10 %, native forest to plantation by 13 %, native forest to crop by 42 %, and pasture to crop by 59 % and *increase* after land-use changes from native forest to pasture by 8 %, crop to pasture by 19 %, crop to plantation by 18 %, and crop to secondary forest by 53 %. In the context of carbon sink strategies for GHG mitigation, the tree species used in afforestation can be important: broadleaf tree plantations planted on previously native forest land or pastures did not affect soil carbon stocks whereas pine plantations reduced them by 12–15 % (Guo and Gifford, 2002).

Wetlands contain large accumulations of organic matter due to waterlogged conditions. When water levels are lowered, for example by drainage, to create farmland, extract peat or stimulate forest growth, organic matter decomposition accelerates and part of the fixed carbon is released in the process of mineralisation (Minkkinen et al., 2002). European wetlands have to a large degree been modified by humans over a long period, particularly in the 19th and 20th century (European Commission, 2007a). Decline of wetlands has decreased — a net loss of 0.4 % in 2000–2006, based on the CLC inventory — however the effect of wetland conversion and disturbance is long-lasting. The use of wetlands has gradually changed since the second half of 20th century, mostly because of recognition of their biodiversity value through, inter alia, the Ramsar Convention on wetlands of international importance (Ramsar, 2005). This has also slowed modification of wetlands and there is a trend towards restoration, in particular as a result of recognising the role of wetlands in securing water balances and carbon sequestration (European Commission, 2007a).

Forest fires can also reduce GHG sinks, especially in the Mediterranean region, where natural carbon stocks in soil are low. While the main cause of fires is human induced, existing land-use practice has a role in prevention aimed at mitigating the flammability of forests. For example, the increase in flammable forest biomass in many Mediterranean countries is associated with a shift of population from rural areas to cities. As a result, large stretches of marginal farmland, especially in mountain areas, have been left uncultivated and have been colonised by bush and even natural pine groves. As a general trend, the wildfire problem worsened in the second half of the 20th century due to the depopulation and abandonment of rural areas, the prolonged protection of forest lands and the growth of extensive areas on the interface of urban and wild land (Goldammer and Kraus, 2007).

3.3 Land use and impacts of environmental change

Today's land-use patterns are likely to be challenged by changing environmental conditions, including climate change (Box 3.2). The long-term sustainability of land-use decisions, formulated in spatial planning documents, therefore has great significance for managing the risks that future generations may face. Although spatial planning polices are generally adopted under the auspices of sustainability or balanced socio-economic development, they can also serve the purpose of adaptation to future changes in environmental conditions.

Increasing urban populations and concentration of people in urban areas result in a high demand for water that can stress the local water balance. When water demand in urban areas exceeds the availability the cities have to transport water from the surrounding regions (SOER 2010 water resources: quantity and flows assessment, EEA, 2010h). Intensified agricultural

Box 3.2 The global links of Europe's land use

There is little doubt that increasing global food demand, the result of population increases and development, is likely to necessitate further land conversion and increased efficiency of food production, at least at the global scale (PBL, 2009). Europe is an importer and exporter of agricultural products. The total volume and intensity of European agricultural production thus matters for the preservation of environmental resources and ecosystems in Europe and around the globe.

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

Conversely — and in a global perspective — the conversion of forests and grasslands to agricultural land is one of the most important drivers for habitat loss and greenhouse gas emissions worldwide. There are clear links between the use of farmland in Europe and global agricultural trends, and both relate to environmental trends. Trade-offs associated with intensifying farming and environmental protection in Europe, and their implications for ecosystems around the world need further evaluation. An important consideration in this regard is the preservation of critical natural capital — such as fertile soils, adequate and clean water resources, and natural ecosystems that serve as carbon sinks, harbour genetic diversity and support food provisioning (SOER 2010 synthesis).

The aggregated impact of land use on the annual availability of biomass in ecosystems can be quantified using the Human Appropriation of Net Primary Production (HANPP) approach (Haberl et al., 2007); net primary production (NPP) is the carbon taken up by plants during photosynthesis, a part of which may subsequently enter long-term carbon stocks in biota and soils. In large parts of Europe, particularly in the central and southern areas, significantly more carbon is directly or indirectly removed through the use of biomass-based products than is sequestered by vegetation. Much of this carbon has to be imported from other countries, mostly outside Europe (Erb et al., 2009).

practices such as irrigation also require much water. The demand is often met by pumping up groundwater. Some aquifers — those containing clay and silt, for example — can compact when ground-water is pumped excessively, resulting in permanent subsidence. In coastal areas, over-exploitation of aquifers can lead to salt-water intrusion. In such areas it is important to manage negative impacts of urban development and irrigated crops through joint approaches, building on land-use planning and economic management incentives in related policy domains, such as the CAP. In particular, this approach should be respected in regions where climate change is projected to result in less precipitation and reduced surface-water supplies, which will increase pressure on the groundwater resource and vulnerability to droughts.

In low-lying coastal areas, damage from subsidence (also for other reasons that over-abstraction of water) could combine with sea-level rise — for example cities in the Rhine-Meuse delta, the Po delta and the Baltic coastal area. This will result in tides and/or storm surges moving into low-lying areas that were previously above high-tide levels. Twelve percent of all EU coastal zones lie below 5 m above sea level and are potentially vulnerable to sea-level rise and related inundations that also increase the risk of soil salinisation (EEA, 2006b). The total value of economic assets in Europe located within 500 m of the coastline, including beaches, agricultural land and industrial facilities, is estimated at EUR 500 to 1 000 billion (EUrosion, 2004). Europe's coastal zones have experienced rapid rates of development and a 7.5 % increase in artificial land cover between 1990 and 2000. This trend continued during 2000–2006, a 4.9 % increase, and the rate has even accelerated slightly, from 0.75 % to 0.82 % per year during that period (CLC 2006 results).

Higher temperatures in urban than rural areas can result in urban heat islands. The reasons for the formation of these are complex and are influenced by the impact of change in albedo, heat transfer from evapo-transpiration from vegetation, and changes in surface roughness. These are directly linked to the degree of soil sealing in residential, commercial and industrial areas and can become a serious threat to people during heat-waves, such as the one in 2003 (SOER 2010 urban environment assessment, EEA, 2010f; EEA, 2008).

Built-up surfaces on flood plains and water retention areas increase the risk of flooding and flood damage — the Rhine has already lost four fifths of its natural floodplains. Similarly, only 14 % of the natural floodplains of the Elbe remain available for flooding (IKSE, 2006), whereas flood-prone urban areas increased by 50 km^2 during 1990–2000 (EEA, 2009b). Local authorities control building development on floodplains, but neither they nor the development planning system can influence wider catchment land use.

Sustainable flood management requires land management decisions to ensure that where increased flooding does occur, it happens in designated areas that are prepared for it. For example, preserving or re-instating natural floodplains upstream can help soak up floodwater before it spills into urban areas (WWF, 2002).

A good example of investing in the safety and vitality of a river basin region is the Dutch spatial planning key decision *Room for the River* (V&W, 2006). Designated floodplains will allow areas to flood, provide storage, enable more natural river movement and benefits to habitats. Wetlands, washlands — areas of the floodplain that are allowed to flood — and flood meadows should be preserved as natural attenuation features (WWF, 2002).

The trend towards intensification of agriculture results from the aim of maximising the crop production-oriented functions of ecosystems. However, highly productive monoculture agro-systems come at a price. Replacement of multi-functional areas by simplified or monoculture land use increases vulnerability to environmental change. Intensively-managed agricultural areas lose a great degree of self-regulation and become highly dependent on permanent external inputs such as energy and chemicals. The observed tendency for landscape polarisation — the intensification of some areas and abandonment of others — therefore reduces the natural capacity of land systems to cope with the impacts of environmental change (Foley, 2005; Selman, 2009).

3.4 Recreational and cultural aspects of land use

Tourism, especially on coasts and mountains, takes land for facilities, transport and other infrastructures affecting the environment and biodiversity, especially when attractions are within sensitive areas. To develop a tourism industry in a sustainable way, the European Commission has launched the network of European Destinations of Excellence (EDEN). Selected sites can promote sustainable tourism by linking tourism to rural life, cultural heritage or protected areas.

Access to green areas, including coastlines, can become more difficult when peri-urban diffuse settlement patterns become dominant. Public access to natural areas may be limited by private land ownership or tourist facilities that restrict free passage. An example of a policy response is the coastal land acquisition by the Conservatoire du Littoral — a public organisation in France. More than 75 000 ha of coastal land has been bought in order to create conservation sites that also ensure public access to the coastline (EEA, 2010c).

Recognition of land as landscape is associated with particular values that can affect the way land is used. The cultural dimension of landscapes may be affected by unfavourable land-use practices. In some cases new land uses are seen as a threat to cultural values, such as the amenity value of traditional land-use patterns associated with a landscape. Some land-use developments result in objections because they are seen as incompatible with outstanding landscape view points, or the spiritual or archaeological heritage of certain sites. One example is resistance by local communities to wind turbine placement in the rural landscape. Thus, land-use decisions influence and are influenced by human interpretation of land as space for living and recreation i.e. much more than a site for food production or energy installations.

4 Outlook 2020

4.1 Land-use outlooks

The driving forces that shape recent land-use trends are also likely to determine future trends: demand for more living space per inhabitant and improved transport infrastructure, socio-economic forces in agriculture that result in simplification of farming systems and concentration on the more productive areas, and an increase in forest area at the expense of semi-natural grassland and scrub cover. In addition, EU policies on bio-energy production are likely to increase their impact on European (and global) land-use patterns as policy targets are implemented over the next ten years.

Land-use outlooks should cover two dimensions: the change ***between*** different land-cover categories and change of land-use intensity ***within*** individual land-cover categories. Analysis of Corine land-cover data 1990–2006 suggests that land conversions in Europe in general are slowing — other than for artificial surfaces, especially on economic sites. However, the uncertainty in this trend is high due to uncertainties in the pathways of the main drivers for land-cover change (Box 4.1).

It is expected that by 2020 urban areas will increase their share in European land stock by approximately 1 % (EEA 2007b), although large differences exist between Member States and regions, with the proportion of the sealed surface ranging from 0.3 % to 10 % (European Commission, 2010d).

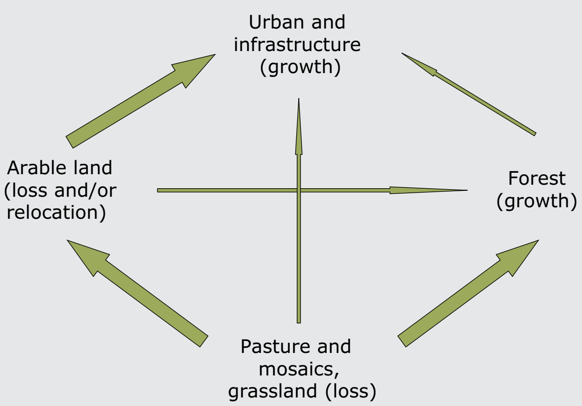
Decreases in total agricultural land-use were projected for 2000–2020 in all development scenarios of the EEA PRELUDE study (EEA, 2007b) and a recent review of land-use outlook studies for the EEA (RIKS, 2010). The available data for 2000–2006 changes confirm the direction of these trends for rain-fed arable land and pastures, which decreased by 0.4 % and 0.3 %, respectively. However, permanent crops have generally not decreased during this period (CLC 2006 data set).

Total forest area has increased consistently over recent decades and the EEA PRELUDE study projected this to continue with its share increasing by around 5 % between 2000 and 2020. The main drivers for this trend were expected to be a mixture of afforestation and natural processes, with increases likely to occur mainly on former

Box 4.1 Exploring future trends for currently dominating land-use changes

Figure 4.1 shows the predominant land-cover trends observed between 1990 and 2006. A review of national contributions to SOER 2010 for land showed that most countries expect a continuation of current land-use specialisation trends — urbanisation, agricultural intensification and abandonment, and natural afforestation. However, this has to be seen in the context of an overall slow-down of total land changes observed in 2000–2006 and the substitution of residential area expansion with dominant growth of economic sites. While most specialisation trends will continue, country feedback shows that they may do so at a lower rate. For example, Ireland expects a slowdown in urbanisation and Latvia expects reduction of unused agricultural land. The Czech Republic, Iceland, Italy and Slovenia expressed concerns about climate change impacts on their territories. Denmark and the Netherlands plan to increase or restore their natural sites.

Figure 4.1 Predominant net land conversions in Europe 1990–2006, based on CLC analysis



Source: EEA.

agricultural land, as well as along the tree margins in mountain and boreal areas (EEA 2007b). However, during 2000–2006 the stock of forested land increased by 0.1 % only (CLC 2006 data).

Tracking and projecting trends in CLC classes is one approach to developing outlooks on future land-use trends. Most land-use outlook studies, however, use a modelling approach, particularly when they investigate trends in agricultural land-use types and intensity. To harvest the outcome of such land-use studies the EEA commissioned a literature review of European medium-term land-use outlooks with a time horizon of 10–20 years.

Five studies were considered to provide information that allows a quantitative comparison and analysis: EFMA Forecast, ETC-LUSI, LUMOCAP and Scenar-II (RIKS, 2010). The EFMA forecast is based on expert opinion, the other studies make use of varying suites of models. They typically give a baseline scenario plus deviating scenarios, based on different driver assumptions regarding, for example, socio-economics and technology as well as (European) policies like the CAP, the Birds and Habitats Directives, the Nitrates Directive and the Water Framework Directive. All studies take the CAP explicitly into account. ETC-LUSI analyses the effects of bio-energy policies, including the EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Only LUMOCAP has results for different climate scenarios, the others do not differentiate in this respect.

A comparison of trends projected by these five studies shows that generally the differences between individual

Table 4.1 Projected patterns of annual land-use change for a 10–20-year time horizon, EU-15

	Cereals		Oilseeds		Fodder	Other arable	Set aside and fallow	Permanent crops	Grasslands	Built up
Study	**(area)**	**(yield)**	**(area)**	**(yield)**	**(area)**	**(area)**	**(area)**	**(area)**	**(area)**	**(area)**
EFMA Baseline	– 0.3 %	0.1 %	1.3 %	0.2 %	– 0.7 %	0.2 %	0.4 %	– 0.9 %	– 0.1 %	
ETC LUSI BAS_2020	– 0.1 %		1.1 %		– 0.7 %	– 1.7 %	– 2.8 %	– 0.4 %	– 0.6 %	
LUMIMP Reference	– 0.7 %		– 0.1 %			– 0.4 %		– 0.3 %	0.1 %	0.3 %
LUMOCAP Baseline	0.5 %	0.7 %	0.9 %	0.5 %	– 0.2 %	– 0.4 %	– 4.8 %	– 1.3 %	– 0.8 %	0.7 %
SCENAR-II Reference	– 0.6 %	0.6 %	– 1.9 %	0.6 %		1.5 %	– 1.0 %	0.0 %	0.1 %	

Note: Numbers stand for % annual change.

Source: RIKS, 2010.

Table 4.2 Projected patterns of annual land-use change for a 10–20 year time horizon, EU-10

	Cereals		Oilseeds		Fodder	Other arable	Set aside and fallow	Permanent crops	Grasslands	Built up
Study	**(area)**	**(yield)**	**(area)**	**(yield)**	**(area)**	**(area)**	**(area)**	**(area)**	**(area)**	**(area)**
EFMA Baseline	– 0.4 %	0.7 %	0.8 %	0.8 %	0.5 %	0.0 %	– 3.7 %	– 0.2 %	– 0.2 %	
ETC LUSI BAS_2020	0.0 %		– 0.4 %		– 0.5 %	– 1.0 %	1.6 %	– 0.5 %	– 0.6 %	
LUMIMP Reference	0.1 %		0.1 %			– 0.2 %		– 0.2 %	0.7 %	0.2 %
LUMOCAP Baseline	– 0.1 %	2.9 %	0.4 %	2.0 %	– 3.1 %	– 1.3 %	0.0 %	– 1.1 %	– 1.4 %	0.7 %
SCENAR–II Reference	– 0.4 %	0.8 %	– 0.3 %	1.4 %		0.0 %	2.3 %	0.0 %	– 0.7 %	

Note: Information for Bulgaria and Romania is not presented here, but trend projections are largely similar to the other new Member States.

Source: RIKS, 2010.

studies are much larger than the differences between their respective scenarios (Tables 4.1 and 4.2). This is partly explained by differences in the initial data — not all studies use the same data sources — as well as land-use class definitions. Absolute figures thus cannot be compared, but looking at the directions of change allows analysis of how well the trends projected by the different studies are aligned.

In line with past trends, the total area of arable land — including cereals, oilseeds, fodder crops, other arable and set-aside and fallow — is generally projected to decrease. Particular losses are foreseen for set-aside and fallow land as well as fodder crops in the EU-15 as recent CAP reforms have abolished the set-aside regime and fodder crops continue their long-term decline. However, set-aside and fallow land in the new Member States are projected to increase to 2020 due to economic and social factors. Oilseeds gain in most studies due to EU biofuel targets. A decline is projected for grassland cover in the old and new EU Member States by nearly all studies, as dairy production intensifies and cows are increasingly kept in stables all year round, and economic pressures on grassland-based livestock systems continue. The area of permanent crops in old and new Member States is projected to decrease in most of the studies analysed.

Most studies provide only limited information about environmental impacts from the projected land-use change. The EFMA Forecast points at increased consumption of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) in the EU-10 and EU-2 (with fertiliser use remaining largely stable in the EU-15). Combined with the shrinking farmland area, this intensification may lead to increased water pollution locally.

ETC-LUSI finds a negative impact, on average, of the EU biofuel target on water quality (see also Box 4.2). While nitrate concentrations in groundwater and surface waters are generally projected to decrease, they would decrease even more without the biofuel target. The associated conversion to biofuel crops is also expected to have negative impacts on farmland birds, particularly in Romania, Bulgaria, Hungary, France, Spain, Portugal and Italy. This is consistent with SCENAR-II findings, which indicate that urban areas, intensive agriculture and forest areas will increase at the expense of grasslands, extensive agriculture and wetlands (Nowicki et al., 2009). As a result, bird populations in general may decrease by 10 %, and farmland bird population are projected to decrease even more.

4.2 Urban development

It is hard to predict the development path of urban land use over the coming decades as the drivers are very complex and interacting. Projections for continuing increases in European population — it was 2.2 % for 2000–2006 in the EU-27 — and urbanisation suggest more

Box 4.2 The potential environmental effect of biofuel production

Biofuels have a role in future energy production. However, the way in which they are produced and managed determines whether they are likely to benefit society, the economy and the environment.

The life-cycle balance of first generation biofuels, such as ethanol from corn, wheat or sugar cane, indicates potential impacts on climate and the environment. Some biofuels can reduce GHG emissions substantially, but in contrast, deforestation of land in the tropics for palm oil production to make biodiesel can increase overall GHG emissions by a factor of up to twenty compared to fossil fuels.

There are also other impacts from energy cropping, such as those on water and biodiversity. For example, eutrophication and acidification of water have become worse in some regions where biofuels are grown, and water used to irrigate biofuel crops can reduce water supplies for food crops in dry areas (UNEP, 2009).

Increasing amounts of land are required to grow crops for biofuels. Displacing food crops with biofuel crops can have serious consequences when more land is needed to grow food. In addition, converting natural land to biofuel production will release carbon stored in vegetation and soils, and the destruction of natural habitats would lead to a significant loss of biodiversity (Eickhout et al., 2008).

The growth in biofuel production has been driven mainly by policy targets and quotas for blending biofuels in vehicle fuels. In the coming years, international trade in biofuels is expected to grow as biofuel consumption increases in the USA, the EU, Brazil, China and other countries.

The International Panel for Sustainable Resource Management (Resource Panel, hosted by UNEP) recommends that biofuel policies should limit quotas and targets to levels that can be supplied in a sustainable manner. Production standards for biofuels should be encouraged and economic measures, such as reforming subsidies, can be used to increase biofuel productivity.

A recent JRC study on potential indirect land-use change (ILUC) linked to EU biofuel policy targets shows the importance of land-use change in reaching the GHG reduction targets mandated by EU sustainability standards. It indicates that ILUC effects are likely to negate the GHG savings foreseen by this policy.

Source: UNEP, 2009; JRC, 2010.

demand for residential occupation and associated living space in urban areas. After 2035, Europe is expecting an overall population decline (Eurostat, 2008) but, once built, urban area itself may not decline. Regeneration of under-used urban areas into green areas is probably the exception but would need major additional effort.

Currently, the living areas per person in cities differ widely: from 14 m^2 in Bulgarian and Romanian cities and less than 20 m^2 in most EU-12 Member State cities to 62 m^2 in Luxemburg (Eurostat, Urban Audit). One can assume that the urban area, particularly in the new Member States, will increase. This is supported by the results of the Second European Quality of Life Survey (Eurofound, 2009) indicating that most people, especially in Bulgaria, Hungary, Poland, Estonia, Latvia, Lithuania, Turkey and the Former Yugoslav Republic of Macedonia, are dissatisfied with the size of their living space. Furthermore, the demographic trend towards smaller and thus more households will also increase living area per person.

If current urban development trends, in particular urban sprawl, continue, they will improve the quality of life in some ways but threaten it in others, such as access to green areas, loss of ecosystem services, increased vulnerability to impacts of climate change, and increases in some health problems (SOER 2010 urban environment assessment, EEA, 2010f). The actual development of urban areas and related environmental pressures depends, therefore, on spatial and qualitative aspects of urbanisation and the extent to which the drivers of urbanisation are managed by appropriate response measures.

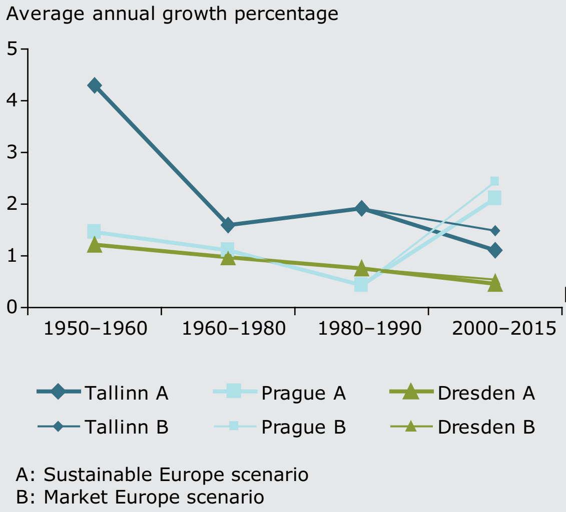
Box 4.3 Case study: urban land-use scenarios for central and eastern European cities — Prague, Tallinn, Dresden

After the fall of the Iron Curtain, it was expected that former socialist cities would sprawl under free market conditions in the way that many of their western neighbours did, but the developments have been much slower and more diverse. Map 2.3 in Chapter 2 shows different development patterns in recent years; the graph below (Figure 4.2) indicates the variations in the development of built-up land in Tallinn, Prague and Dresden in the past and under two future scenarios — Sustainable Europe and Market Europe. The quantitative differences in urban expansion between the scenarios are surprisingly small considering the average annual growth rates — the pace of urbanisation is influenced mainly by the baseline. For Dresden and Tallinn the past trend is projected to continue; only for Prague is considerable urban expansion projected. Prague is characterised by the largest population, an optimistic demographic prognosis for the Czech Republic, and good economic potential, which might make the city a real European metropolis.

In Tallinn, the differences in land use in the two scenarios are more striking and easily measurable. High GDP growth combined with a steeply decreasing population in a small country heavily dominated by the capital region seems to be a fertile ground for rapid urban sprawl if tight planning controls are not introduced and enforced.

Dresden is the least-dense city and is characterised by the lowest growth for the simulated period. Since the developments of the 1990s were not due to local demand, this case illustrates how external factors and direct foreign investment can over-rule internal drivers.

Figure 4.2 Average annual growth percentages of built-up areas in Tallinn, Prague and Dresden for different periods and under the Sustainable Europe (A) and Market Europe (B) scenarios



The conclusion is that the future development of central and eastern European cities depends primarily on the general economic success of the country and its ability to cope with the demographic challenges of declining and ageing populations. Integration of the city into the European urban network and the position of the city in the national urban hierarchy play a crucial role in attracting human and financial resources. Cohesion and structural policies will contribute to growth and attractiveness of cities in the central and eastern Europe, but it is planning regimes and strategic development plans that will need to steer new development and the future shape of the cities.

Source: Sagris et al., 2007.

Accessibility can also be relevant to urban sprawl. Cohesion policy, as well as the development of the Trans-European Transport Network (TEN-T), while improving accessibility, may lead in particular cases to urban sprawl. However, the eventual effects of the cohesion policy and its impact on land use depend on the actual design of the policies, the way they are implemented, and accompanying spatial planning measures.

The multiple drivers of urbanisation create a very complex picture: unlike the relatively certain trends in household size, living space, and accessibility associated with a further growth of urban areas, the impacts of the 2008–2010 economic slow-down and of such future lifestyle developments as the demand for second homes are very uncertain. The trends of development and related urban sprawl are likely to vary across Europe, even where differences were believed to be absent, for example among the new EU Member States (Box 4.3).

Land prices and land-use patterns are interconnected and have high potential for use as indicators, especially of processes such as urban sprawl. However, there is no clear evidence that land prices can initiate land-use changes — although in some cases they clearly contribute to these processes, as seen, for example, when looking at the interface between urban and rural areas and in situations of urban pressure. In transition economies, changes in land prices can imply changes in market prices but also imply changes in land-use patterns, as experiences in eastern Europe show (EEA, 2010c).

5 Responses

This section aims to review potential policy approaches to the challenge of managing Europe's land resources in an environmentally compatible manner. For the purpose of this assessment, policy responses have been grouped into three possible approaches:

- integrated programmes for land-use planning, regional development and management of natural resources;
- sectoral policies that influence economic drivers for certain land-use types and regulate them;
- targeted policy instruments that focus on certain locations or land-use types and generally rely on targeted planning or protection regimes.

The analysis below reviews these in the order set out above, with Sections 5.1 and 5.2 covering the first approach.

5.1 Regional planning

The coordinated use of land resources has an important role in achieving a balanced spatial organisation of society that allows building on compromises between competing objectives. It is in regional and local spatial planning in the Member States where the principles of sustainable land use, such as zoning and protection of areas, coherent compact settlements or brown-field development, are implemented. Much depends on the design of the regional planning system and how well it fits into the societal context, as well as on implementation practice and the culture. Thus, despite most European countries having good planning systems in place, this has not prevented unfavourable spatial developments like urban sprawl — although this varies between Member States and regions (Box 5.1)

European policy, although having no spatial planning responsibility, sets the framing guidance for planning. For example, polycentric spatial development approaches, as opposed to urban agglomerations and diffuse settlement patterns, have the potential to deliver optimal mixes of urban/rural activities, access to services and necessary concentration of economic drivers. In this way good land-use practice can result in reductions in environmental pressures, for example from transport.

At the European level, the 1999 European Spatial Development Perspective (ESDP), a non-binding framework that aims to coordinate various European regional policy impacts, already advocates the development of a sustainable, polycentric and balanced urban systems with compact cities and strengthening of the partnerships between urban and rural areas; parity of access to infrastructure and knowledge; and wise management of natural areas and the cultural heritage.

The 2008 Green Paper on territorial cohesion (European Commission, 2008), and the 2007 EU Territorial Agenda and Action Plan (COPTA, 2007) build further on the ESDP (Box 5.2). Specific actions relevant in the field of 'Land', in particular are action 2.1d: 'Urban sprawl' and action 2.2: 'Territorial impact of EU policies'. The Territorial Agenda is supplemented by the Leipzig Charter on sustainable European Cities that creates links between general territorial development and urban development policies from a European perspective.

The European Community's laws on environmental impact assessment require the assessment and minimisation of any potential negative environmental impacts of projects (Environmental Impact Assessment Directive, EIA) as well as plans and programmes (Strategic Environmental Assessment Directive, SEA). Their implementation has shown that they can improve the consideration of environmental aspects in planning projects, plans and programmes in the Member States, contribute to more systematic and transparent planning, and improve participation and consultation.

However, the effectiveness of the tools, in particular the SEA, which is still in its infancy, is diverse. The effect of these directives could be further improved by better guidance regarding screening criteria, identification of alternatives, and an improved data situation (European Commission, 2009b). Also, the SEA does not include policies, which are the basis for some plans and programmes. Their inclusion would facilitate an even more preventive and thus efficient approach.

In contrast at the European level, a Community Impact Assessment is required for all important Community initiatives and assesses their economic, social and environmental impacts. This could be extended to also assess territorial impacts. Within the Commission by

Box 5.1 Examples of different urban development patterns in neighbouring areas of the Netherlands and Belgium

Even though both countries show similar wealth and economic development, striking differences in urban land-use pattern — compact in the Netherlands and scattered in Flanders, Belgium — are observed (Map 5.1, based on Corine land cover). Important reasons for the differences can be showed in the planning system as well as of the factors:

The Netherlands

Established and enforced strong spatial planning because:

- society is built on consensus and consultation; collective interests are highly valued;
- a de-politicised planning culture with trust in the application of expertise in decision-making enables long-term orientation;
- housing development is dominated by two large players building far bigger complexes than single houses.

Belgium

Spatial planning and its implementation over recent decades has been weak because:

- a liberal, competitive society aims at the best individual solutions, sometimes at the expense of general public interest;
- the political context for planning allows more locally focussed, short-term and less transparent decision-making;
- buildings are mostly erected individually; home ownership has been strongly promoted since the 19th century.

Thus the power of spatial planning depends on socio-economic factors as well as the political culture in which it is embedded and the degree to which collective interests can be promoted via different regional planning system (Vries, 2008; Decker, 2008).

Map 5.1 Example of different urban patterns

Example of different urban patterns in the neighbouring areas of the Netherlands (rather compact) and Belgium (rather sprawled), 2006

Urban Morphological Zone (UMZ)

Rural background

Country border

Source: EEA, based on Corine land cover.

Box 5.2 Territorial cohesion and environmental objectives

Cohesion Policy has always focused on economic, social and environmental issues. With the adoption of the Lisbon Treaty and the reference to territorial cohesion, environmental sustainability becomes a more visible and important component of Cohesion Policy. With the adoption of the Europe 2020 Strategy, green growth has received more attention and will also be integrated into the next period of Cohesion Policy. This stronger emphasis on the environmental dimension should encourage a more explicit consideration of the territorial dimension of the environment — the recognition of inter-regional/trans-national connections in relation to environmental and natural resources and a recognition of natural boundaries/areas as appropriate management units for environmental assets.

In response to the inclusion of territorial cohesion alongside the twin objectives of economic and social cohesion in the Treaty, the ministers in charge of territorial cohesion have included the following among the spatial development priorities in the Territorial Agenda:

- promoting trans-European risk management to face hazards, mitigate and adapt to climate change, consisting of integrated Trans-European and cross-border strategies for flood protection, drought prevention, integrated coastal zone and mountain area management, technological hazard management, etc.;
- and strengthening of ecological structures in order to create an integrated and sustainable Trans-European green structure.

It is important for the Member States to build links between spatial and trans-national planning and funding through the Cohesion Policy. Ideally, such planning, based on the principle of territorial cohesion, would provide the framework for setting budget priorities. This would go a long way to addressing the key problem identified in the Barca review of the EU Cohesion Policy — the lack of a coherent, place-based territorial perspective.

Source: European Parliament, 2007; Barca, 2009; EEA, 2010b.

DG REGIO, a new Inter-service Group on territorial cohesion has been launched. Its mandate includes: analyses of Community interventions from a territorial point of view with special regard to different types of territories; a knowledge base on the territorial dimension and impact of Community policies; and discussion of potential territorial impacts of new policy proposals.

Apart from many encouraging activities at all levels, progress towards more compact and polycentric structures across Europe is still limited. Urban sprawl is continuing as a general trend in every country, although to varying extents. Policy- and decision-making is still sectoral and fragmented, in contrast to the finding that the wise integration of many single measures and not just one measure alone can halt unsustainable spatial development (EEA, 2009b). Thus, economic interests stand against environmental interests although both could be fulfilled with an integrated approach (Box 5.3).

5.2 Integrated management of river basins and coastal zones

The integrated river-basin management approach established by the Water Framework Directive (2000/60/EC) closely relates to sustainable land-use practices. For example, the WFD requires as a basic measure full implementation of the Nitrates Directive which concerns the protection of waters against pollution by nitrates from agricultural sources (91/676/EEC). This Directive addresses land-use activities by limiting nitrogen inputs to land, ensuring sufficient manure storage capacity and encouraging good practice such as natural buffering areas and accurately balanced fertilisation.

Another example is the Floods Directive (2007/60/EC), which will also affect land-use practice, mainly on areas affected by floodplains. This Directive requires Member States to develop flood risk maps and management plans and to implement these. This will have consequences for land-use practices throughout a river basin and therefore for floodplains. The Directive applies to inland waters as well as all coastal waters across the whole of the EU.

The European Flood Action programme emphasises the importance of damage prevention by appropriate spatial planning — avoiding construction of houses and industrial buildings in current and future flood-prone areas; adapting future developments to the risk of flooding; and promoting appropriate land-use, agricultural and forestry practices (European Commission 2004). There are examples of trans-national prevention programmes, for example for the Rhine across Switzerland, France, Germany and the Netherlands ([2]), and the Meuse across France, Belgium and the Netherlands ([3]). Wider trans-national cooperation is stimulated by macro-regional strategies

([2]) www.iksr.org.
([3]) www.cipm-icbm.be.

Box 5.3 Development and economic growth with less urban sprawl — simulation of urban land-use development in the Algarve region (Portugal)

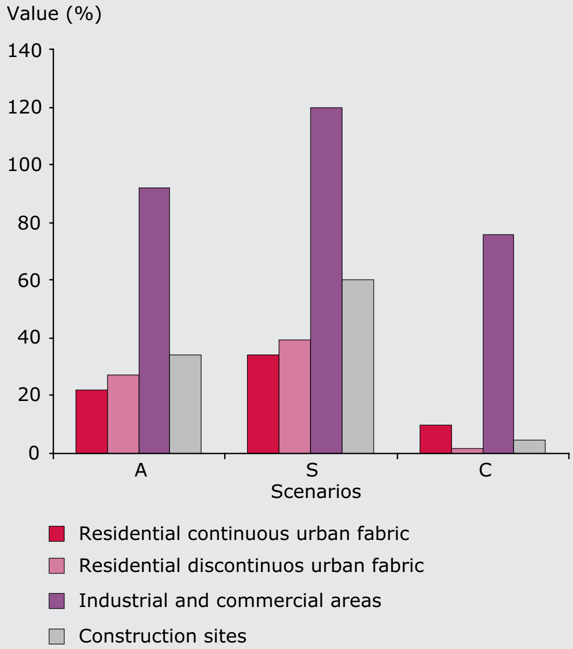
Activities related to tourism and provision of services in the Algarve represent two thirds of total GDP and 60 % of total employment in the region, and are expected to grow by 2.9 % per year over the next decade. Total GDP has increased significantly since 1986 when Portugal joined the EU. The current population of permanent residents is about 400 000 and is growing steadily.

Land-use dynamics have changed substantially, especially in the western part of the region. The eastern coast is still relatively well-preserved and requires careful management due to valuable but vulnerable ecosystems. While areas covered by forest and permanent crops were relatively stable between 1986 and 2004, since 1997 arable and fallow areas have decreased dramatically.

Different scenarios (Figure 5.1) for regional development to 2020 have been simulated to evaluate the impacts of economic trends and spatial policies on land use:

- *Scenario A Business as usual*: continuation of current conditions, where agriculture, fisheries and tourism are the main economic activities. Internal demographic movements are the major drivers of land-use changes. GDP increases by 2.9% per year.
- *Scenario S Scattered development*: urban land-take is the result of high population growth, especially due to the influx of tourists, and economic growth both in the industrial and service sectors. Increase in GDP is twice that in Scenario A at 6 %.
- *Scenario C Compact development:* spatial policies and restrictive planning aim at concentrating urbanisation in designated areas. GDP growth is as in Scenario S, 6 %.

Figure 5.1 Active land uses



The study mapped the development of urban features for the three scenarios. Urban land take — in particular for discontinuous residential areas — is by far the lowest in Scenario C at less than 5 % despite the same GDP growth as Scenario S which shows an increase of almost 40 %. Spatial policy in Scenario C leads to a compact and polycentric development of the urban agglomeration with less fragmentation, preserving natural and other open space — an important attraction for tourists. It illustrates that urban sprawl is not a necessary consequence of economic growth, which can as well be achieved with compact urban development.

Source: Petrov et al., 2009.

of the EU Regional policy for example, for the Danube (European Commission, 2010d).

The guiding principles for flood risk management plans use a strategic approach and require consideration of long-term developments that take a 50–100 year perspective on the floodplain. This will affect physical development in these areas such as building. In the same way, flood-risk maps will influence the development of spatial plans and subsequent land use.

The capacity of soils and vegetation to retain water is an important flood prevention feature, in particular reducing peak discharges across river basins. The way agricultural and forestry land is used is therefore relevant to flood risk management. The CAP reform of 2003 and current policy development have a role to play in flood protection through the cross-compliance instrument and agri-environment measures; for example by promoting soil protection and the maintenance of permanent pastures and thereby improving the capacity of soils for water retention.

The objective of sustainable land-use practice in the context of river-basin management could be the concept of multi-functional land use that would result in a combination of flood prevention measures with agri-environment practices, territorial planning policies and nature development strategies, including river restoration. This is confirmed by the principle of an interdisciplinary approach to flood-risk management plans, where all relevant aspects of water management, physical planning, land use, agriculture, transport and urban development — the degree of soil sealing — and nature conservation are considered at national, regional and local levels.

Following the European Strategy for Integrated Coastal Zone Management (ICZM) (European Commission, 2000) and EU ICZM Recommendation (Council, 2002), several Member States and regions have started to implement ICZM strategies that could be of relevance to sustainable land use and stabilisation of coastal erosion, especially from the perspective of climate change impacts such as sea-level rise. Evaluation in 2007 (European Commission, 2007b) confirmed that the principles of the recommendation are still valid and European action for sustainable development of coastal zones should be continued.

5.3 A sectoral response: the EU Common Agricultural Policy (CAP)

The CAP has a key role in shaping land-use patterns and intensity on agricultural and also on forested land. While farmers represent only 4.7 % of the EU's working population, they manage nearly half of EU land. The CAP is the main EU instrument for supporting and guiding agricultural land use, accounting for 34 % of the EU budget in the period 2007–2013. Past CAP spending has supported modernisation of farming and helped to intensify production, with significant environmental impacts linked to soil erosion, water pollution, over-exploited water resources as well as biodiversity.

Various CAP reforms since the 1990s have increasingly decoupled farm support from production, established certain environmental safeguards linked to the receipt of farm payments, and introduced rural development and agri-environment measures. The budget share of these measures remains small, however, and increasing demand for food and biomass could lead to further agricultural intensification. In addition, the majority of CAP payments still go to intensive farming areas that do not favour biodiversity. Despite past CAP reforms, EU spending could be better targeted to protect biodiversity, for example in areas of high nature value farmland (Box 5.4).

While there are environmental shortcomings in the current design and budget structure of the EU common agricultural policy the environmental progress made in past CAP reforms has to be acknowledged. The recent Commission Communication on 'The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future' sets out options for further environmental reform (European Commission, 2010b). The Communication defines a 'territorially and environmentally balanced EU agriculture' as the main contribution of the CAP and sets out three reform options that will be decided at political level.

From the analysis presented in this assessment and elsewhere it is clear that further environmental reform of the CAP would be an important step in securing EU environmental policy targets, e.g. in relation to biodiversity protection, water quality or the reduction of greenhouse gas emissions. The need for appropriate environmental management across all farmland implies that a wide range of policy instruments in both current pillars of the CAP need to be strengthened or introduced, as set out in the Communication itself. At the same time,

Box 5.4 The spatial distribution of HNV farmland and CAP reform options

The spatial distribution of biodiversity across European farmland follows environmental conditions and the type and intensity of local farming systems whereas CAP farm support payments are aligned with historic spending patterns and administrative boundaries. Previous EEA analysis has shown that the favourable management of HNV farmland is insufficiently supported by current CAP spending patterns (EEA, 2009c). On the other hand, existing CAP policy instruments and reform options provide considerable opportunities for supporting farming systems and farming areas with high biodiversity. A crucial issue for environmental effectiveness of farm support will be to align the distribution and type of public spending to the spatial distribution of critical environmental resources and biodiversity on farmland across EU Member States.

Various options for reform of the CAP are being discussed within the European Commission, the European Parliament as well as EU Member States. Environment Commissioner Potočnik has suggested that direct support to farms in the form of area-based payments could differ according to region and type of land-use. Farms with more permanent grassland, crucial for maintaining biodiversity and adapting to climate change, could receive higher payments. Cross-compliance, or compliance with certain basic environmental laws, should be mandatory for all such payments. In future, cross-compliance rules could require minimum areas devoted to biodiversity or crop rotation and respect for the integrated river basin management approach under the Water Framework Directive (Potočnik, 2010).

(4) Green infrastructure is an interconnected network of natural areas, including agricultural land, greenways, wetlands, parks, forest reserves, native plant communities and marine areas that naturally regulate storm flows, temperatures, flood risk and water, air and ecosystem quality.

the geographic distribution of agri-environmental issues across the European territory would require an approach to the design and implementation of CAP support payments as well as rural development measures that is as spatially targeted as possible.

5.4 Examples of targeted policy instruments

The designation of nature protection areas and connecting them by ecological networks as part of green infrastructure ([4]) is one of the responses that help to limit the pressures from land conversion and intensification of land-use. Nature conservation means leaving space — land and water area — for biodiversity. The network of Natura 2000 sites creates conditions for the preservation of protected habitats and species on about 18 % of the EU-27 territory. At the same time, only 17 % of the species and habitats of European interest have a satisfactory conservation status (European Commission, 2009a).

The main objective of national parks and nature reserves is protection of wildlife and land- and sea-scape values. The role of protected areas in other aspects of natural resource management and human livelihoods is equally important — a wide range of values are maintained in protected areas, including food, biomass production, water resources, health, tourism, cultural and spiritual values, and buffering capacity against climate change and natural disasters (Stolton and Dudley, 2010).

Brown-field sites are an example of land-use potential that is not efficiently exploited. Such sites include derelict land contaminated by former industrial, commercial or governmental operations. The growing number of such sites in urban regions is linked to structural transitions towards service and knowledge-based economies. Failure to renew brown-field sites often affects the environmental quality of the surrounding area, and firms and people relocate to green-field sites, resulting in urban sprawl. Brown-field sites have therefore become a persistent problem that requires a policy response.

The environmental advantages of brown-field remediation are clear: relieving pressure on rural areas and green-field sites, reducing pollution costs, more efficient energy use and natural resource consumption, facilitating economic diversification and meeting emerging housing requirements. Europe has several examples of regional strategies for economic regeneration and brown-field development (OECD, 2001) and the recycling of artificial surfaces in several countries has reached 30 % or more of the total area of land take (CLC 2006 results). Stronger links between EU urban and soil policies could encourage this further, for example by following up 6th EAP Thematic strategies.

5.5 Towards an integrated approach to land use

The previous sections have reviewed different approaches and policy instruments for guiding and managing land-use interests. These should ideally be brought together in one integrated approach.

Policy decisions that define land use are mostly implemented through spatial planning and related functional zoning of land. This involves trade-offs between many sectoral interests, including industry, transport, communication, mining, agriculture and forestry. In particular, agriculture and forestry represent the largest share of land use by economic sectors: farmers and other managers of rural land producing food, feed, fibre and fuel are the largest group of natural resource managers on the planet (FAO, 2007).

Decision-making for land-use allocation is also based on environmental considerations; examples include nature conservation areas and corridors for species migration, river-basin management and flood alleviation, and soil and water protection. Together with landscape values and recreation resources, these environmental factors represent the multi-functional aspect of land use aimed at win-win solutions.

The importance of integrated land use that promotes the multi-functional approach to land resources is reinforced by the emerging policy and scientific consensus on the importance of land-management practices for mitigating and adapting to climate change, as stated by United Nations Framework Convention for Climate Change activities on Land Use, Land-Use Change and Forestry (LULUCF). However, it may often be difficult to estimate GHG removals by and emissions from land use and forestry resulting from LULUCF (UNFCCC, 2010). EU climate-change policy addresses land use in its white paper on climate change and adaptation through measures that in general are aimed at increasing the resilience of ecosystems and land-based production systems (European Commission, 2009c).

European spatial development is driven by many different interrelated drivers and has a regional and European as well as a local dimension. These drivers act at all scales and require an approach across all administrative levels. This also influences what data have to be collected for land-use trend analysis (Box 5.5).

An integrated assessment needs to take into account agri-forestry data that guide production, urban-rural typologies and information on territorial cohesion, and ecological data for land-use impacts on biodiversity. An integrated approach (Figure 5.2) also requires that statistical information, such as on agricultural land area

Box 5.5 Re-conceptualisation of land

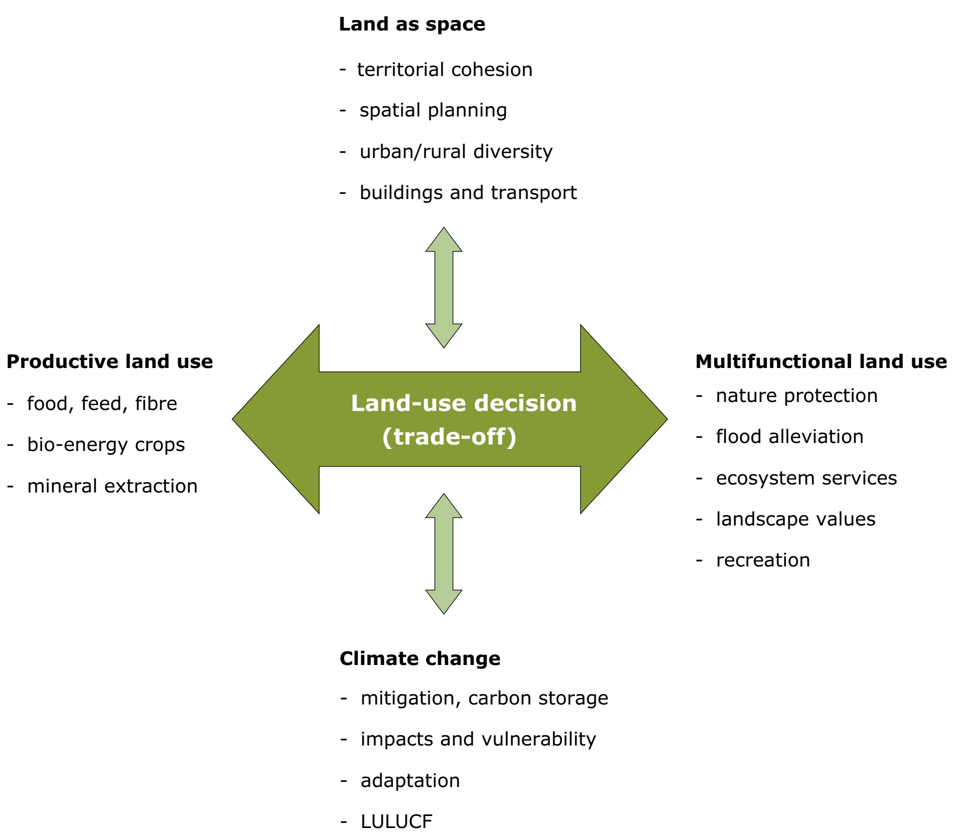
Land provides the most fundamental resources for humankind, but it is finite. Can land provide enough resources to supply Europe sustainably? Much has to be done to answer this question but only the first steps have been taken in the development of an appropriate land monitoring and accounting system. To move on, a new conceptualisation of land is needed to establish whether current land-use practices are sustainable. It will also need explicit consideration of trade-offs between the environmental consequences of land use, society's demands on land and the economic opportunities provided by land.

The main challenge for sustainable land use is to find ways to adapt our demand for resources from the land with the regenerative cycles and buffering capacities of ecosystems. Multifunctional but medium-intensity land use would allow for the co-generation of land-use products and ecosystem services. The strict segregation of land-use functions could be transformed to landscape mosaics designed to achieve integrated methods of production and consumption. This should balance both the excessive intensification and the abandonment of agricultural land and contribute to the preservation of rural land systems that are rich in biodiversity.

This transformation is already being observed as a shift away from near total dependence on fossil-based raw materials towards a bio-based, renewable economy that makes use of the engineering and design of nature. This could also lead to a transformation of rural societies and affect economic sectors such as agriculture and forestry. However, this transition will require that land is seen as a limited but renewable resource able to serve all segments of society.

Source: Seto et al., 2010.

Figure 5.2 **Proposal for a conceptual framework for integrated land assessment — towards an integrated approach in land use**



Source: EEA.

and other land-use functions, is linked to spatial land data, such as land-use/land-cover type, resulting in challenges for data assimilation into models (Lobley and Winter, 2009).

Initiatives towards such an integrated approach, as requested in the Community Strategic Guidelines on Cohesion 2007–2013 (European Commission, 2006), implying compliance with the precautionary principle, efficient use of natural resources and minimisation of waste and pollution, need to be vigorously pursued and, in particular, implemented.

The far-reaching consequences of European and other policies for spatial impacts are only partially perceived and understood. Tackling the challenges needs completion of a comprehensive knowledge base and better awareness of the complexity of the problems, as currently expressed in the discussion towards a territorial impact assessment instrument (Territorial, 2010).

The impact of EU sectoral policies on land can be intentional or unintentional and can result in both positive and negative effects on the territorial development and cohesion of Member States. The coherence of these EU sectoral policies and a better integrated approach should help to build on regional identities, potential and diversity to develop territories across Europe. Full awareness and assessment of the possible impacts of relevant policies is therefore of vital importance.

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