TOWARDS A GREEN INFRASTRUCTURE FOR EUROPE

Developing new concepts for integration of Natura 2000 network into a broader countryside

EC study ENV.B.2/SER/2007/0076

ATECMA ECOSYSTEMS RIKS TERSYN EEZA-CSIC

SUMMARY

Aspects related to ecological coherence and connectivity play an important role in ensuring the normal functioning of ecosystems, and this is essential for providing ecosystem services such as food air quality, carbon sequestration, flood management, water treatment, local climate conditions, soil erosion prevention etcé

The European Union is experiencing on the one hand enlargement and economic growth and on the other hand several social challenges - aging of society, migration from marginal and economically unfavourable regions. Analyses of all socioeconomic processes lead to the development of a Member States initiative called territorial Agenda for European Union (2007). This process provides an opportunity for planning and implementation of a European Green Infrastructure, especially stressing its role for opportunities for sustainable development.

Definition and implementation of Green Infrastructure involves land planning issues and a big number of different stakeholders. This leads to the conclusion that the physical definition of the Green Infrastructure is a political issue that should be tackled at the appropriate political scale . G. Bennett (2009) defines the function of GI as the ensemble of planning approaches that maintain ecological functions at the landscape scale in combination with multi-functional land uses.

Because we have no well defined limits for the physical distribution of the Green Infrastructure, it is not possible to render a spatial vision of it; however it is possible to auscultate the status of the Green Infrastructure through measuring the integration of Natura 2000 Network. Green infrastructure is defined by the type of land uses it contains; those land uses are conditioned by socioeconomic factors. In this work, the socioeconomic factors which lead to changes in land uses and the trends and changes in land uses from 1990 to 2000 (CLC), are analysed. On this base, two hypothetic socioeconomic scenarios (rural and urban) have been built to assess the expectable land uses changes and trends in each case.

Parallel, a methodology has been developed to measure the integration of the Natura 2000 Network in to a wider countryside by measuring land use similarity and this methodology has been applied to all scenarios available in Corine Land cover (1990, 2000, and hypothetic scenarios). With this data it was possible not only to measure the integration of Natura 2000 into the wider countryside, but also to measure the vulnerability of Natura 2000 to changes in land use promoted by socioeconomic factors (at regional level).

In this work, a revision of previous and ongoing approaches to the which are part of Green Infrastructure concept, such as the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), the Pan-European Ecological Network (PEEN), the European Green Belt etcé The implementation of the Green Infrastructure has a has a physical impact on European land; this means that it implies a lot of sectors: Agriculture, Forestry, Water Management, Linear Infrastructures, Extractive Industry, Urban Environment, Nature Tourism and Recreation, as well as Spatial Planning, and pressures such as Invasive Alien Species and Climatic change.

In conclusion, we recommend DG ENV to set up a Task Force among Commission DG to integrate the GI concept in to other sectors, implementation of connectivity assessments for all European countries, the development and implementation of a communications strategy, and a set of recommendations for the sectors involved in the Green Infrastructure implementation.

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Towards a European Green Infrastructure

"Natura 2000 preparatory actions, Lot 3:
Developing new concepts for integration of Natura 2000 network into a broader countryside"
Acronym: Green Infrastructure.
Service Contract Nº 070307/2007/484442/MAR/B2

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Background to this study

The need for healthy ecosystems is now widely recognised, not just to halt the loss of biodiversity, but also to benefit from the many valuable services they provide. An essential condition for healthy ecosystems is the maintenance of ecological coherence. However, habitats throughout Europe are becoming increasingly fragmented. Many initiatives are already playing a role in tackling this issue, such as the Natura 2000 Network. But, given the scale of the challenge, more needs to be done to build an ecologically coherent green infrastructure for Europe for the benefit of all, people as well as nature.

Against this background, DG Environmentõs Nature and Biodiversity Unit launched a tender entitled: ô*Developing new concepts for integration of the Natura 2000 Network into the broader countryside*ö. The study runs for 18 months from December 2007 and involves the following organisations: Atecma (Spain, project lead) RIKS (Netherlands), TERSYN (France), EEZA-SCIC (Spain) and Ecosystems (Brussels).

One of the key tasks of the project was to:

1. prepare an assessment of possible trends in land use changes in the EU and its potential effects on the integration of the Natura 2000 network into a wider countryside based on CORINE Landcover data sets (2000) and other available relevant information. In particular this involved:
   - <u>Task A1:</u> Assessment of trends of socio-economic factors, related to land use changes (carried out by TERSYN)
   - <u>Task A2:</u> an assessment of land use changes and trends based on CORINE Land Cover (RIKS)
   - <u>Task A3:</u> assessment on land use changes based on hypothetical socioeconomic scenarios. (RIKS, TERSYN)
   - <u>Task A4:</u> Evaluation of the integration of Natura 2000 Network into a wider countryside in the different scenarios proposed(ATECMA, EEZA-CSIC).
2. to write a report based on the findings of the above analysis and on an analysis of the EUõs existing policy and financial framework (ATECMA with contributions from RIKS, TERSYN and EEZA-CCIC);
3. to develop an indicative map of boundary conditions for the connectivity of Natura 2000 at NUTS II level (ATECMA, EEZA-SCIC).

The present document is the final report of the contract based on the findings of the study. It includes at the end some suggestions for the role of the EC in building a green infrastructure within the EU.

To support this work, the project also organized, as part of the contract, an EC workshop in Brussels on the issue of Green Infrastructure (This part of the contract was undertaken by ECOSYSTEMS). Attended by over 100 people from across Europe, the aim of the workshop was to discuss and clarify an appropriate Community response to help build a ôgreen infrastructureö for Europe, based on existing experiences across different countries and sectors. The conference proceedings, ppt presentations and background documents for this workshop are available on: *http://green-infrastructure-europe.org/*

Chapter 1. Introduction: The Green Infrastructure Concept

Content

Chapter 1. Introduction: The Green Infrastructure Concept

1.1. Purpose of the document

The objective of this study is to analyze the integration of Natura 2000 network into a wider countryside, taking into account changing trends and tendencies of land use and the influence of socioeconomic factors on these land use changes.

Fragmentation of ecosystems and habitats as a result of land use changes poses a serious threat to biodiversity in Europe. Fragmentation of habitats disturbs the normal life cycle and ecology of species by preventing species from reaching their migration and dispersal destinations. As the negative impacts of fragmentation have become apparent the importance of maintaining an ecological coherence and connectivity within ecosystems and landscapes, including between protected areas has been increasingly recognised.

This highlights the value of maintaining a 'green infrastructure' across the EU that allows the broader countryside outside protected areas to remain permeable to biodiversity. Defining what is meant by a green infrastructure is however not an easy task as it means different things to different people, depending on their sector of activity.

The present document has been structured in six chapters. This introductory chapter reviews the different concepts of a green infrastructure as this is important to for understanding later on how the assessment of trends in land use changes can affect the integration of Natura 2000 sites and the permeability of the landscape.

The second chapter sets the policy and legal context at EU level as regards a possible Green Infrastructure and reviews various examples of existing GI initiatives across the EU. The third chapter contains the project's analysis of how socioeconomic changes have influenced land use changes and trends.

Chapter four is devoted to cartographic analysis of land use changes in Europe , part one is a cartographic analysis using LUMOCAP (based on Corine Land Cover) on land use changes and trends from 1990 to 2000, part two takes profit of former assessments and generates scenarios of land uses changes and trends depending on different socio economic scenarios.

Part three is an assessment of the boundary conditions for connectivity and hence intended to measure the integration of Natura 2000 into a wider landscape as a basis to know the status of the Green Infrastructure in Europe. This analysis is done for the data contained in LUMOCAP for Corine Land Cover 1990, 2000 and for the hypothetic socioeconomic scenarios proposed in Par two of this chapter. Part four is an analysis of the vulnerability of the Natura 2000 network in the European regions (NUTS 2) to the changes proposed in the hypothetic scenarios. The objective of this last analysis is to know the resilience of N2000 in the different regions to the changes in land uses promoted by changes in the European socioeconomic status.

Chapter five looks at the integration of the Green Infrastructure concept into other EU policy sectors and reviews the role, relations and impacts of those different sectors on the Green Infrastructure. Sectors considered are Agriculture, Forestry, Water

Management, Linear Infrastructures, Mining, Urbanism, Tourism of Nature, Invasive Species and Climatic Change.

Sixth chapter gathers the main conclusions of the assessment and propose and strategy for the implementation and management of the Green Infrastructure by its parts and needs and taking in account different sectors involved in this issue.

The document is an information tool for those sectors and managers involved in one way or another in the Green Infrastructure issue, and having in account that the Green Infrastructure covers must of the European territory the target public for the document is from almost most sectors in the European administration both in the European Commission and member States.

1.2. The Green Infrastructure Concept

The Green Infrastructure is a concept which is being used more widely used in several environmental forums. It does not mean the same for everybody. For some professionals it refers to infrastructures related to water management in urban areas plus gardens, street trees urban parks and urban nature related infrastructures (as it is a zoo), for other people, the Green Infrastructure is all open space not covered by grey infrastructure (man built infrastructures) this may encompasses from mountain tops to back gardens in city houses.

Benedict et al (2000) define the Green Infrastructure as ñan interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations.ò

In the workshop held In Brussels in March 2009 ñTowards Green Infrastructure for Europeò (see Annex 1) Workshop Proceedings, a specific definition was achieved for this concept, but the confirmation that the concept was widely applied for different territory elements came through. Several definitions where proposed:

Å Planning/strategic approaches that maintain ecological functions at the landscape scale in combination with multi-functional land uses.

Å Existing natural and ñman madeò structures that can deliver sustainable land use and services for society.

Å The part of a territory devoid of permanent man-made structures, that is providing directly or indirectly, partly or totally through the vegetation it supports, a series of services to the population living on it or more or less near to it.

Å System/network of open space, consisting of natural and man-made structures that provide directly or indirectly multiple benefits to society and support and improve ecological functions.

Å Strategic or/and management approach to improve and sustain the multifunctional system of natural and man-made green structures, that provides benefits to society and maintain ecological functions.

In the workshop most participants agreed that whatever it is the definition of Green Infrastructure, it is clear that the Green Infrastructure is much more than a network of natural protected areas (or ecological network), that it provides much more services than biodiversity and nature conservation and that it is a multifunctional tool to ensure ecosystems services.

In this context, green infrastructure consists of natural and man-made elements (such as reforestation zones, green bridges, green urban areas, high nature value farmland or forest areas). It ensures efficient and sustainable use of land by integrating interacting functions or activities on the same piece of land. An essential condition for healthy ecosystems is the maintenance of ecological coherence. That is vital to ensure that the functional elements of ecosystems can continue to interact, both between themselves and with their physical environment.

Protected areas are a key element of any effective biodiversity policy but they are not sufficient. Integrating protected areas into the broader land/sea-scape enhancing and restoring connectivity among site, between sites and with the wider environment is crucial. Such an integrated management needs to achieve the conservation of entire ecosystems within a multi-functional landscape. A key tool integrating biodiversity policy into other sectors such as agriculture, transport, land use and energy policy is Green Infrastructure.

However, ecosystems and habitats throughout Europe are becoming increasingly fragmented mostly through land-use changes and intensification. The maintenance of landscape features, as part of green infrastructure, is therefore important for the existence and movement of wild flora and fauna, especially in the light of the pressures that are associated with climate change. Such structures need to be integrated in decisions on land use planning.

By giving back space to ecosystems, Green Infrastructure can maintain and create landscape features which guarantee that ecosystems continue to deliver the services such as clean water, productive soils and attractive recreational areas supporting our economies and societies and make an essential contribution to natural mitigation of and adaptation to climate change. Such a robust multi-functional system of protected and unprotected green areas will strengthen ecosystems resilience and enable migration, dispersal and genetic exchange of wild species.

1.2.1. Components of the Green Infrastructure

Given the wide span of definitions of the Green Infrastructure, and the wide range of the components and parts of the Green Infrastructure we may take as Green Infrastructure as everything which is not grey (or built) infrastructure, but this is very simple. There are elements of Grey Infrastructure such as fauna passages under or over roads and highways that should be considered as part of the Green Infrastructure, Also some consider that sewage treatment plants should also be considered a part of a Green Infrastructure due the environmental role of this kind of buildings.

It is clear that when we talk about Green Infrastructure we should differentiate among the urban and the rural Green Infrastructure. Unless both are clearly part of the total Green Infrastructure they differ in multiple factors.

In the Urban Green Infrastructure it should be mentioned as first component the urban parks (sometimes included in Natura 2000 network), city gardens, street trees, church yards, zoos, house back gardens. The role of the urban Green Infrastructure is to make cities liveable. No one of us may conceive a city without green elements. Whatever we consider to be green infrastructure it is clear that its role is to ósoftenô and ógreenô the urban environment.

Undisputable parts of the rural Green Infrastructure are the natural protected areas network (Natura 2000 network), beside this, it should be also included all natural and semi natural unprotected areas, forests of all types, pasturelands, agriculture lands, wetlands, rivers and all space free from human use with or with out vegetation cover as they are mountain peaks, inland and sea cliffs, mobile dunes etcé

In this document we will focus more in the Rural Green Infrastructure because the needs, elements, functions and managing of the two infrastructures are very different and it is in this context that the integration of the Natura 2000 Network into the wider environment comes most into play.

1.2.2. The role of Natura 2000 Network in the Green Infrastructure

Natura 2000 network is the core of the Green Infrastructure. The goal of this Network is to ensure the favourable conservation status of habitats and species of Community interest. Most of them render the benefits for human population cited upward, but they also are the reservoir of autochthonous biodiversity and are the supplier of this biodiversity for other less preserved areas. To maintain those protected areas and its values it is necessary to keep them for deleterious activities inside or around them, and to keep them correctly interconnected in order to aloud the genetic renovation of the wild species populations. Isolated protected natural areas tend to loose diversity and to a progressive biological simplification. By themselves they are bubbles of nature and face extinction unless they are enough big or are properly connected to other natural areas.

1.2.3. Benefits and properties of the Green Infrastructure

Green Infrastructure is a tool to maintain the benefits and services that the ecosystems provide.
In this way, Europe gets most of the inhabitantõs food from the Green Infrastructure, while some of it comes from abroad. Trees and forests help to clean the air from pollutants, they are also carbon sinks, they give shadow to the soil in hot periods maintaining under limits the soil temperature in the countryside and refreshing and cleaning the air in the cities in summertime. Mountain forests help to collect clean water, recharging water tables, reducing erosion by slowing down runoff. Rivers transport the water across the territory helping both with wetlands to the depuration of this water. Natural and rural landscape is used by human population for rest and leisure, giving an added value to public health.

The 2008 Interim report of the TEEB (The Economics of Ecosystems and Biodiversity) aims to promote a better understanding of the true economic value of ecosystem services and to offer economic tools that take proper account of this value. This report stresses the huge significance of ecosystems and biodiversity and the threats to human welfare if no action is taken to reverse current damage and losses

To maintain these values and benefits, ecosystems forming the Green Infrastructure need to be correctly managed, respecting its needs and giving the adequate level of protection to the key elements. So, best preserved natural areas should be correctly protected. Important functions of natural areas as it is an appropriate level of connectivity among natural areas should be maintained and taken in account. An finally in the cases where properties and functions of the ecosystem a have been lost, due to misuse of natural resources, they should be restored

Humans get ecosystem services (as they can be clean water, clean air, raw materials, amusement and business opportunities) when the ecosystem works properly and is capable of rendering those services. The way the ecosystems are utilized may affect the correct functioning of the target ecosystem or the adjacent ones, this affection may have negative and positive effects which may be relevant or not for the general function of the ecosystems. The European Green Infrastructure is an ensemble of ecosystems linked among them and defined by the climate, geology, topography, natural history and human land use of the territory. Human land use used to influence the natural history of a region with changes in forests, grasslands, fauna etc… Progressively and specially from the beginning of the industrial era, human activities are influencing the topography, some times the geology and now we are influencing the climate. To face the challenges that unpleasant changes in the ecosystems of the Earth, the Convention on Biological Diversity (CBD), adopted the Ecosystem approach.

1.2.4. The Ecosystem approach

At its second meeting, held in Jakarta, November 1995, the Conference of the Parties (COP) of the Convention on Biological Diversity (CBD) adopted the ecosystem approach as the primary framework for action under the Convention, and subsequently has referred to the ecosystem approach in the elaboration and implementation of the various thematic and cross-cutting issues work programmes under the Convention (Decision II/8). Description and principles of the Ecosystem Approach were presented to the COP at its fifth meeting held in Nairobi in year 2000 (as SBSTTA 5 Recommendation V/10). The twelve principles recorded in the document provide a useful source of inspiration for enhancing and conserving a European Green Infrastructure. In fact the Green Infrastructure, although not a direct consequence of the Ecosystems Approach, it can be said that it is based on this approach.

The rationale of this approach (see box 1) understands that ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way. Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their biotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.

An ecosystem can be defined, as it is the GI, in several ways and at different scales, the European Green Infrastructure can be defined in this way as an ecosystem or a network of ecosystems with specific parts, needs, functions and services. It can also be considered as a tool to strengthen ecosystems.

Moreover, this approach could be the theoretical basis for the implementation, conservation and use of the European Green Infrastructure. This means that a big part of human activities influence in some way the Green Infrastructure, and they are or should be influenced by the Green Infrastructure. Hence it is necessary to incorporate, at the appropriate level, the impacts on Green Infrastructure in the planning and implementation of human activities and where necessary correct the negative impacts and enhance the positive ones (if existing).

Box 1.1 The ecosystem approach

“The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach will help to reach a balance of the three objectives of the Convention. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems. The term "ecosystem" does not, necessarily, correspond to the terms "biome" or "ecological zone", but can refer to any functioning unit at any scale. The scale of analysis and action should be determined by the problem being addressed.

The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. The ecosystem approach integrates other past and well-known approaches to deal with complex situations.

The ecosystem approach has 12 complementary principles:

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice.
Principle 2: Management should be decentralized to the lowest appropriate level.
Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:
(a) Reduce those market distortions that adversely affect biological diversity;
(b) Align incentives to promote biodiversity conservation and sustainable use;
(c) Internalize costs and benefits in the given ecosystem to the extent feasible.
Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
Principle 6: Ecosystems must be managed within the limits of their functioning.
Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
Principle 9: Management must recognize that change is inevitable.
Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

1.2.5. References

Benedict, M.A. and McMahon, E.T. 2002. Green Infrastructure: Smart Conservation for the 21st Century. The Conservation Fund.

Davies C., MacFarlane R., McGloin C., Roe M.; Green Infrastructure Planning Guide; http://www.greeninfrastructure.eu/

North West Green Infrastructure Guide (Sep 2007). The North West Green Infrastructure Think Tank (England; UK). http://www.greeninfrastructurenw.co.uk/html/index.php?page=index

Chapter 2. Background: Setting the Context

Content

Chapter 2. Background: Setting the Context

Across the EU, the importance of infrastructures and ecological networks can be appreciated by the number of initiatives launched at transnational, national and regional level. Most of them differ in conception, approach and methodology but aim to reach a common objective of preserving biodiversity.

This section provides an overview of the relevant EU policies in relation to green infrastructures as well as some of the initiatives carried out in different countries and regions and other key documents.

2.1. EC Policy Background and Initiatives

EU Biodiversity Communication and Action Plan

In May 2006, the European Commission adopted a Communication on *óHalting biodiversity loss by 2010 ï and Beyond: sustaining ecosystem services for human well-beingô* The Communication underlined the importance of biodiversity protection as a pre-requisite for sustainable development and set out a detailed EU Biodiversity Action Plan (EU BAP) to achieve this.

The EU BAP identifies four main policy areas and defines ten key objectives to deliver the 2010 biodiversity target. In the scope of this study, Objectives 2 and 3 are to be highlighted as they concern in particular the need óto conserve and restore biodiversity and ecosystem services in the wider EU countryside and EU marine environmentô

A mid term review[1] was published in November 2008 to assess progress in meeting the EU BAP targets. It concluded that, whilst progress had been made in some areas, there was still a major effort to be made and that reaching the 2010 target was now highly unlikely without a major political will across all sectors. .

The Natura 2000 Network

The óBirdsô and óHabitatsô Directives are the cornerstones of the EUês policy response to halting biodiversity loss by 2010. They set the same high standard for nature conservation across 27 countries. At the heart of the Directives lies the creation of a Europe-wide ecological network of protected sites ï the Natura 2000 Network ï which is destined to conserve over a thousand rare, threatened and endemic species and some 220 natural habitats listed in their annexes. Around 25,000 sites have been included in the Network so far, covering around 17% of the total land area of the European Union.

Natura 2000 and ecological connectivity

Although the Natura 2000 Network is now the largest network of conservation areas of its kind anywhere in the world, its long-term success is dependent upon its <u>ecological coherence</u> and overall resilience. Species need to be able to migrate, disperse and

[1] The mid term report can be downloaded from:
http://ec.europa.eu/environment/nature/biodiversity/comm2006/index_en.htm

intermix between Natura 2000 sites and across the wider landscape in order to survive. In this regard, Article 10 of the Habitats Directive and Article 3 of the Birds Directive recognises that ecological coherence of the Natura 2000 network as well as habitat quality is essential for the long-term survival of many species and habitats.

Monitoring the conservation status of EU species and habitat types

The Habitats Directive requires Member States to monitor the habitats and species listed in the annexes (Article 11) and, every 6 years, to report to the EC following an agreed format (Article 17). This requirement is not just restricted to Natura 2000 sites: data must also be collected outside the Natura 2000 network in order to have a full appreciation of the conservation status of each species and habitat type listed.

The main results of this monitoring work will be written up in a consolidated report for the EU which will include an assessment of conservation status based on best available data (based among others on trends and ideally in comparison with favourable reference values). The conservation status assessments for species and habitats, both on Member States biogeographical level and on EU-biogeographical level for the reporting period 2001-2006 can be viewed on: http://biodiversity.eionet.europa.eu/article17.

Climate change adaptation and biodiversity

The effects of climate change are already being felt at global and European scales. To prevent significant economic and social impacts, the EU is currently working on the design of an Adaptation Framework to reduce the EU's vulnerability to the impacts of climate change. This framework will complement and strengthen the actions taken by Member States.

In April 2009 the EC presented a policy paper known as a White Paper on adaptation to climate change. This document constitutes a framework for adaptation measures and policies to reduce the EU's vulnerability to the impacts of climate change. Regarding habitat's connectivity, the Paper recognise that in the future it may be necessary to consider establishing a permeable landscape in order to enhance the interconnectivity of natural areas.

The EU Ad Hoc Expert Working Group on Biodiversity and Climate Change has also prepared a discussion paper "Towards a Strategy on Climate Change, Ecosystem Services and Biodiversity". In this paper they said that: "the conservation and sustainable use of biodiversity and ecosystem services has the potential to contribute significantly to mitigating climate change and to help human societies adapt to its impacts"

This document also stresses the necessity of taking immediate action to conserve and restore terrestrial and marine biodiversity and ecosystem services as these are the basis for cost-effective climate change adaptation and mitigation and engaging other sectors, as agriculture, finance, transport, energy, regional planning, water management, fisheries, forestry, tourism, development policy, health, built environment to maintain and increase ecosystem resilience and to ensure that their activities do not further damage biodiversity and ecosystem services *http://circa.europa.eu/Public/irc/env/biodiversity_climate/library*

Strategic Environmental Assessments: the key to better spatial planning

The purpose of the EU SEA-Directive is to ensure that environmental consequences of certain plans and programmes are identified and assessed early on in the decision making process and at a more strategic level. The public and environmental authorities have the possibility to make comments which can be integrated into the decision making process. In this way the SEA has a major role to play in ensuring a more integrated, efficient and transparent planning process.

Thanks to the SEA procedure, biodiversity is also taken into account early on in the planning process which provides a means of safeguarding functioning ecosystems and ensuring a more coherent spatial planning approach towards creating a green infrastructure and a more permeable landscape.

EU guidance available on:
http://ec.europa.eu/environment/archives/eia/sea-support.htm

Environmental Impact Assessment

The “EIA Directive” 85/337/EEC states that development consent for projects which are likely to have significant effects on the environment should be granted only after prior assessment of the likely significant environmental effects of these projects has been carried out. The EIA Directive defines project as the execution of construction works or of other installations or schemes, other interventions in the natural surroundings and landscape.

The EIA procedure ensures that environmental consequences of projects are identified and assessed before authorisation is given. The public can give its opinion and all results are taken into account in the authorisation procedure of the project. The public is informed of the decision afterwards. The EIA Directive outlines which project categories shall be made subject to an EIA, which procedure shall be followed and the content of the assessment.

Like SEAs, EIA allow biodiversity issues, both within and outside protected areas, to be taken into consideration when approving new development projects which can help avoid further habitat fragmentation.

The Economics of Ecosystems and Biodiversity

Taking inspiration from ideas developed in the Millennium Ecosystem Assessment, which made significant progress in assessing current knowledge on biodiversity and ecosystem services, The Economics of Ecosystems and Biodiversity (TEEB) initiative, aims to promote a better understanding of the true economic value of ecosystem services and to offer economic tools that take proper account of this value.

TEEB will be conducted in two phases. The interim report published in 2008 summarizes the results of Phase I. It demonstrates the huge significance of ecosystems and biodiversity and the threats to human welfare if no action is taken to reverse current damage and losses. Phase II will expand on this and show how to use this knowledge to design the right tools and policies.
For Information go to:
http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm

2.2. EU Research Projects Funded by DG RTD

Several research projects funded under the EU Research Framework Programme are relevant for green infrastructures:

MACIS: The *Minimisation of and Adaptation to Climate change Impacts on biodiverSity* project ran until November 2008. It reviewed and analysed existing projections of climate change impacts on Europe's biodiversity and developed methods to assess the potential impacts in the future. MACIS project results make it possible to identify which parts (habitats) of the Green infrastructure would suffer more from the effects of Climate Change and which ones would help to buffer the negative impacts.
For information go to: http://www.macis-project.net/

ALARM: The *Assessing LArge-scale environmental Risks with tested Methods* project ran from 2004 to 2008. Based on a better understanding of terrestrial and freshwater biodiversity and ecosystem functioning, ALARM developed and tested methods and protocols for the assessment of large-scale environmental risks in order to minimise negative direct and indirect human impacts. For information go to:
http://www.alarmproject.net/alarm/

COCONUT: The *Understanding effeCts Of land use Changes ON ecosystems to halt loss of biodiversity due to habitat destrUction, fragmenTation and degradation* project, synthesized existing data about land use change and habitat fragmentation and the effects on biodiversity. With this information COCONUT developed decision tools and policy option for stopping biodiversity loss.
http://www.coconut-project.net/

SCALES stands for Securing the Conservation of biodiversity across Administrative Levels and spatial, temporal, and Ecological Scales. The SCALES project will seek ways to build the issue of scale into policy and decision making and biodiversity management. The general objective of SCALES is to provide the most appropriate assessment tools and policy instruments to foster our capacity for biodiversity conservation across spatial and temporal scales and to disseminate them to a wide range of users.
http://www.scales-project.net/

These four projects are linked and complement each other to identify policy options to stop biodiversity loss due to climate and land use change and hence to the conservation and proper functioning of the European Green Infrastructure.

2.3. EEA Reports

The European Environment Agency has produced a wealth of different reports and land use models on various aspects of the Environment within 32 countries of Europe. This is important because, nowadays, land use in Europe is the main driving force in the configuration (both in the positive and negative sense) of the Green Infrastructure. There are too many to list here but the following thematic links may be of particular interest:

Land use page has the following reports and maps /data:
http://www.eea.europa.eu/themes/landuse
- EEA Briefing 2/2008 - Ecosystem services - accounting for what matters
- Urban sprawl in Europe - The ignored challenge
- The changing faces of Europe's coastal areas
- Spatial and Ecological Assessment of the TEN - Demonstration of Indicators and GIS

Methods
- Land accounts for Europe 1990-2000
- Agriculture and environment in EU-15 - the IRENA indicator report
- PRELUDE: land use scenarios for Europe:
http://www.eea.europa.eu/multimedia/interactive/prelude-scenarios/prelude
- LUCAS: explore land use resources and ground level pictures
http://www.eea.europa.eu/themes/landuse/clc-lucas
- Corine Land Cover data http://www.eea.europa.eu/themes/landuse/clc-download
- Land and Ecosystem Accounting (LEAC)
http://www.eea.europa.eu/themes/landuse/land-and-ecosystem-accounting-leac

The Biodiversity page has the following reports
http://www.eea.europa.eu/themes/biodiversity
- Europe is losing biodiversity – even in protected areas
- Understanding the full value of biodiversity loss
- EEA Signals 2009, key environmental issues facing Europe

2.4. Ecological Networks Initiatives: CBD, PEBLDS, PEEN AND EECONET

Review of experiences with ecological networks, corridors and buffer zones
CBD Technical Series No. 23, 2006.

This document contains detailed information on the development and implementation of ecological networks in each of the five UN regions. The examples and case studies provide a wealth of information on ecological networks. The study also focuses on lessons learned and on the suitability of ecological networks for biodiversity conservation, sustainable use and poverty alleviation, and on their contribution to the 2010 target.
Document from: http://www.syzygy.nl/Documenten/cbd-ts-23.pdf

Integrating biodiversity conservation and sustainable use: lessons learned from ecological networks
IUCN, 2004

IUCN's 5th World Parks Congress (2003) concluded that parks should not exist as unique islands, but need to be planned and managed as an integral part of the broader landscape. Ecological networks provide an operational model for conserving biodiversity that is based on ecological principles and allow a degree of human use of the landscape. This publication illustrates the development of several ecological networks around the world, demonstrating their benefits both for conservation and sustainable development.
Available from: http://data.iucn.org/dbtw-wpd/edocs/2004-002.pdf

The Development and Application of Ecological Networks: a Review of Proposals, Plans and Programmes
IUCN, 2001.

This report comprises a worldwide review of a selection of ecological network initiatives that are currently being developed or implemented. It includes an inventory of a wide range of proposals, plans and ongoing programmes to establish ecological networks at scales varying from the regional to intercontinental and summary findings on the main features of the initiatives. The report is intended as a contribution to IUCN's review of experience in developing and applying ecological networks.

Available from:
http://www.syzygy.nl/Documenten/The_Development_and_Application_of_Ecological_Networks.pdf

General Guidelines for the Development of the Pan-European Ecological Network (PEEN)
Nature and Environment No. 107, Council of Europe, 2000.

This document was prepared as part of the work programme to establish the Pan-European Ecological Network under the Pan-European Biological and Landscape Diversity Strategy (PEBLDS). The guidelines provide a reference document for use by all actors involved in establishing and managing the Network. They aim to establish a common operational understanding on: (i) the objectives and characteristics of the Network; (ii) the process through which the Network will be developed and implemented; (iii) the relation between the PEEN and other ecological networks; (iv) ensuring compatibility between the Network and other land uses.

In approaching this task, the guidelines present a coherent framework for guiding an array of cooperative and decentralised actions that will be taken by actors at all levels and in a wide range of sectors. They focus specifically on the conservation and sustainable use of European importance and support and reinforce the full implementation of the many existing initiatives that contribute to the conservation of biological and landscape diversity in Europe. They also indicate the supplementary actions that will be necessary to establish the PEEN.
Available from:
http://www.syzygy.nl/Documenten/General_Guidelines_for_the_Development_of_PEEN.pdf

The Pan-European Ecological Network: taking stock
Nature and Environment No. 146, Council of Europe, 2007.

In 1995, when the European Ministers of the Environment met in Sofia, they launched the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), so as to strengthen environment and biodiversity conservation policies. The setting up of the Pan-European Ecological Network (PEEN) covering Eurasia was one of the key steps taken under the Strategy. Work has continued on this project, and it is now based on the numerous national, regional and trans-regional ecological networks being set up throughout Europe.

This book looks at the implementation of the PEEN in the 55 states concerned. It has been written by a team comprising, under the aegis of the Council of Europe, numerous government experts and specialists dealing with the issue of ecological networks. It is intended to reassure Ministers, policy-makers and scientists that they made the right decision in supporting the creation of the Pan-European Ecological Network with a view to (re-)creating a true green infrastructure for Europe.
http://book.coe.int/EN/ficheouvrage.php?PAGEID=36&lang=EN&produit_aliasid=2223

Support for ecological networks in European nature conservation
ECNC, 2003

This report presents the results of an explorative study into the understanding and appreciation of ecological networks as a policy concept in Europe. The aim of this study was to provide information that would be relevant for the implementation of the PEEN. The study also took into account the understanding and appreciation of

ecological networks in general: whatever doubts exist concerning the validity or feasibility of ecological networks will affect opinions at a Pan-European scale.
Available from: http://www.ecnc.org/file_handler/documents/original/view/26/2003--support-for-ecologicalnetworkspdf.pdf

Indicative map of the Pan-European ecological network for central and eastern Europe
ECNC, 2002.

This technical report reflects the outcome of this pioneer project; for the first time an indicative map for central and Eastern Europe is developed that, based on a common approach, identifies the possible location of major components of the European ecological network for this region. The countries which are covered by the indicative map are: Belarus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Slovak Republic, Romania, European Russia and Ukraine. Until now, no ecological networks have been designed that cover such a large and diverse region.
Available from: http://www.ecnc.org/file_handler/documents/original/view/51/2002--indicative-map-of-thepeen-cee-backgroundpdf.pdf

Pan European 2010 Biodiversity Implementation Plan
UNEP/Council of Europe, 2005

Within the framework of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) action plans have been developed to facilitate the achievement of these targets, while benefiting of a new initiative - Countdown 2010 - an independent communication and technical support instrument to profile the importance of the global 2010 target in the pan-European context and to monitor the progress of implementation of these targets. The action plans propose a number of catalytic activities that highlight and address elements of the key targets that best can and should be undertaken under the direct umbrella of the PEBLDS, through concerted actions, regional cooperation and capacity-building, with the involvement of governments, non-governmental organizations, relevant stakeholders, and economic sectors. Available from:
http://www.peblds.org/files/meetings/straco_2005_3_stakeholders_version_plan_e.doc

Interaction between policy concerning spatial planning and ecological networks in Europe (SPEN)
ECNC, 2009.

This overview introduces the relationship between ecological networks and spatial planning. The European dimension of spatial planning is described and the interactions between ecological networks and spatial planning are summarized. Various European approaches to ecological networks in relation to spatial planning are illustrated with examples.
Available from:
http://www.ecologicalnetworks.eu/documents/publications/spen/SPENOverviewChapter1.pdf

2.5. Examples of Ongoing Transnational Initiatives

The European Green Belt

The European Green Belt has the vision to create the backbone of an ecological network, running from the Barents to the Black Sea that is a global symbol for transboundary cooperation in nature conservation and sustainable development. Moreover, the initiative is aimed to better harmonise human activities with the natural environment, and to increase opportunities for the socio-economic development of local communities.

Based on the first working group meeting for the Green Belt, a book has been written and published in 2006. It sets out both the theoretical and practical basis for the initiative. The book gives an overview of the historical context and highlights some of the key transboundary cooperation events that have taken place within its range. It also looks to the future and lays out a plan for what the Green Belt can become in the coming years.
For information:
http://www.europeangreenbelt.org/
http://www.europeangreenbelt.org/005.database_publications_gbbook.html

Biologically Important Forests from Baltics to Balkans

BirdLife's European Forest Task Force

Forests of high conservation value are disappearing from Europe. In order to prevent the loss or increased rarity of numerous species of forest flora and fauna, we first need to identify areas of special importance for declining and rare species. During 2002-2009, consistent mapping of biologically important forests based on a common set of ecological and conservation criteria was carried out in Estonia, Latvia, Lithuania, Poland, Belarus, Romania and Bulgaria.

The major product is an interactive and user-friendly map service, available on the internet. It can be used as an important source of information for scientific purposes (e.g. potential habitats of rare species, migration corridors, etc.), tourism development and education. In particular, however, the mapping's chief goal is to provide strong ecological premises for restoration of ecological connections and functioning forest landscapes at the continental scale. Such a perspective is a necessary attribute of an efficient adaptive management of the European forest biodiversity resources.
For information: http://www.forestmapping.net

Wings over Wetlands Project

The Wings Over Wetlands (WOW) Project is the largest international wetland and waterbird conservation initiative in the African-Eurasian region. Funded by UNEP-GEF, the German, Swiss, French, Swedish and Danish governments, the WOW is a partnership of international conservation organizations and national governments, which aims to improve and conserve healthy and viable populations of African-Eurasian migratory waterbirds. This will be achieved by assisting a wide range of partners to conserve the critical wetland areas that these birds require to complete their annual migrations across Africa and Eurasia, by improving international cooperation and by building local professional capacity.

Once developed, the Critical Sites Network (CSN) Tool will present currently dispersed information in an integrated fashion along the entire Flyway by providing decision-makers and conservation organisations with the improved data access needed for

timely and focused wetland and waterbird conservation. The Capacity Building component produces a Training of Trainers programme that is being adopted to regional conditions in four subregions of the project. The project also supports field projects in eleven important wetland areas in 12 countries including Estonia, Hungary, Lithuania amongst others.
For information: http://www.wingsoverwetlands.org/

Development of a Carpathian Ecological Network

The Carpathian EcoRegion Initiative (CERI) is a coalition of NGOs and research institutes working towards a common vision for conservation and sustainable development of the Carpathians. The Initiative created the first cross-cultural biodiversity and social-economic assessment of the Carpathians which helped to generate high-level political support for the sustainable development of the region. The Summit in Bucharest, April 2001, and the signing of the draft framework Carpathian Convention organized by partner UNEP Vienna ISCC, were significant political steps towards ensuring the goals of the CERI in the Carpathian Mountains.

The development of an ecological network in the Carpathians as a constituent part of the PEEN is one of the most important objectives of the Framework Convention on the Protection and Sustainable Development of the Carpathians. The BBI/Matra as well as the DBU foundation supports the implementation of the Carpathian Convention by producing a Carpathian Biodiversity Information System as a base for the development of an Ecological Network for the Carpathians and by strengthening the capacities of the NGO network in the Carpathians.
For information: http://www.carpates.org/

Establishing an Alpine Ecological Network

Establishing an ecological network in the Alps is one of the key goals of the Protocol "Conservation of Nature and the Countryside" under the Alpine Convention. The Alps are the largest natural region left in Europe and therefore of extraordinary importance for biodiversity. But the Alps are also home to 14 million people and one of the most visited areas in the world. This is not without impact on biodiversity. Habitat loss and fragmentation, climate change, changes of agricultural practices and pollution count among the most important reasons for biodiversity loss and landscape destruction of the Alps.

The creation of a functioning ecological network in the Alps can contribute to conserve the extraordinary rich alpine diversity. Work has already been started. Three closely linked initiatives are working together in implementing such an ecological network: the platform "ecological network" of the Alpine Convention, the Ecological Continuum project started by four active alpine network organizations and the ECONNECT project of 16 partners.

The Ecological Continuum Project was started in June 2007 by ALPARC (Alpine Network of Protected Areas), CIPRA (International Commission for the Protection of the Alps), ISCAR (International Scientific Committee Alpine Research) and the European Alpine Programme of the World Wide Fund for Nature (WWF) with the aim of maintaining or restoring ecological connectivity between important areas for nature conservation in the Alps. During a pre-project (2007-2008) the Ecological Continuum Project compiles some basic information for following project for establishing ecological networks in the Alps, mainly to harmonize terminology, including a common definition of the "ecological continuum" to be submitted to the alpine states and the EU as well as to evaluate and assess existing approaches in view of their application in the Alps.

For information: http://www.alpine-ecological-network.org/
Assessment report:
http://www.alpine-ecological-network.org/images/stories/081016FinalWPA(1)(1).pdf

Relevant instruments in the field of Ecological networks in the Alpine region

In nature and species conservation a paradigm shift has started in the last few years: static nature protection in isolated protected areas is not sufficient for conserving biodiversity, but approaches are needed that take the dynamic of nature and land use change into account. This change of attitudes contributed to the establishment of the model of a functioning ecological network in the Alps, which can contribute to conserve the extraordinary rich Alpine diversity.

This background report provides brief information on the most important instruments, such as conventions, legislation, regulations and programmes connected with ecological networks. Available from:
http://www.cipra.org/pdfs/341_en/at_download/file

Feasibility Study for a transnational Alpine-Carpathian-Corridor Project

In last decade a priority was noted to safeguard the connection between the Alps and the Carpathian mountains. Because of an increasing barrier effect of infrastructure, increasing settlement-area and intensive land use, the protection of an ecological corridor – the so-called Alpine-Carpathian Corridor (ACC) – has been determined as the measure necessary to safeguard migration and genetic exchange, going beyond the protection of ecological connectedness. The aim of the Alpine-Carpathian Corridor feasibility study was to prove that all possible barriers in the corridor area can be addressed within a comprehensive. This is now being taken forward through ERDF funding (details missing).
For information:
http://www.wwf.at/downloads/cms_uploaded/acc_feasibilitystudy_wwf_2008_47d503d31e6ab.pdf

2.6. Examples of National and Regional Initiatives

France

France is currently passing a new law to create a green and blue infrastructure across the country – known as la Trame Verte et Bleue (TVB) by 2012 which will become an obligatory element of all future spatial planning policies. The legislation is being tested through a series of pilot projects in 45 regional national parks across France.

The green infrastructure will be founded on scientific data and will be made up of protected areas and other areas that will ensure the connectivity and global functionality of biodiversity across the country. The blue infrastructure will have an equivalent structure for fresh water bodies and their associated ecosystems.

The infrastructure will be elaborated through a partnership of government, local authorities and stakeholders groups. They will be coordinated at the level of each region in close association with the local associations and in concertation with land owners and users.
For information:

http://www.legrenelle-environnement.gouv.fr/grenelle-environnement/spip.php?article707

Estonia

Estonia was the first country to develop the ecological network concept and to elaborate the model into a comprehensive plan and implementation programme. In 1983 this proposal was finalized as a plan to establish a “Network of Ecologically Compensating Areas”, a national scheme that aimed to achieve far broader goals than biodiversity conservation. In Estonia's vision, the ecological-network concept is regarded as a means to integrate land use with landscape functions in a model that can be incorporated into regional and national planning processes. Thus, from its inception, the Estonian ecological network has been developed as a spatial-planning tool for the purpose of balancing and integrating land uses.

The concept of the Network of Ecologically Compensating Areas is now incorporated into spatial planning and environmental legislation: the 1995 Sustainable Development Act, the 2004 Act on Nature Conservation and the 1995 Planning and Building Act as well as the new Act on Planning (2002), which required that green network should be defined at State level, and all 15 counties and municipalities should prepare a map of the ecological network for their territory. In 1999 the Governmental decree for second phase of county planning (1999-2004) “Defining environmental conditions for the development of land-use and settlement structure”, which included two subthemes: green network and valuable landscapes was approved. By 2005 all 15 counties have defined green networks, according to methodology developed by J. Jagomägi and K. Sepp (2001).

As currently delineated, the Estonian Green Network covers about 50 percent of the country's territory. The county maps of the Green Network are at a scale of 1:50,000 and are used as a framework for defining the conditions that are necessary to ensure sustainable development in the region. The process through which this is achieved involves local public hearings. In Järva County, for example, the map delineates four levels of core area – varying from one or two kilometres to up to 50 kilometres across – and interconnecting corridors. These corridors are configured on the basis of data indicating the needs of species for dispersal and migration and the existence of natural linkages, including stepping stones in the landscape.

The network that is delineated in each county plan lays down the conditions that will apply to the regulation of land use in the development planning process. This is particularly concerned with reducing conflicts between different land-use demands within the network, with the appropriate intensity of land uses and with how serious conflicts of interest – such as between a road and a wildlife linkage – should be resolved in a structural way. The specific measures adopted in the final plan for Järva County were approved by the national government in 2003, with the result that the plan now has the force of law.

Germany

In 2002 the German Nature Conservation Act was amended. In Art. 3 it now calls for the establishment for an ecological network (Biotopverbund) on at least 10 % of the German territory. The German federal states are requested to implement this network following a transboundary approach. A system of recommended common criteria for identifying components of ecological networks was agreed on by experts from the Federal Nature Conservation Agency and the federal state authorities in 2004. Applying these criteria core areas and corridors of national and international relevance are currently being identified. A comprehensive national ecological network plan is expected to be finalized by early 2010.

The federal states are in charge of the implementation of ecological networks. The national government can only support the states by providing technical and scientific support and by funding of selective model projects. In implementing ecological networks the federal states follow different approaches. Some states use bottom up approaches with local initiatives applying for funds for local or regional projects. There is no binding time schedule for the implementation of a national ecological network although the National Strategy on Biodiversity calls for its implementation by 2010. There also is no special budget for the implementation of ecological networks neither on the federal level nor on the state level.
For information:
http://www.bfn.de/0311_biotopverbund.html

Netherlands

The Dutch government decided in 1990, following a multi-year research programme, to develop a National Ecological Network that could provide the long-term basis for ecological sustainability throughout the country. Given the scale of the initiative, establishing the network is a long-term enterprise with full implementation scheduled for 2018.

The National Ecological Network as originally adopted in 1990 was an "oversized" indicative map of core areas, nature development areas and corridors. It is the task of the 12 provinces to delineate the precise boundaries of the network. This is being done using 132 habitat and landscape types for which minimum aggregate total areas have been fixed at national level. The final network is intended to cover about 730,000 hectares, or 17.5 per cent of the Dutch countryside.

The open areas of the Barcelona Region

According to landscape ecology principles, territorial planning should be based on a system of functional open areas. This approach must depart necessarily from the analysis and the assessment of the characteristics and attributes of these spaces. The perspective of this diagnosis must be multidisciplinary, which brings together their natural, economic and social values.

In this context, the Diputació of Barcelona has set up a territorial information system (GIS based) for the network of open areas of the province of Barcelona (SITXELL), a project focused on obtaining, analysing and assessing the information about non urban areas. Its main goal is to give support to the policies of the local administration referring to open areas (both natural and agricultural lands), so that the socioeconomic development of the territory can be compatible with the persistence and improvement of the functionality of natural systems. Its application at different land scales, from regional to local planning, has allowed for the integration of the objectives of conservation and management of the open spaces in the land planning system.
For information: http://www.diba.es/parcsn/parcs/index.asp?parc=18

Ecological corridors of Murcia Region

Nowadays, the maintenance of ecological connectivity has acquired a growing importance in nature conservation policy. For example, the management of connectivity and ecological coherence of the Natura 2000 network is a legal requirement imposed by the Habitats Directive 92/43/EEC on its Article 10.

In this context, the Region of Murcia (Spain) has carried out a study to define a network of ecological corridors which ensures the coherence of the regional Natura 2000 network. To do so, the study was based on an analysis of connectivity of a selected range of protected habitats representative of the Region. New techniques were used for modelling habitat suitability and resistance that conform to reality with the utmost precision. The analysis was complemented with field work to analyse possible conflict zones for connectivity. The result led to the identification and characterization of high connectivity areas connecting the region's Natura 2000 sites.

Wales

The concept of Green infrastructure is being used in Wales as the spatial expression of the Ecosystems Approach. The focus is therefore on the benefits to society and the economy of natural heritage in the form of Ecosystem Goods and Services. At a regional level there are a number of projects taking forward the ecosytsems approach through initiatives such as Integrated Rural Development and Integrated Coastal Zone Management.

Nationally, the Welsh Assembly Government is integrating a green infrastructure plan into the South East Wales section of the Wales Spatial Plan. This work is a manifestation of the Welsh Assembly Government's commitment to sustainable development and the Wales Environment Strategy. It sees the environmental infrastructure of the city-region as the essential life support system for social and economic development, making the landscape more permeable to wildlife and more accessible for people, helping society and wildlife to adapt to climate change, improving the quality of life, promoting healthier lifestyles, increasing tourism and improving the image of the area.
For information:
http://wales.gov.uk/location/south_east_wales/spatial/?lang=en

2.7. Integration into Other Policies

2.7.1. Spatial planning

KEN - Knowledge for Ecological Networks

The main gap in knowledge concerning ecological networks currently relates to the practical implementation of such networks. This Dutch funded project aims to broaden the horizon of ecological network implementation by involving relevant fields of knowledge hitherto not strongly involved, and exploring possibilities for synergy with other societal and policy sectors, especially concerning issues such as stakeholder involvement, promoting economic and land use activities that are beneficial to maintaining ecological connectivity.
http://www.ecologicalnetworks.eu/documents/Presentations/KEN%20Workshop%20Vught%2011%20Feb%2009%20-%20introduction%20-%20A.%20Cil.pdf

SPEN – Interactions between Policy Concerning Spatial Planning and Ecological Networks in Europe

This overview introduces the relationship between ecological networks and spatial planning. The origins, characteristics and development of the ecological network model are discussed, including the most important variations, and the key features of

ecological networks that are relevant to spatial planning are outlined. The European dimension of spatial planning is described and the interactions between ecological networks and spatial planning are summarised. Various European approaches to ecological networks in relation to spatial planning are ordered and each approach is illustrated with examples.
www.ecnc.org/download/normal/ProjectManagement/89/SPEN%20Overview%20Report.pdf

Restoring ecological networks across transport corridors in Bulgaria

Transport corridors, such as roads and railroads, have been shown to be major causes of habitat fragmentation. They not only cause the loss of natural habitats but also affect the quality of adjacent habitats, inhibit animal movements and, last but not least, increase unnatural wildlife mortality due to collisions with traffic. The main objective of the project was to develop a long-term programme for defragmentation measures at transport corridors in Bulgaria in order to restore ecological networks and preserve biodiversity.
http://www.ecnc.org/completed-projects_37.html?action=detail&id=61

2.7.2. Transport

DG ENV Study: Preparing evaluation methods for EU-level landscape fragmentation

The report brings a proposal for a methodical guide for assessment of landscape fragmentation caused by traffic. Parts of west and central Europe including areas of Belgium, Netherlands, Luxembourg, Germany, the Czech Republic, Slovakia and Poland were selected to demonstrate outcomes. This model area presents a wide spectrum of ecological and social conditions, also enabling description of landscape fragmentation on a large scale. This can be downloaded from.www.evernia.cz

From grey infrastructure to a green infrastructure

Roads, railways and waterways have been constructed to facilitate our movements, but our increased mobility has caused an increasing pressure on our landscape. This paper produced by Wouter van Merlo during his traineeship at DG Environment focuses on constructed grey infrastructure (roads mainly and to a lesser extend railways and waterways) and its relation with the landscape. It also looks at how experiences with developing a grey infrastructure can help those want to realise a green structure. The paper can be downloaded from:
www.green-infrastructure-europe.org

COST 341: Habitat Fragmentation due to transportation infrastructure

This project aimed to assess habitat fragmentation caused by construction and use of the transportation networks in Europe. Best practices regarding methodologies, indicators, technical design and procedures for the avoidance, mitigation and compensation of adverse effects on nature were collected in a handbook for practitioners. A database offered on-line information on European expertise, data on existing literature, and a glossary of terms used in the field of infrastructure and habitat fragmentation.
http://cordis.europa.eu/cost-transport/src/cost-341.htm

2.7.3. Agriculture

Englandøs Rural Development Plan

71% of Englandøs land (9.3 million ha) is farmed. As well as food and timber production agricultural systems make a significant contribution to the natural environment, but how the land is managed (the farming system) will affect the type and quality of ecosystem services that are provided. For example, the enterprise type and farming system can determine whether carbon is stored or lost; whether water is of high quality and can support aquatic life or whether it has to be cleaned before it can be drunk; it can affect the quantity and quality of habitats and therefore species diversity and numbers and whether wildlife has the space in which to respond to pressures such as climate change.

Agri-environment schemes have existed in England since 1987, rewarding farmers who give a commitment to environmental management on their land. The current scheme, Environmental Stewardship, was launched in 2005 and is a key part of the Government and EU funded Rural Development Programme for England 2007-2013, with £2.9 billion of funding to support sustainable agriculture throughout the countryside. The scheme is administered by Natural England on behalf of Defra and is one of our main tools for meeting our Natura 2000 commitments as well as improving environmental management in the wider countryside.

Environmental Stewardship has ensured that thousands of farmers and land managers have the funding and advice available to help them undertake work to conserve and improve the countryside ï delivering environmental benefits throughout England. Funding and advice through Environmental Stewardship is helping land managers to conserve, enhance and promote the countryside by:
Ålooking after wildlife, species and their many habitats;
Åensuring land is well managed and retains its traditional character;
Åprotecting historic features and natural resources;
Åensuring traditional livestock and crops are conserved;
Åand providing opportunities for people to visit and learn about the countryside.

Underlying these benefits, Environmental Stewardship is helping the natural environment to adapt to climate change, for example, by reducing greenhouse gas emissions, providing and protecting carbon storage, and helping to manage flooding. At the start of 2009, nearly two thirds of Englandøs agricultural land was covered by environmental agreements ï thatøs over six million hectares of land in over 60,000 agreements.
For more information on Environmental Stewardship, go to the Natural England website at www.naturalengland.org.uk/ourwork/farming/funding/es

2.7.4. Climate change

Dutch initiative to develop climate corridors

One component of this research programme is the development of óStrategies for optimizing the nature conservation potential of the Dutch Ecological Network and the surrounding multifunctional farm landscape under predicted climate change scenarios'. For more details go to National Research Programme on Climate Change and Spatial Planning: http://www.klimaatvoorruimte.nl

2.8. Other Interesting Documents

EEB report – Building a green infrastructure for Europe

Ensuring connectivity between important biodiversity areas means investing heavily in the construction of green bridges, tunnels, fish passes, restoration of rivers and wetlands, including the removal of obsolete infrastructure, and the creation of suitable habitats in the farmed landscape. In other words, a 'Green Infrastructure' network is now fundamental to preserving biodiversity as well as ecosystem functions in Europe. In this paper EEB explains the importance of constructing this 'Green Infrastructure', what it will look like, and identifies key policy recommendations for the new European Parliament and Commission.
http://www.eeb.org/publication/documents/EEB_GreenInfra_FINAL.pdf

Linkages in Practice: a Review of Their Conservation Value

Wildlife corridors have for many years been the subject of a lively debate on the real conservation value delivered by connectivity. This booklet aims to clarify the practical value of maintaining, enhancing, creating or restoring linkages. The importance of connectivity is discussed, the main issues in assessing the value of linkages are presented, experience with four examples of linkages is reviewed and conclusions are drawn on the value of connectivity for biodiversity conservation. http://www.syzygy.nl/Documenten/Linkages_in_Practice.pdf

European Corridors – Strategies for corridor development for target species

This brochure provides examples of corridor approaches for European target species, such as those protected under the Birds and Habitats' Directive or those that apppear in the Global or European Red Lists. The examples show that ecological networks are not merely a theoretical concept, but that they can also provide practical guidance for conservation measures. They build particularly on the information gathered over the years in landscape ecological research, especially on the effects of fragmentation.
http://www.ecnc.org/file_handler/documents/original/view/29/2004--europeancorridorspdf.pdf

Green Infrastructure – supporting connectivity, maintaining sustainability

The fragmentation of habitats by infrastructure developments, urbanization and land-use changes etc. leads to habitat loss and degradation (e.g. by creating smaller habitat patches that are dominated by edge-habitats, and greatly affected by disturbance and other external influences). "Green infrastructure" is a relatively new term but it can also mean different things to different people. This paper produced by Aleksandra Sylwester during her traineeship at DG ENV aims to present the different concepts and definitions of the term "Green Infrastructure" that currently exist, as well as provide information for future policy developments. On the basis on available information this paper aims to explain the relation between green infrastructure and ecosystem elements like ecosystem functions and services. The paper can be downloaded from:
www.green-infrastructure-europe.org

Integrating biodiversity and Natura 2000 in urban areas

This 2006 study for the Brussels Institute for the Environment provides an overview of the management and policy issues surrounding the integration and promotion of biodiversity in cities and urban areas and illustrates this through 28 practical case studies from across EU.
http://www.eukn.org/eukn/themes/Urban_Policy/Urban_environment/Environmental_sustainability/bio-natura-urban-areas_1517.html

UK: North East Green Infrastructure Planning Guide

The North East Green Infrastructure Planning guide was produced by the North East Community Forests, University of Newcastle upon Tyne and Northumbria University using stakeholder involvement and action research principles. The guide is intended to assist planners undertake Green Infrastructure Planning at the local level. The purpose of the guide is to facilitate the production of geographically-based green infrastructure plans. It is intended that this method might help to provide a more informed and systematic way to consider the competing priorities of green infrastructure within the spatial planning process.
http://www.greeninfrastructure.eu/images/GREEN_INFRASTRUCTURE_PLANNING_GUIDE.pdf

Green Infrastructure guide for the East Midlands, UK

The Guide aims to assist local authorities and community based initiatives at local and sub regional level and around the UK. Building on the 2005 'East Midlands Green Infrastructure Scoping Study' and the subsequent 'Green Infrastructure for the East Midlands A Public Benefit Mapping Project' studies, the Guide incorporates numerous innovative Case Studies from around the region that demonstrate models for effective GI.
http://www.emgin.co.uk/images/PDF_Files/River_Nene_Regional_Park/Publications/I%20guide%20LR.pdf

Critical Climate Change Functions of Green Infrastructure for Sustainable Economic

The aim of the work is to highlight how and where the climate change mitigation and adaptation functions of existing and/or potential GI are critical for the short term sustainable economic development of the NW region.
http://www.greeninfrastructurenw.co.uk/resources/Critical_CC_Fns_of_GI_for_Sus_Ec_Dev_in_the_NW.pdf

Green Infrastructure: Smart Conservation for the 21st Century

"Green infrastructure" is also applied in the US. Green Infrastructure: Smart Conservation for the 21st Century takes readers from the origins and history of this concept to its implementation and benefits today - demonstrating how green infrastructure plans can allow for both future growth and the protection of significant natural resources. The Conservation Fund has published a book: 'Green Infrastructure: Linking Lands and Communities' by Mark Benedict and Ed McMahon which presents the principles and practices that link landscapes and communities across the USA.
http://www.conservationfund.org/sites/default/files/GI_SC21C.pdf

Maryland's Green Infrastructure

The Maryland Department of Natural Resources (US) is working to identify those undeveloped lands most critical to the state's long-term ecological health. These lands, referred to as Maryland's green infrastructure, provide the natural foundation needed to support diverse plant and animal populations, and enable valuable natural processes like filtering water and cleaning the air to take place. Identification and prioritization of the green infrastructure is an ongoing process, as newer data and improved methodologies become available. Documents and maps pertaining to these assessments are contained on the following web page. http://www.dnr.maryland.gov/greenways/gi/gi.html

Chapter 3: Physical Impacts (land use changes) of Socio-economic Evolutions

Content

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3.1. Introduction: From the examination of long-term evolutions towards a conceptual framework

A main driver for impacts on the Green Infrastructure come from land uses, and they, in turn, are driven by socio-economic evolutions. Understanding and predicting how land use changes are affected by socio-economic developments is therefore key to working out how to maintain a coherent green infrastructure and on how to work towards great landscape permeability.

The search of correlations between socio-economic evolutions and land-use changes is an extremely difficult exercise in various respects. The question of scale at which the socio-economic evolution is observed is a crucial issue. Aggregating areas with very different economic or demographic evolutions provides average values which do not represent any more the diversity of local evolutions.

In addition, global economic indicators like change in GDP or in the number of jobs do not provide very precise information on economic impacts in terms of land-use changes. Economic growth generated by the development of manufacturing activities (as it is the case in many countries of central and eastern Europe) does not have the same land-use impacts as economic growth generated by the development of services or of tourist activities. As it is not possible to use a very detailed economic disaggregation when working at Europe-wide scale, proxies have to be elaborated. For this purpose, a conceptual approach is necessary. The examination of processes over a long time period is helpful in identifying relevant concepts for the interaction between socio-economic evolution and land-use changes.

Looking at the territorial evolution of Europe during the past half century (since the end of WWII) shows an intense interplay of contraction/polarization and dispersal trends. This interplay has changed over time, with various impacts in terms of densification or depopulation processes. A few milestones of such processes can be mentioned here.

Territorial contraction/polarization patterns have been strong throughout Europe from the end of WWII up to now. Two main periods can be differentiated. The first ends in the early 1980s (with variations from country to country). It corresponds on the one hand to the last phase of the move from rural societies to urban societies and on the other hand from the move from fordist to post-fordist industrial systems.

During this period, especially during the 1950s and 1960s, migration flows from rural areas to cities have been significant, boosted by strong demographic growth. In the countries of central and Eastern Europe, the policies of the former communist regimes aimed at counteracting rural-urban migrations and the expansion of large cities. Their efficiency has generally been limited. Rural-urban migrations were not totally contained, but favored mainly the development of medium-sized and small cities. The second period started during the 1980s and is still on-going. While rural-urban migrations have slowed down, the internationalization of the European economy and the emergence of the globalization process have been leading to accelerated growth of large cities, now well-known as “metropolisation process”.

The development of the information economy and of the knowledge society is strengthening this process. In the countries of central and Eastern Europe, this process started later on. During the transition period after 1990 and until the late 1990s, deep economic restructuring led to high unemployment rates in the large cities and in the regions with heavy, obsolete industries, so that urban-rural migrations developed in a number of cases, especially in the mid-1990s. This process was however one of short duration. The trend of strong economic growth which started in almost all CEEC in the late 1990s benefitted almost exclusively to the capital cities and to a few other large metropolitan areas (especially in Poland). The territorial contraction process is strong and sustained in most countries of central and Eastern Europe, considering that the share of population living in rural, less urbanized areas is much higher than in western Europe and that rural-urban migration flows are still significant.

In the context of the overarching contraction/polarization process which has been lasting up to now, a number of secondary processes worked in the opposite direction, especially if one considers smaller territorial scales. Dispersal tendencies were observed for instance during the 1950s and 1960s under the influence of industrialization processes in rural areas which took place in both western and central and eastern Europe, but with different characteristics. In western Europe, the industrialization process of rural areas was based on light, labour-intensive manufacturing industries with low qualification levels and lasted until the mid 1970s. In central and eastern Europe, the industrialization of rural areas was a political objective and was mainly based on heavy industries, especially, but not exclusively there where raw materials were available. The economic crisis of the second half of the 1970s and early 1980s led to the revival of the contraction process, however more strongly in western Europe than in central and eastern Europe. The decline of old industrial regions (which started at different times, according to the countries concerned) has also led to the dispersal of population and economic resources, although a large part of outmigration flows from such regions concentrated again in other large cities of other regions.

More recently, other processes have contributed to dispersal trends throughout the territory. This is for instance the case for the development of soft rural tourism which has contributed to slowing down the contraction process and to reversing somehow the trend of devitalisation taking place in a number of rural areas. In a different sector, the development of regional airports driven by the emergence of low-cost companies has made possible to curb down the growth of major airports and of surrounding areas and to generate development dynamics in a number of less developed, previously landlocked regions, thus contributing to a more balanced distribution of economic activities and population. The development of the residential economy, taking place especially through the migration of retirees from the cities to the countryside has started a few years ago and will be amplified in the coming decades, considering that large numbers of people will reach soon retirement age. This will contribute to the revival of rural areas sufficiently endowed with attractiveness factors and appropriate services. The recently increasing global demand of agricultural products (biofuels, food products) is also likely to drive economic and demographic substance to numerous rural areas and therefore to contribute to dispersal trends or at least to the limitation of polarization ones.

Contraction/polarization processes lead to densification of the territory where they take place and, therefore to increasing territorial imbalance in terms of population density and economic activities. Metropolitan areas are by far not the only territorial category where contraction and densification processes take place. These can also be observed in numerous coastal areas and mountain valleys. Dispersal processes, on the contrary, counteract contraction processes. They generally favour better balance in terms of densities, but they may also cause depopulation processes, as it can be observed in various remote rural regions or old industrial areas.

The scale at which processes are observed is of great importance. Contraction/polarization processes observed at national or transnational scale, leading to the growth of metropolitan areas at the expense of other territorial categories, generally generate dispersal processes in the form of suburbanization, when observed at a narrower scale. The same is true for dispersal processes observed at wider scale which may result in local contraction processes at the scale of small or medium-sized towns.

Territorial development policies developed and implemented during the past five decades have generally considered that contraction/polarization processes are stronger than dispersal processes and that the organization of the territory in terms of settlement systems and transport networks has to take this into account. This is however not incompatible with the objective of better territorial balance pursued by the regional policies or with that of polycentricity promoted by the ESDP (European Spatial Development Perspective). In numerous European countries, the territorial organization, in terms of visions and policy objectives, is based, explicitly or implicitly, on nodal-axial systems. Concepts such as development axes or "eurocorridors" etc. have resulted from such approaches. A particularly important aspect, in this respect, has been the need to ensure the profitability of expensive transport infrastructure. It can also be observed that the nodal-axial systems, as policy objectives and backbone of the territorial organization, have crossed various economic paradigms (fordist, post-fordist economy, information society, global economy) and have maintained a rather high level of continuity.

It is however obvious that the level of success in implementing the territorial development objectives based on nodal-axial concepts and visions, has not always been impressive and that numerous factors had counteracting effects. These belong to the "natural" forces driving the economy and society, but also to the field of public policies, especially those with strong sectoral character. A striking example, in this respect, is the distribution of traffic flows and the related development of transport infrastructure. The strong development of exchanges in the context of the European integration and globalization calls permanently for the construction of new infrastructure, especially in the road and motorway sector. Because of the saturation of trunk networks in more and more regions, traffic is diverting on secondary networks, also in areas which were not meant to be part of the main nodal-axial system. Traffic growth on such networks produces emissions, makes capacity improvements necessary which, in turn, induce growth and densification processes.

With regard to green corridors in relation to socio-economic processes, the concepts of contraction/polarization/densification and dispersal/depopulation appear relevant for structuring the analysis of present trends and the foresight of probable future evolutions. These overarching concepts will be examined according to the evolution of various factors during the past decade (economy, demography, mobility, evolution of transport systems, dynamics of urban and rural Europe, urban-rural interactions etc.) with the aim to provide explanations to the land-uses changes observed.

3.2. Economic contraction/polarization and dispersal/depopulation processes during the past decade[2]

[2] This section is mainly based on :
ESPON Study 3.2. "Long-term scenarios for territorial development in Europe" 2007.
Fourth cohesion Report of the European Commission. 2007.

Among all factors with physical-spatial impacts, economic factors are those with the most rapid fluctuations and therefore with the most frequent changes on the territory. They are rather numerous, but those which are most related to the location of investments and enterprises are connected to the profitability of businesses. The territorial differentiation of economic processes is generally characterized by two main indicators: economic growth (or decline) expressed by the national or regional GDP evolution and the evolution of employment. Both indicators are not necessarily positively correlated: economic restructuring processes may generate economic growth, but temporarily decline in employment. The analysis will be sub-divided in two parts: Part I, with an explanatory-descriptive character, will concentrate on processes while Part II will attempt to provide more quantitative information on trends at various scales.

3.2.1. Part I: Main economic processes which shaped the territorial evolution in Europe during the past decade

Among all economic processes with territorial impacts, four categories will be particularly emphasized: those related to European integration, those generated by the globalization process, those induced by innovation and finally those connected to the restructuring of the economy of the weakest regions.

As measured by trade flows, European integration seems stronger than intercontinental globalisation. For the countries of the EU-25, the share of intra-European trade (in relation to total foreign trade) has grown from 52% by 1960 to 66% by 1990 and has remained stable at this level during the last decade. Most of the small European countries (including Norway and Switzerland) have a very Europe-oriented trade pattern whereas the largest countries (Germany, UK, France and to a lesser extent Italy and Spain) show clear extra-European trade patterns. Growing intra-European integration can also be demonstrated in the case of Central and East European countries. The increasing orientation of their foreign trade pattern towards Western Europe has clearly preceded their recent political integration within the EU-27. There are however signs of different evolutions, either in the direction of globalisation at the intercontinental scale or of more regional integration with EU or non-EU countries. For instance, in the UK, foreign trade which was traditionally less European in nature, has shown over the last decade a further decline with respect to the relative (export) market shares, a trend probably linked to the growing internationalisation of the UK's economy and to the specific role of the London metropolis (globalisation). In the case of Greece, after a phase of growing European economic integration, the foreign trade pattern has revealed a more recent trend towards strengthening links with neighbouring non-EU countries (regional integration).

The economic effects of European integration have strong impacts on the growth of trade flows and therefore on the development of transport infrastructure. This aspect of the economic evolution is particularly important in terms of land-use impacts on open spaces and therefore on green corridors. On the ground, the impacts are in first place the increase of roads and roads size, the increase of traffic flow and new infrastructure developments to afford the economic growth.

Accelerating globalisation is considered to be a major driver of territorial development in Europe. While the average level of openness to the world at the European scale is rather modest, the impacts of globalisation are much greater at the scale of individual regions[3]. A number of regions have taken advantage of the globalisation process to

3 ESPON Study 3.4.1. . « Europe in the world ». Draft Final Report. Coordinator: UMS RIATE.

strengthen their position. These are especially the first level (London, Paris) and second-level metropolitan areas, also including those of the New Member Countries (Warsaw, Prague, Budapest). Other central regions may benefit from globalisation processes, provided they have good environmental conditions: economies strongly supported by research and development, medium-sized cities with strong cultural, scientific or tourist potential. Some peripheral or semi-peripheral regions may also benefit from the globalisation process: if they have significant technology centres and parks; if they are specific órelaysô for the development of technological industries (like Ireland between the USA and the UK); if they are tourist regions able to develop qualitative products competing with low-cost destinations outside Europe or are western regions of the New Member Countries of Central and Eastern Europe hosting relocated industrial plants.

By contrast, a number of other regions have been and continue to be negatively affected by the globalisation process. In more central parts of Western Europe, this has been the case for a long time for regions with heavy industries (steel production, coal mining) which had first to compete with the ñmaritimisationò process (the transfer of heavy industries towards coastal areas) and, more recently, with extra-European production. A similar evolution has affected regions with textile and clothing industries and this process is even accelerating as a result of liberalisation measures. Negative impacts of globalisation can also be observed in various ñfordistò regions, for instance those where automotive or electro-technical industries were developed during the 1960s and which have now to compete against the regions of Central and Eastern Europe, or against Asian countries. Globalisation also endangers the ñMarshallianò districts based on small and medium-sized enterprises (SMEs) with low R&D inputs which are increasingly facing the competition of low-wage countries. A number of more peripheral regions, both in the EU-15 and in the New Member Countries, are likely to be negatively affected by globalisation too, in particular those with low-cost, low-technology manufacturing activities (like northern Portugal) and some tourist regions affected by the competition of new destinations in the world. Liberalisation measures in the field of international agricultural trade will affect a number of rural regions, some positively (those which are competitive enough to export outside Europe), but most negatively because of increasing imports of low-cost agricultural products. Accelerating globalisation naturally favours the regions with the most advanced economies or with specific comparative advantages, such as a low-wage labour force. In this respect, metropolitan areas in Europe are largely favoured, when compared with the more rural areas, but a number of east-European regions are witnessing significant foreign investments because of lower labour costs. The east/west divide is progressively being replaced by a metropolitan/non metropolitan divide and this trend is likely to become stronger over time, although a number of factors, such as the proportion of the population which is highly educated, expenditure in R&D activities and the registration of patents still favour most western regions, especially those of the pentagon and of Northern Europe.

This shows that the globalisation process has both contraction/polarisation impacts, especially on powerful metropolitan areas (in western and central/eastern Europe) and dispersal effects on a number of less urbanised or old industrial regions, the economy of which is based on intermediate or low technologies.

The innovation capacity is an equally important factor of territorial differentiation. Various levels of innovative performance can be identified in the European context.

Based on their SII score[4] (Summary Innovation Index) and the growth rate of the SII, European countries can be divided in four groups:

- Switzerland, Finland, Sweden, Denmark and Germany make up the group of ñ*leading countries***ò**
- France, Luxembourg, Ireland, United Kingdom, Netherlands, Belgium, Austria, Norway, Italy and Iceland all belong to the group of countries showing ñ*average performance***ò**
- Countries ñ*catching up***ò** are Slovenia, Hungary, Portugal, Czech Republic, Lithuania, Latvia, Greece, Cyprus and Malta.
- Countries ñ*losing ground***ò** are Estonia, Spain, Bulgaria, Poland, Slovakia, Romania and Turkey

The promotion of innovation is however characterised by very strong territorial imbalances throughout Europe. This concentration varies in intensity according to the indicators considered. Strong territorial concentration at EU level is observed in the fields of R&D intensity, employment in high technology services and R&D infrastructure. Concentration in the northern half of Europe is observed in the fields of R&D personnel and population with tertiary education. In the case of employment in high and medium/high technology manufacturing, the contrast is pronounced between the manufacturing heartlands of Europe and the rural periphery. A number of new member countries perform well, but important differences exist between countries, in particular in the field of R&D intensity and employment in high technology services. Important imbalances also exist between regions at the national level in most countries.

The innovation capacity can be considered as a potential for future economic development. It is not easy, however, to relate the innovation capacity of the various European regions to land-use evolutions. The analysis shows that among the countries with the highest innovation capacity, most are countries with metropolitan areas of moderate size and expansion rate (Finland, Sweden, Denmark, Switzerland).

Specific attention has also to be paid to less developed regions because the growth of added value is much higher in most of them (especially in the regions of central and eastern Europe) than the European average. A part of this positive evolution can certainly be attributed to the structural policies from which they benefit. The experience of the period 1995 to 2003 indicates that while sectors of activity contributed differentially to the overall increase in value-added, there was some similarity in the pattern of growth between regions with different levels of GDP per head. Growth, therefore, tended in some degree to be concentrated in the same broad sectors. In all the regional groups, value-added in agriculture declined over this period, but more in the regions with the lowest GDP per head than in the others. Value-added in industry, on the other hand, increased in both regional groups with GDP per head below 75% of the EU average but declined, if only marginally, in regions with higher levels. Value-added in construction and services grew in all the regional groups. In each of the three broad service sectors, the rate of growth of value-added varied inversely with the level of GDP per head. In all three sectors, therefore, it was higher in the lower income regions than elsewhere and in each case lowest in the high income group. In all the regional groups, growth of value-added in business and financial services was particularly high. In each case, therefore, there was a shift in output both from industry and, more especially, agriculture to services and within these from basic to more

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[4] EIS 2005. The EIS (*European Innovation Scoreboard)* is the instrument developed by the European Commission, under the Lisbon Strategy, to evaluate and compare the innovation performance of the Member States. The EIS 2005 includes innovation indicators and trend analyses for all 25 EU Member States, as well as for Bulgaria, Romania, Turkey, Iceland, Norway, Switzerland, the US and Japan.

advanced services. The latter include education and health care, which account for much of the value-added in public services. But economic growth is not matched by growth in employment. The number in work fell over this period in these regions as growth of productivity outstripped that of output. Relatively high productivity growth occurred in all broad sectors except agriculture, so narrowing the gap in value-added per person employed. In agriculture, where the gap was equally wide, productivity remained almost unchanged, so moderating the reduction in employment from the fall in output. This partly reflects the subsistence nature of the sector in many of the regions concerned and its role as an employer of last resort, in the sense that many of those unable to work in other parts of the economy take up ð or remain in ð subsistence farming as a means of supporting themselves.

In industry and construction in these less developed regions, growth of productivity exceeded the growth of value-added and employment fell. This was also the case in public services, where despite growth of value-added of almost 7% a year, the number of employed declined slightly. Employment growth was, therefore, confined to basic market services and business and financial services, especially the latter, where it amounted to 3.5% a year. This, however, was not sufficient to offset job losses in the other sectors, partly reflecting the relatively small size of the service sector in these regions but more importantly the scale of productivity increases in a context of relatively high output growth. Productivity increases were on a much smaller scale in other regions, where the productivity gap was much narrower, including those with GDP per head of between 50% and 75% of the EU average. Here net job creation in services more than compensated for large job losses in agriculture. These job gains were particularly substantial in business services (employment growing by 4.5% a year), a feature common to all the regional groups. Such growth, combined with the growth of education and health care within public services has significant implications for the demand for labour. Together with the decline of jobs in agriculture and in industry ð or at least low growth ð it implies a rising demand for labour with high education and skill levels and a reduction in the demand for manual labour, both skilled and low skilled. It is coupled, moreover, as more detailed investigations show, with a similar shift of jobs within sectors ð towards managerial and professional type jobs and away from, for example, jobs on the production line ð as a consequence of automation and changes in working methods. The challenge facing lagging regions is to accommodate these shifts by ensuring the availability of a work force with the education levels and the skills required as well as the provision of the infrastructure, services and amenities which support business development.

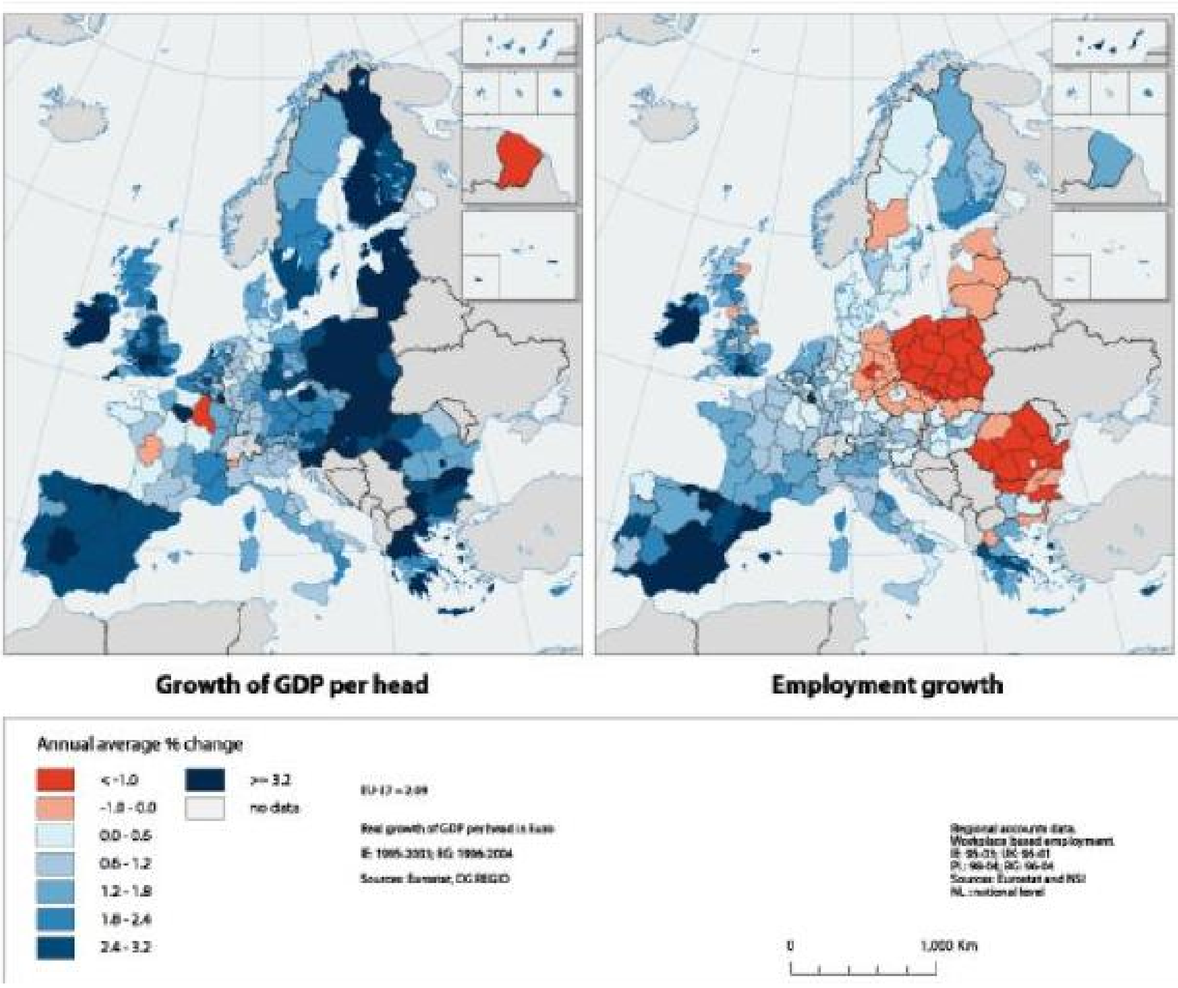
Regional characteristics remain determinants of economic structure. The structure of economic activity in regions is linked not only to the level of GDP per head but also to their inherent features. Although economic activity tends to shift from low value-added to high value-added sectors as regions develop, detailed analysis indicates that the sectoral composition of activity will continue to reflect in some degree the underlying characteristics of the regions concerned. Such factors as geographical position, topology, climate, the pattern of urban settlements, cultural and industrial heritage and accumulated know-how which are important determinants of comparative advantage tend to influence the structure of the economy even in regions with relatively high levels of GDP per head.

In a number of less developed regions, especially in central and eastern Europe, it could be assumed that strong economic growth is accompanied by significant land-use changes. This hypothesis is only partially true, because the growth process has been characterised so far by a shrinking of employment and by a territorial contraction/polarisation of activities in agglomerations. While the new service activities generally concentrate in the city centres, pressure on open spaces results only indirectly from economic development, as it is mainly caused by the suburbanisation of residential functions and by the development of transport infrastructure.

3.2.2. Part II: Quantitative appraisal of economic contraction/dispersal processes during the past decade

Economic growth (expressed in GDP) during the past decade has been much stronger in the less developed European countries and regions than in the most prosperous ones. While the EU-27 GDP increased annually by 2.3.% (in the average) between 1995 and 2004, the three Baltic States had the most impressive growth (Estonia: 6.8%; Latvia: 6.4% and Lithuania 6.0%) and most other new Member States were also above the EU-27 average (Hungary: 4.5%; Poland: 4.3%; Slovenia: 3.9%; Slovakia 3.8%; Cyprus 3.4%). Only the Czech Republic (2.2%), Bulgaria (1.6%) and Romania (1.9%) had growth rates below the EU-27 average. The four (former) cohesion countries had also growth rates above the EU-27 average, but with strong differences from country to country (Ireland: 7.6%; Spain: 3.7%; Greece: 3.8%; Portugal 2.6%). The growth rate of GDP in Ireland was almost three times as high as that of Portugal.

Figure 3.1 Growth of GDP and Employment



Source: Fourth cohesion Report of the European Commission 2007

Taking a more territorial approach reveals that in all of these countries, especially in the new Member States, a large part of the divergence in regional prosperity was a result of high concentration of economic activity and growth in and around the capital city. Moreover, even in the countries in which disparities remained much the same or where they narrowed, GDP per head in the capital city region grew faster than in other parts of the country. Between 1995 and 2004, all capital city regions, with the exception of Berlin, increased or at least maintained their share of national GDP. The increase was particularly marked in Warsaw, Prague, Budapest, Sofia and Bucharest. The relative growth of capital city regions is strongly related to their attraction as locations for business as well as for individuals. This tends to lead to unbalanced territorial development within countries unless there are other centres of economic activity, in particular other large cities or conurbations ð or even networks of smaller cities and towns to provide the same kind of attraction

The relative concentration of low income regions on low value-added activities is evident from comparing their division of value-added and employment between sectors with that in regions with higher levels of GDP per head. The generation of value-added in regions with GDP per head below 50% of the EU average, which are all situated in the new Member States, comes much more from agriculture and industry than in higher income regions and less from services, predominantly business and financial services and education and healthcare within public services.

Employment trends show a rather different pattern. Employment growth averaged just under 1% a year in the EU-27 over the period 1995ï2004. There was a marked difference, however, between the relatively high rate of increase up to 2001 and the absence of any growth at all in the two last years when GDP increased relatively little. Employment growth was particularly high throughout the period in Spain, (3.3% a year) and was also above the EU average in Italy ð one of the few countries in which employment growth was maintained after 2001 ð France and the UK. In Germany, on the other hand, growth was below average and employment fell significantly after 2001. In Portugal, employment rose by almost 2% a year up to 2001 but has hardly risen at all since then, reflecting the low rate of GDP growth. In Greece, employment increased by much less than the EU average up to 2001 (by only around 0.5% a year), but has risen at a much higher rate since 2002 (by almost 2% a year up to 2005). Most of the other countries, apart from the new Member States, experienced a relatively high rate of employment expansion between 1995 and 2001 ð over 2% a year in the Netherlands and Finland, 4% a year in Luxembourg and over 5% a year in Ireland ð and little increase or a reduction in the subsequent two years. Since 2003, employment has risen but by less than 1% a year in most cases.

The sectoral structure of EU employment reflects the continued shift towards a service economy and the ongoing decline in employment in agriculture and industry. Since 2000, total employment in the EU has increased by 8.5 million, mainly driven by strong net employment creation of almost 11.5 million in the service sector. The latter has more than made up for the employment contraction in industry (down 1.6 million) and agriculture (down 1.2 million) since 2000. Within industry, employment has contracted particularly strongly in manufacturing, where it has fallen by 2.2 million (or about 6% on 2000 levels), although this has been offset to a certain extent by the rise in employment of 0.8 million in the construction sector. Within services, where employment has expanded in all sub-sectors apart from financial intermediation, the main drivers of employment creation have been real estate, renting and business activities (up 3.5 million), health and social work (up 2.3 million) and education (up 1.3 million).

The physical translation of economic development is more realistic if economic development is expressed in employment change. Employment figures are however situated at the end of the economic chain. They express results more than causes and are therefore more volatile. Economic growth rates, on the opposite, may have no significant physical impacts in the short term, but they bear potential for the future. The physical impacts of growth rates in the longer range are more diversified and more indirect in nature than those of employment change. In this respect, the economic growth of metropolitan areas in the new Member States, although associated in the past decade with decline in employment, bears significant potential for land-use change in the near future. The contraction process observed at large scale will certainly be accompanied by a dispersal process at metropolitan/regional scale.

3.2.3. Demographic contraction/polarization and dispersal/depopulation processes during the past decade[5]

As opposed to the economic evolution which may rapidly and frequently fluctuate, the demographic evolution is generally characterized by long-range processes. Migration movements are however more volatile than natural demographic evolution, because they are frequently linked to economic and political factors. At local and regional level, the specific demographic characteristics (for instance the share of young or old people) may generate rather diverging evolutions in terms of densification or depopulation. Part I will concentrate on processes of change, while Part II will provide quantitative information on demographic trends at various scales during the past decade.

3.2.4. Part I: Main demographic processes which shaped the territorial evolution in Europe during the past decade

Compared with major global population trends at world scale, Europe is famously out of line with its natural population evolution declining, or at zero in the majority of European states. But as with other parts of the world, it is experiencing high levels of immigration. In nation state terms, the countries with the highest levels of population ageing are Italy (share of population over 65 in total population: 18.0%), Greece and Sweden (17.3%), Belgium and Spain (16.8%), Portugal (16.4%), Germany and Bulgaria (16.2 %) and France (16.0%), while those with youngest populations are Cyprus (11.6%), Slovakia (11.4%) and Ireland (11.2%). At territorial scale, European demographic developments are characterized by extremes; parts are very congested, others experiencing severe depopulation. On the whole the natural population movements are negative, but this is not generally the case in areas of high density. In such regions, on the whole large agglomerations, a combination of a high proportion of young people and immigrants have produced populations out-growing available jobs and services and out of synchronisation with the demographic situation across the rest of Europe.

Natural growth is slowing down throughout the Union. The significant reduction in fertility rates (the average number of children per woman declined from an average of 2.5 in the EU in 1965 to 1.5 in 1995), which underlies the slow-down in population growth, began in the 1960s in northern Europe and spread some 10 years later to the southern countries and some 20 years later to central and eastern countries. The same trends are, therefore, evident in all parts of the EU. Nevertheless, there are substantial differences between regions in both the direction and scale of population change.

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5 This section is mainly based on :
ESPON Study 3.2. "Long-term scenarios for territorial development in Europe" 2007.
Fourth cohesion Report of the European Commission. 2007.

Immigration from outside Europe is the major factor by which many national population levels are being maintained. While most countries in Europe have been a desirable destination, some countries are considered much more so (such as the UK and France) resulting in imbalances across the EU and high rates of illegal immigration. Nonetheless all EU countries with the exception of Latvia, Lithuania and Poland currently have a positive crude net migration rate. The share of population originating from external immigration is therefore not insignificant in Europe. The composition of the immigrant population according to nationality obviously varies in each destination country, being dependent upon: the migratory tradition within the country; the nature, scope and coverage of the networks established by previously established foreign communities; the employment opportunities offered at the destination; the geographical proximity between the country of origin and the destination country and certain determining factors such as historical and cultural links with former colonies and protectorates. Hence immigration to Portugal is sourced largely by Cape Verde, Angola, Guinea and Brazil, France by North and Sub-Saharan Africa, the Netherlands by Surinam and the Former Dutch West Indies. Recent developments in Central and Eastern Europe have given rise to new migratory waves, thereby increasing the in-take of immigrants from neighbouring states. Eastern European countries host large numbers of refugees and internally displaced persons, in particular from Armenia, Bosnia and Herzegovina, Croatia, Georgia and the Russian Federation. Many of the refugees and internally displaced persons have not been able to return to their countries or homes and face an uncertain future throughout the region.

In the five years 2000–2005, the Member States experiencing the largest net inward migration (i.e. immigration less emigration) were the three cohesion countries in the south of Europe, Spain, Greece and Portugal plus Italy, countries where immigration had previously been relatively low. In Spain migrants added over 8% to population over this period, while in the other countries, they added over 3%. Inflows were also relatively high in Cyprus as well as in Ireland, in both of which the shares of foreign-born residents was already relatively large (above 10%). By contrast, net migration into Germany, France and the UK, in which foreign-born population shares were also high, amounted to less than 2% of their population.

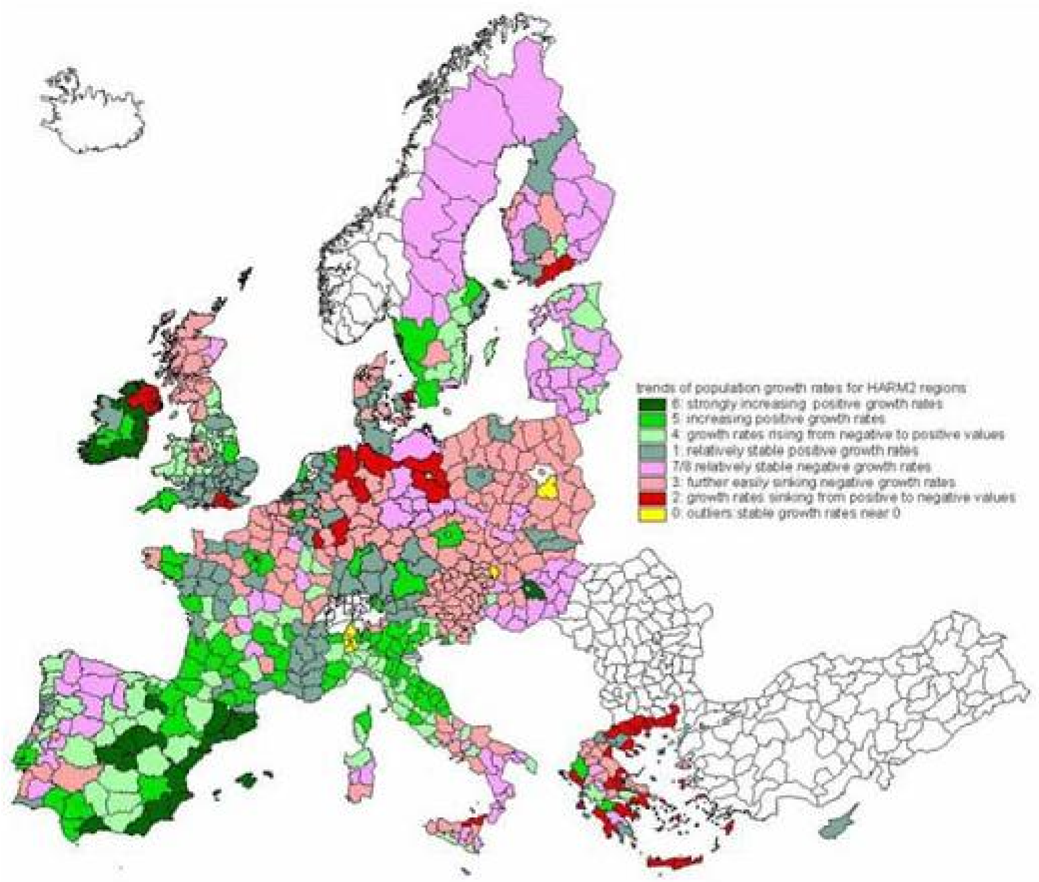
The significant variable when it comes to the location of a high proportion of foreign population is the urban–rural one. Most cities and notably most capital cities have a much higher proportion of foreign nationals, foreign-born and second and third generation immigrants than other towns or outlying rural areas. For instance in the Netherlands, 48% of the population of Amsterdam can be defined as immigrant, approximately half of these being defined as ethnic minorities, while in the Netherlands as a whole it is 8%. Obviously, countries with a colonial past, and capital cities with a history of migration, have a significantly higher proportion of foreign residents than those with neither. Thus the highest percentage of foreign citizens is maintained in countries such as Germany, France, the Netherlands and the UK and in cities such as Luxembourg (59.15%). There are marked increases in capital cities with a more recent history of immigration, such as Madrid (12.75%), Dublin (8.4%), Rome (6.6%) and Lisbon (6.27%). In capitals with a longer tradition of migration the percentage of children of immigrants (first, second and third-generation) is high, such as in Amsterdam (20%), Luxembourg (23.7%) or Berlin (18%) and the proportion of foreign or ethnic minority communities will increase significantly over the next 25 years due to the higher fertility rates of most in-coming groups. Even in countries without links with former colonies and no strong history of immigration the pattern is clear, thus in Vienna the percentage of foreign nationals is over 16% compared to the national average of approximately 9%.

3.2.5. Part II: Quantitative appraisal of demographic densification/depopulation processes during the past decade

The demographic evolution of EU-27 during the last decade (1995-2004), with an annual growth rate of 0.3%, has been rather modest. It is symptomatic that all countries of central and eastern Europe have lost population during that period (Bulgaria: -0.9% per year; Czech Republic: -0.1%; Estonia: -0.7%; Latvia: -0,8%; Lithuania: -0,6%; Hungary: -0,2%; Poland: -0,1%), while all ñoldò member countries had positive growth rates, as well as Cyprus and Malta. Only three countries had annual growth rates above 1% (Ireland: 1.3%; Cyprus: 1.4%; Luxemburg: 1.1%). In most West-European countries, the annual growth rate was comprised between 0% and 0.5% (Belgium, Denmark, Germany, Greece, France, Italy, Malta, Austria, Sweden, UK, Portugal), while Spain (0.9%) and the Netherlands (0.6%) had somewhat higher growth rates. A first characteristic of demographic evolution at Europe-wide scale is a general dispersal/depopulation trend in central and eastern Europe and a concentration trend in western Europe.

Within countries, the densification and dispersal/depopulation trends show different patterns. In western Europe, a number of capital regions had stronger growth rates than the national average. This was the case for the region of Brussels (0.6% against 0.3% per year), Madrid (1.5% against 0.9%), Athens (1.6% against 0.4%), Stockholm (0.9% against 0.2%), London (1% against 0.3%). A significant exception was Berlin (-0.3% against +0.1%). In addition to the capital regions, a number of other west-European regions have achieved demographic growth rates well above the national average (Walloon Brabant in Belgium, Bavaria and Baden-Wurttemberg in Germany, Central Macedonia in Greece, Catalonia, the region of Valencia, Murcia, Balearic and Canary Islands in Spain, Alsace, Pays de Loire, Brittany, Aquitaine, Midi-Pyrénées, Rhône-Alpes, Languedoc-Roussillon and Provence-Alpes-Côte dôAzur in France, Bolzano, Trento, Emilia Romagna, Marche in Italy, Utrecht in the Netherlands, Tirol and Vorarlberg in Austria, Algarve in Portugal, Lincolnshire in the UK). A number of West-European regions have been however characterised by a demographic evolution significantly below the national average (Bremen, Saarland in West-Germany, Thessaly in Greece, Asturias in Spain, Champagne-Ardenne in France, Molise, Basilicata, Calabria in Italy, Limburg in the Netherlands, Carinthia, Burgenland in Austria, Itä-Suomi in Finland, Norra Mellarsverige and Mellestra Noorland in Sweden, North-East and Merseyside in the UK). In various countries, clear densification and dispersal/depopulation patterns can be identified at meso-level. In Spain, for instance, the contrast is striking between the north-west regions which are subject to population decline and the Mediterranean south-eastern regions where population growth is strong. In France, the Atlantic and Mediterranean regions are subject to densification processes while a number of rural and old industrial regions in the centre and in the northern parts are characterised by depopulation. Densification processes in southern regions at the expense of the northern ones can also be observed in the Nordic countries. In Italy, the opposition is just the reverse. While various north-eastern regions had above-average demographic growth rates, most regions of the Mezzogiorno were in a process of depopulation.

Figure 3.2. European regions with a similar behaviour of population growth rates (long term trends)

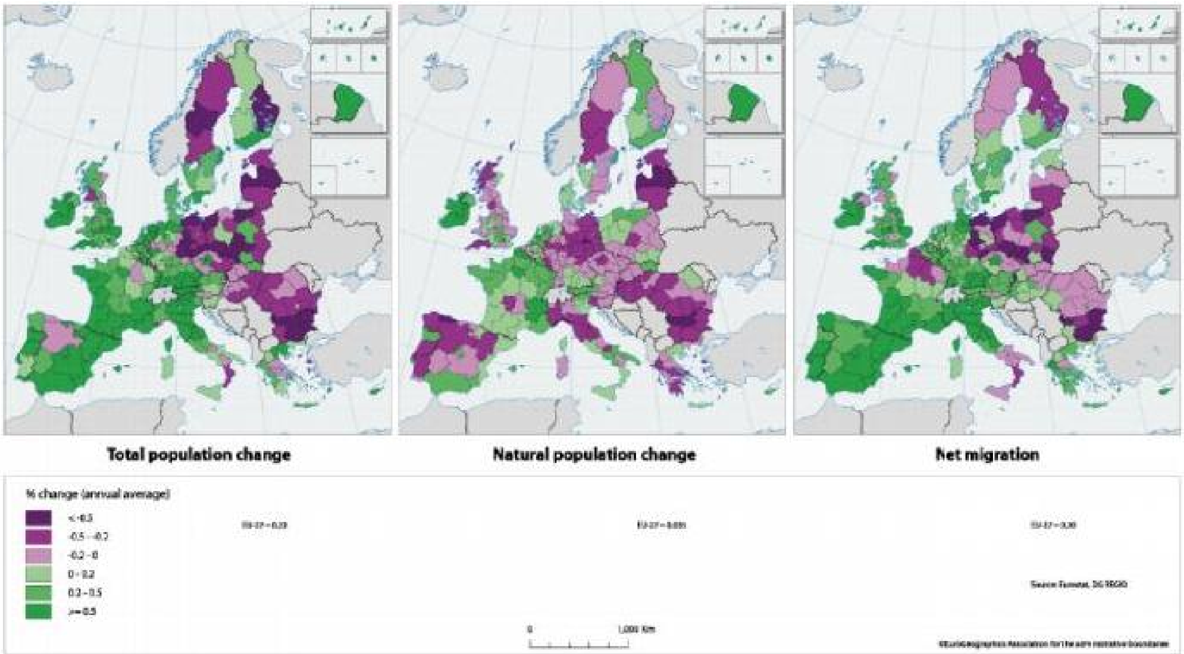


Source: Scenar 2020. Scenario study on agriculture and the rural world.
ECNC/LEI/ZALF/IfL/CEU. Study commissioned by DG Agri. 2006.

In central and eastern Europe, while the main trend is one of dispersal/depopulation, contrasts are to be found between regions with strong and weak decline. In East-Germany, demographic decline has been particularly strong in Sachsen-Anhalt, Sachsen, Thüringen and Mecklenburg-Vorpommern, while Brandenburg has somewhat benefitted from the de-concentration of Berlin. Regions with strong demographic decline were Severozapaden and Severen Tsentralen in Bulgaria, Kozep-Magyarrorszag in Hungary, Lodzkie, Slaskie, Swietokrzyskie, Dolnoslaskie and Opolskie in Poland, Vest in Romania. It is hardly possible to identify a clear pattern with regard to the intensity of dispersal/depopulation in central and eastern Europe. Generally, however, regions along the western borders and around the metropolitan areas have been less disfavoured by depopulation than the old industrial and remote rural regions.

More than 60% of all regions (covering 72% of EU population) experienced an increase in population over the period 2000–2004. In around half of these, the increase was due to both natural population growth and net inward migration. These regions include most of the regions which comprise the capital city and other higher income regions in Member States – in, for example, southern Germany, the North-East of Italy and in the South and East of Spain. They also include, however, most regions in France and a few less prosperous parts of the UK (Greater Manchester and East Wales) . In one in four regions (covering 26% of the EU population), natural population decline was more than outweighed by net inward migration. These regions include most regions in western Germany and the UK, northern and central Italy and Spain, Slovenia, central and southern Portugal and several regions in Greece. In a further 8% of regions, the reverse was the case, natural growth of population outweighing net outward migration. These are mainly in southern Italy, north and west of France and northern Finland. One in three regions experienced population decline; in the majority this was due to a combination of natural population reduction and net outward migration. These regions are mainly in the new Member States ð in Bulgaria, Romania, Poland, Latvia, Lithuania, and several parts of the Czech Republic, Hungary and Slovakia, but also in eastern Germany and northern Sweden.

Figure 3.3. Components of population change, 2000-2004



Source: Fourth Cohesion Report of the European Commission. 2007.

Over the period 2000ï 2004, just under half (119) of the NUTS 2 regions in the EU experienced natural growth of population. In 30 of these regions, growth was over 0.4% per year ð 11 in France, four in Spain, five in the Netherlands, four in the UK (inner, outer London, Berkshire, Buckinghamshire and Oxfordshire, and Northern Ireland), both regions in Ireland and one each in Belgium (Brussels), Sweden (Stockholm) and Austria as well as Cyprus. By contrast, the natural population decline was 0.2% a year or more in 71 regions spread across the EU, as result primarily of very low fertility rates. In 16 regions, the natural decline was over 0.4% a year ð in four regions in eastern Germany, three in Hungary, almost all the regions in Bulgaria and in Liguria in Italy, Asturias in Spain, Alentejo in Portugal and Latvia.

Migration has also been the main factor responsible for differential rates of population growth across EU regions. Some 77 NUTS 2 regions in all experienced net outward migration over the period 2000ï 2004, the highest rates (0.5% a year or more of population) being in eastern Germany, Poland and Bulgaria. Outþows were also significant (0.2% a year or more) in southern Italy, northern France, northern and eastern Finland and a few parts of the north of the UK (North-Eastern Scotland and Tees Valley & Durham). By contrast, 68 regions experienced net inward migration of over 0.5% a year over these four years and 34 regions, of over 0.8% a year. Eleven of these were in Spain, 7 in northern and central Italy, 5 in the UK and 4 in the south of France. They also include a number of island regions ð Cyprus, Malta, Canary Islands, Balearic Islands and Corsica. Economic factors in the form of differences in income levels and employment tend to be the main factors inducing people to move between regions. In Germany, all of the new Länder in the east have experienced a net outflow to the western Länder since the early 1990s, reflecting the substantial gap between the twin terms of income and employment levels. In Italy, migration still tends to be from the less prosperous south to the more prosperous north. In France, people have moved away from the old industrial regions in the North, such as Nord-Pas-de-Calais or Lorraine, to the south.

3.3. Transport functions and land-use development[6]

Among all economic functions, transport is one with major land-use and environmental implications. The relationships between transport and land-use developments are not completely uniform in Europe. Strong regional variations can be observed both in the amount of land used by transport functions and in the speed of land-use changes caused by transport functions. Regional variations are related to the level and speed of economic development, to the geographical situation as well as to the transport and territorial development policies which have been implemented. The continuous development of transport infrastructure has harmful impacts on open spaces. The analysis will concentrate in the first part on processes in the transport sector with significant land-use impacts and in the second part on the situation of transport infrastructure at territorial level (regional density of infrastructure endowment in the early 2000s).

3.3.1. Part I: Recent and on-going processes related to the transport sector with significant land-use impacts

The past decade saw not only a worrying increase in traffic congestion in urban areas, but also a new phenomenon of congestion of the major arteries of the trans-European network, increasing the number of bottlenecks. Missing links in the infrastructure, and a lack of inter-operability within specific transport modes and for intermodal transport systems, are all reasons aggravating this congestion of the network. All transport modes are affected: road transport, but also railway transport – the railways themselves estimate that, on the basis of existing technologies, 20% of the railway track is bottlenecked. In the new member countries, growing motorisation generates congestion on low-capacity, obsolete road networks. Also air traffic is increasingly affected by delays. In contrast, the peripheral regions still suffer from isolation due to a lack of connections with the centre of the continent, and also congestion on the central parts of the network. The peripheral countries of the European Union are thus directly affected by the deterioration of traffic conditions in transit countries. EU-enlargement and increasing integration accelerates this traffic growth, in particular for freight.
European transport suffers from an imbalance between transport modes, to the detriment of railways, more particularly in the rail freight transport, of maritime shipping and of inland waterways. While this reflects the fact that some modes have adapted better to the needs of a modern economy, it is also a sign that not all external costs have been included in the price of transport and certain social and safety regulations have not been respected, notably in road transport. In the present transport programmes of a number of member countries, motorways are consistently prioritised

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[6] This section is mainly based on :
ESPON Study 3.2. "Long-term scenarios for territorial development in Europe" 2007.
Fourth cohesion Report of the European Commission. 2007.
TERM Reports 2001, 2005, 2007. European Commission
ESPON in progress. Preliminary results by Autumn 2003.. Synthesis Report

over other types of linkages. The trend towards wider car ownership continues apace and EU statistics as a whole for this factor will show a marked increase in the coming years as the new Eastern European members see a significant rise in personal car ownership. Though oil price increases may have an impact here, it is likely that prices will have to rise to a truly phenomenal level to significantly impact this situation as the desire for the ófreedomô that car ownership potentially brings is basically inelastic in economic terms.

The overall modal investment shares have hardly changed since 1980, dominated in 1995 by road (62 %) and rail (28 %). Rail receives a larger share of total investment than its share of total demand, but this has not made rail flexible enough to meet new transport demands. These investment trends have been one reason for the length of the motorway network increasing by more than 70 % since 1980 while the length of conventional railway lines and inland waterways decreased by about 9 % (mainly due to the closing of unprofitable small lines). Half the additional length of motorways constructed between 1990 and 2004 in the EU, was built in Spain and Portugal. The high-speed rail infrastructure is gradually being extended in line with plans for the TEN: the length of high-speed track almost tripled between 1990 and 1999, to more than 2 700 km, and is expected to increase to 24 000 km (of new and upgraded existing lines) by 2010. However, high-speed rail will only be efficient if well linked to a quality regional network. High-speed rail can result in a shift in modal shares, in particular as regards short distance flights (there is evidence for this on the Paris-Lyon, Brussels-France and Madrid- Seville links), but can also induce extra travel. The shift from road traffic is more limited, as high-speed rail typically serves longer distances.

The change in the use of different modes of transport highlights the continuing predominance of road transport for freight, which now accounts for over 44% of the total, while the share carried by rail has remained unchanged at around 10%. Rail is significantly more important in the new Member States, its share exceeding 30% in the Baltic States and Slovakia, though it has declined rapidly since the early 1990s. As a consequence of the growth of traffic, the major transit routes across Europe have become increasingly congested, most notably in the Benelux countries and Germany, but also in Austria and the Czech Republic as well as in France along the Rhone valley and the Mediterranean coast.

Roads, along with sea transport, have, therefore, accounted for almost all the growth of freight over the past 10 years. This growth is closely correlated with growth of GDP, averaging some 2.8% a year over the period 1995 and 2004, somewhat more than the latter. Road haulage increased by 3.4% a year as against only 0.6% for freight by rail. Growth of freight by road was especially high in the Baltic States and Slovenia, where it reached 300% in Latvia between 2000 and 2004 as a result, in addition to their economic growth, of the transit routes which go through them (international freight accounts for around 75% of the total in these countries, or even more in the case of Lithuania). It was also high in Poland (101%), Spain (117%) and, above all, Ireland (212%), as a consequence of both high growth rates and road construction.

The growth of sea transport has also continued, principally as a result of the growth of container traffic and encouraged by investment in expanding capacity and in establishing inter-modal links. Growth has been especially significant in ports in the new Member States (in Gdansk, Riga, Tallinn and Constanta), goods traffic increasing by between 30% and 60% over the period 2000 to 2003. If it is to be sustained, however, it needs to be accompanied by investment in transport links with the surrounding area.

The use of river transport remains small except in Germany and the Netherlands and shows little sign of increasing. The Danube, which has considerable potential in this regard, is an exception, the volume of freight transported expanding since 2000, while still remaining small in Hungary, Bulgaria and Romania. This potential, however, requires substantial investment in port capacity and links with surrounding areas if it is to be realised, necessitating in turn close cross-border coordination and cooperation between the regional and national authorities concerned.

As regards air travel, the number of passengers continues to grow following the fall after the September 11 2001. The volume of air traffic is largest in the UK, reflecting the predominant position of Heathrow. It is next largest in Spain because of the scale of tourism, with over 30 million passengers a year flying into Palma de Mallorca and Malaga. The largest growth of traffic has occurred in secondary airports, reflecting their use by low-cost airlines, and in the capital cities of the new Member States, stimulated by enlargement.

Transport infrastructure, and in particular roads, takes up increasing amounts of rural and urban land. Land is under continuous pressure for new transport infrastructure. Road and rail infrastructure takes land mainly from agricultural use and to a lesser extent from built-up areas. Between 1990 and 1998, over 30 000 hectares (ha), about 10 ha every day, were taken for motorway construction in the EU. Urban road transport (parking space, roads, petrol stations, etc.) takes up increasing amounts of urban land. In several cities this is correlated with the spread of urban areas. Other modes are less land-intensive. For example, land take per passenger-km by rail is about 3.5 times lower than for passenger cars, and bicycles need 10 to 12 times less space than cars.

The expansion of transport infrastructure and intensification of its use jeopardises the future of many designated nature areas. Transport conflicts more and more with nature conservation. Some 1 650 special bird areas (SPAs) designated up to 1997, 66 % of the total number, have at least one major transport infrastructure within 5 km of their centres, as have 430 Ramsar sites (wetlands), 63 % of the total. The future of many sensitive rural areas, in particular in mountainous areas (such as the Alpine region), wetlands and coastal zones could be jeopardised by further expansion of the infrastructure and intensification of its use. The EU territory is becoming highly fragmented by transport infrastructure. The average size of contiguous land units that are not cut through by major transport infrastructure ranges from about 20 km^2 in Belgium to nearly 600 km^2 in Finland, with an EU average of about 130 km^2.

3.3.2. Part II: Territorial situation of transport infrastructure

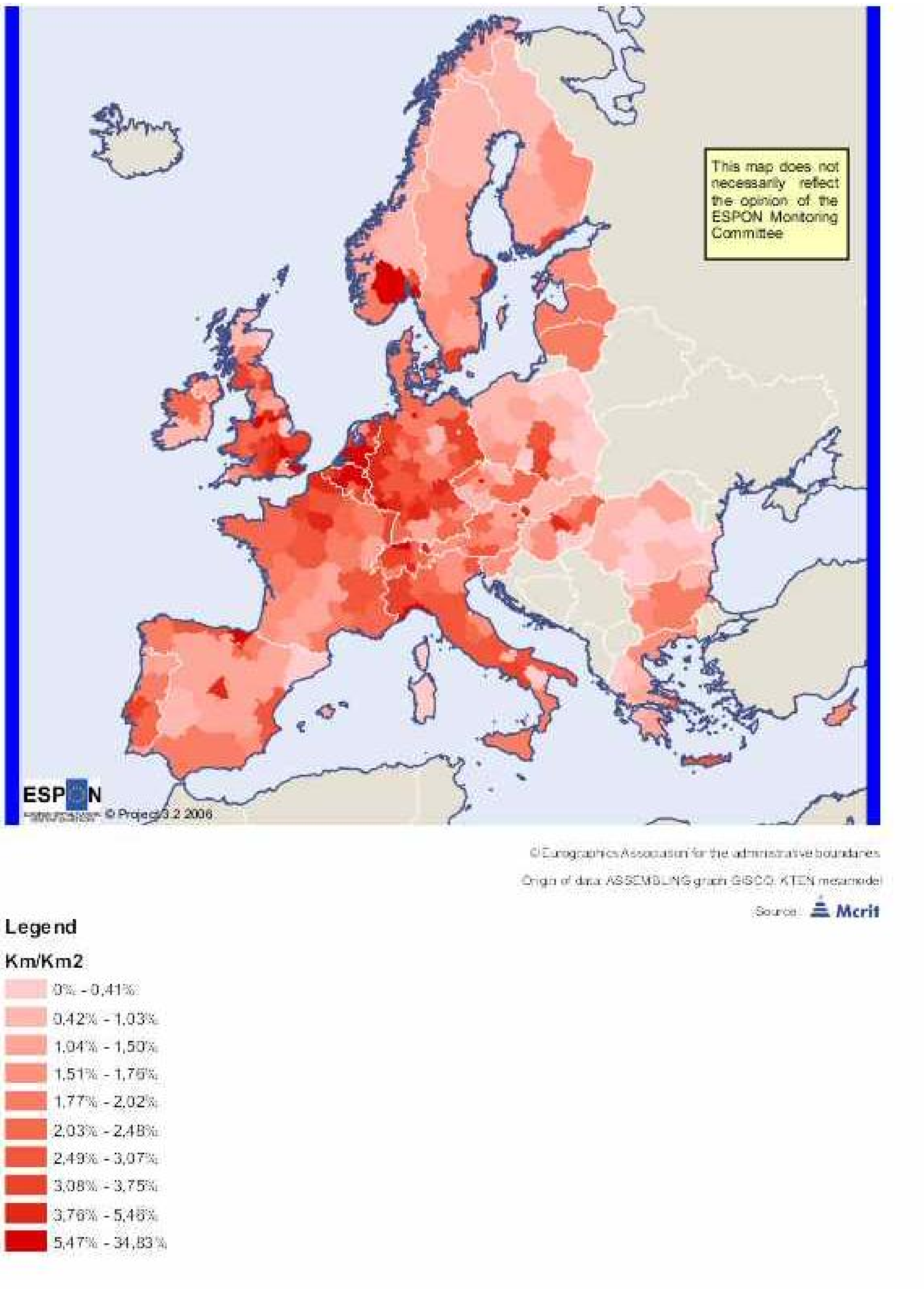
The relationship between infrastructure endowment and the territory can be appraised through the measurement of infrastructure density. With regard to the impacts of transport infrastructure on open spaces, infrastructure density seems to be the most relevant indicator, especially if it is associated to that of fragmentation level of open spaces. Information related to the evolution of infrastructure density over the past decade is not available at this stage. Information about the regional situation of infrastructure in the early 2000s is however useful to show the regional disparities and therefore the potential for catching up processes.

Infrastructure density may be appraised in relation to the surface of regions, to their population or to a combination of both. The analysis provided here is based only on the density in relation to the surface of regions, because this appears the most useful indicator with regard to the impact of transport infrastructure on open spaces.

Road density (Map Road density 2000 by MCRIT Barcelona)

Regions with high road density in the year 2000 (in km of main roads per km2) are mainly concentrated in the central parts of Europe (in the so-called pentagon London-Paris-Milan-Munich-Hamburg). A number of regions with high road density are also to be found in the European periphery, for instance in the coastal areas of the Iberian Peninsula as well as in the Madrid region, in central and southern Italy, in northern England, in the capital regions of the Nordic countries. In the EU-15, a good correlation seems to exist between the population density and the road density. The regions of western Europe with low road density are those of the Nordic countries (except the capital regions), those of central Spain (except the Madrid region), Ulster and southern Ireland, western Greece, northern Scotland, Corsica and Sardinia. In all countries of central and eastern Europe, the road density is much lower than in western Europe, especially than in the pentagon. Only few regions have high road densities. These are some of the capital regions (Warsaw, Bratislava, Budapest, Prague) and a few other regions (especially southern Poland). Thanks to EU support from structural policies, the road density is subject to rapid evolution in eligible regions. The pattern of road density increase observed in the Iberian Peninsula during the past two decades is likely to be reproduced in the new member countries of central and eastern Europe. As a working hypothesis, it can be assumed that the catching up process will be strong in regions with low road density but with high population density.

Figure 3.4. Road Density 2000

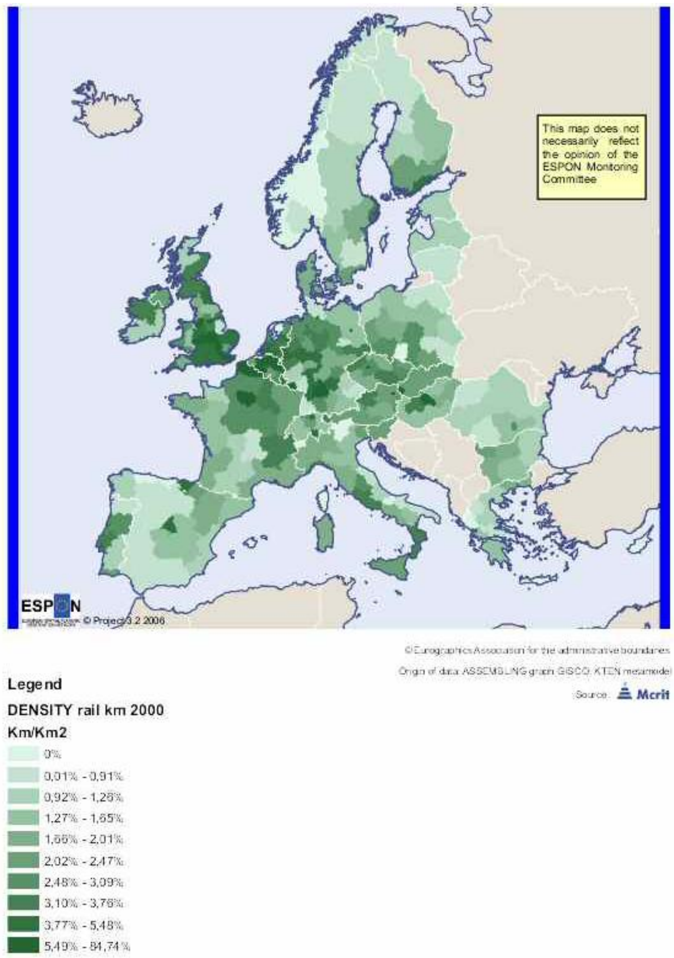


Source: MCRIT Barcelona

Rail density (Map Rail density 2000 by MCRIT Barcelona)

The territorial pattern of rail density throughout Europe is rather different from that of road density. The contrast between western Europe on the one hand and central and eastern Europe on the other hand, which exists in the field of road density, is much less obvious in the field of rail density. A number of regions of the Czech Republic, Slovakia, Poland, Hungary, Slovenia have relatively high rail densities, comparable to those of the west-European pentagon. Regions where rail densities are particularly low are the northern regions of the Nordic countries, the western regions of Spain, the French regions of the "Massif central", the southern regions of Ireland, the western regions of Greece, numerous regions of Romania, eastern Poland and Lithuania. The pattern of evolution of the railway infrastructure is rather different from that of the road infrastructure. In western Europe, the construction of new railways takes place only in the case of high-speed rail lines, which are almost all located in the pentagon and in Spain. In the new member countries of central and eastern Europe, investments in railways concern mainly the modernization of existing railway networks which are dense, but obsolete. In these countries, a substantial part of the network consists of single-track lines or is not electrified (only 11% of lines in Latvia and 7% in Lithuania as against an EU average of 50%). Severe speed restrictions are also in place in a number of countries because of the poor state of repair of the network.

Figure 3.5. Rail density 2000



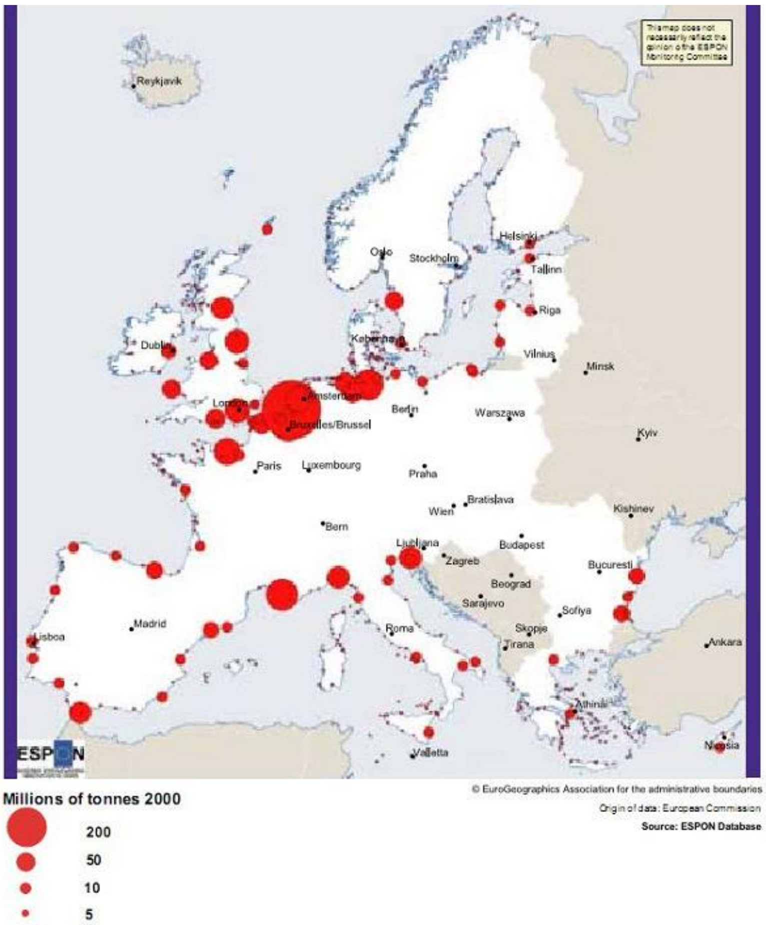
Source: MCRIT Barcelona

Commercial seaport infrastructure (Map : Commercial seaport infrastructure from ESPON)

Commercial seaports with more than 5 million tons turnover are rather well distributed throughout the various European seaboards. If one takes into account their size and turnover, the picture is exactly the reverse. There is an overwhelming concentration of very large ports in the Channel and North Sea area (Rotterdam, Antwerp, Amsterdam, Bremen, Hamburg, Le Havre) and only four of this category (Marseilles, Genoa, Trieste, Barcelona) in the northern Mediterranean. The Baltic Sea, the Atlantic coast, the rest of the Mediterranean and the western Black Sea only have medium-sized and small commercial ports.

The dynamics of commercial port infrastructure are driven by the growth of maritime traffic (globalization, EU enlargements), the strong development of container traffic, the increasing size of container ships and the strong competition between ports. Support from EU structural policies in eligible regions also contributes to their expansion. A significant trend is the comparatively stronger development of large seaports caused by the increasing size of container ships. Important investments are being made in the seaports of the new member countries, both along the Baltic Seaboard and the western Black Sea (especially Gdansk, Riga, Tallinn and Constanta).

Figure 3.6. Commercial seaport infrastructure



Source: ESPON in progress. Preliminary results by autumn 2003.

Commercial airports (Map: Commercial airports infrastructure from ESPON)

As in the case of commercial seaports, the spatial distribution of commercial airports throughout the territory of EU-27 is rather well balanced if their size is left out of consideration. Areas with relatively low airport density can be found in Spain (outside Madrid and the coastal regions), central France (outside Paris), Bulgaria and Romania (outside the capital regions). If airport traffic is considered, the picture is rather different, with a strong concentration of large and medium-sized airports in the Mediterranean regions, in particular where tourism is important. In the new member countries and Nordic countries, large airports are primarily those of the capital cities. The largest number of small airports (traffic below 500 000 passengers per year) is to be found in the Nordic countries and in the new member countries, outside the capital regions. In recent years, traffic growth has mainly taken place in second-rank airports thanks to the development of low-cost companies and in the capital cities of the new member countries. The development of regional airports brings with it road traffic growth, as most regional airports are not connected to public transport systems, and generally calls for capacity improvements of the road infrastructure leading to airports.

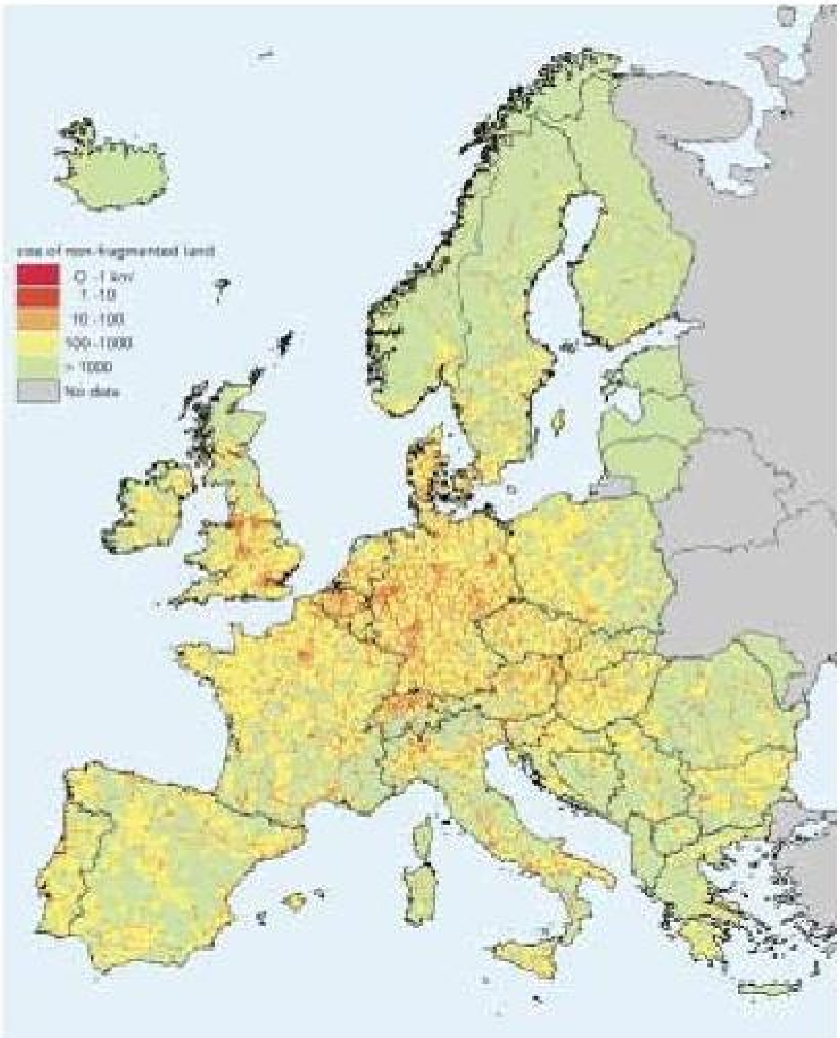
Figure 3.7. Commercial airports infrastructure

Source: ESPON in progess. Preliminary results by Autumn 2003.

Fragmentation of open spaces through transport infrastructure (Map: Partitioning of land by transport infrastructure, 1997 from TERM 2001)

The impacts of transport infrastructure on the fragmentation of open spaces are particularly strong in the regions of the pentagon. Highest fragmentation levels (1997) are to be found in the main urban regions as well as along major corridors connecting them. In the various European peripheries, the level of fragmentation of open spaces is generally lower, in particular outside main corridors. Regions with the lowest levels of fragmentation of open spaces through transport infrastructure are the Nordic countries, the Baltic States, Romania, central Spain (outside Madrid), large parts of southern France and northern Scotland. No information is available on the evolution of the fragmentation level during the past decade since 1997. It can be assumed that the fragmentation level has significantly increased in the Iberian Peninsula and that a similar process is starting in the new member states of central and eastern Europe.

Figure 3.8. Partitioning of land by transport infrastructure, 1997



Source: TERM 2001 Report. European Commission

3.4. The dynamics of urban systems[7]

The evolution of urban systems in Europe is conditioned by a wide variety of factors stretching from technological evolution to socio-cultural issues over accelerating globalisation. The impacts of such trends are not similar however in all countries and regions, because the national urban systems are not all at the same stage of the long-range urbanisation cycle which has crossed Europe for more than one and a half century, starting in England and reaching progressively the continent and, later on, the European peripheries. This cycle comprises various phases from urbanisation caused by rural-urban migration, maturation, de-urbanisation and urban sprawl, re-urbanisation combined with the widening of catchment areas of large agglomerations etc. It must be added to this that the countries of Central and Eastern Europe have been subject to a specific urbanisation process during the post-war period, related to the communist regimes and the planned economy. Urban Europe is therefore rather diversified, both in terms of morphological patterns, of evolution characteristics and of urban-rural relationships.

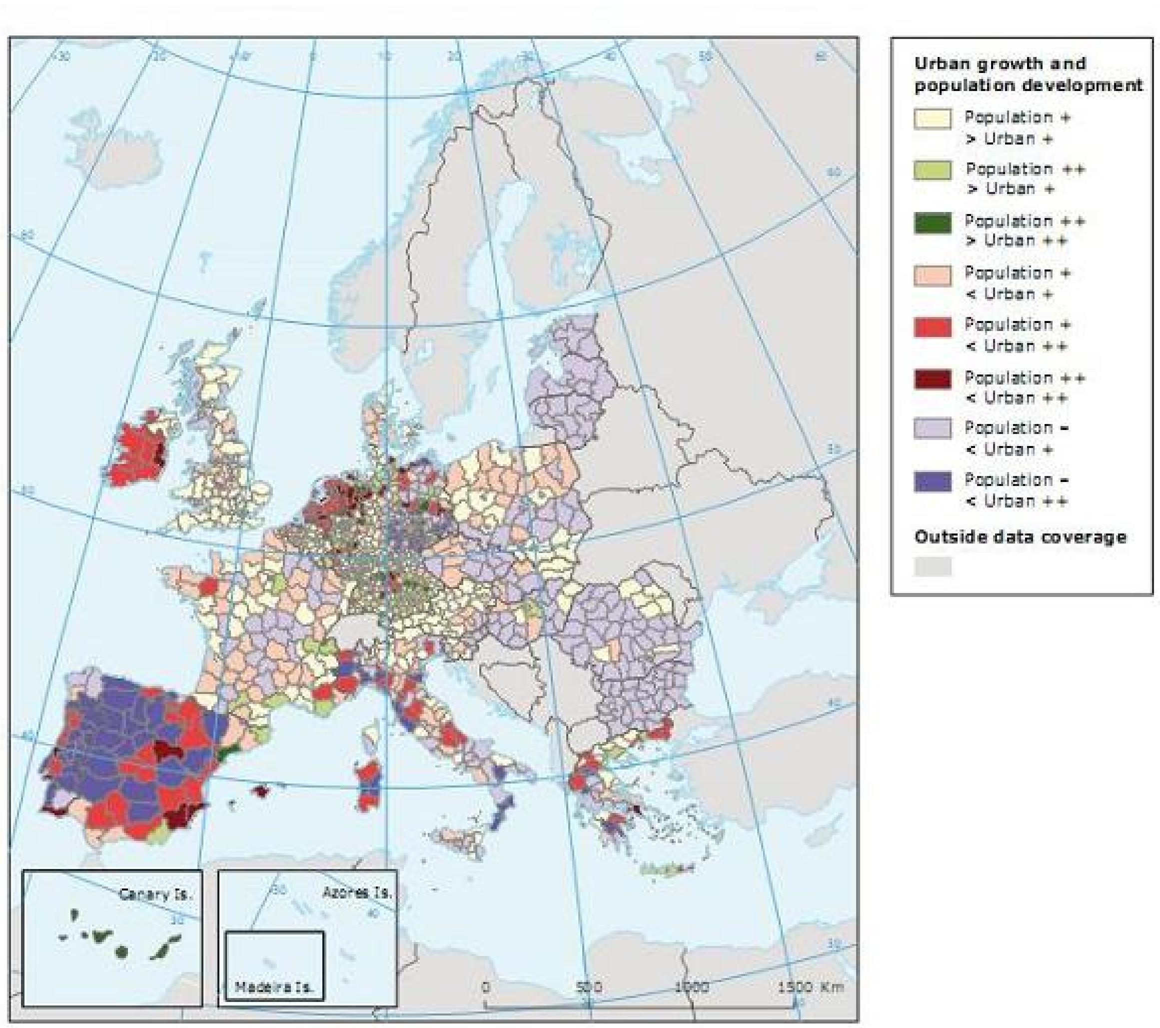
3.4.1 Dynamics at global European level

Considered at this level, the EU urban system constitutes the main motor of the core-periphery divide of the European space. The "core" corresponding to the pentagon (i.e. the area cornered by London, Paris, Milan, Munich and Hamburg) includes both the European Global Nodes (Paris, London) and the large majority of strong MEGAs (Metropolitan European Growth Areas) which hold highly developed RTD, financial and tertiary education activities, company headquarters etc. It also benefits from a stronger networking/complementarity among Functional Urban Areas facilitated by a high accessibility. In the present context of accelerating globalisation and growing external competition, of rapid technological development and of further European integration, the global European urban system is subject to both polarisation and dispersal forces. The pentagon, understood as the area comprising the leading European urban functions, tends to expand along major corridors in various directions: towards the East, as a consequence of the recent EU enlargement, especially along the corridors leading to Vienna/Bratislava/Budapest, Prague and southern Poland, Berlin and Warsaw, but also towards the north (Copenhagen and southern Sweden) and towards the south (Rhone valley and connection to the metropolitan areas of the "Latin Rim"). In England, the pentagon progresses towards the Midlands. The peripheries of the EU territory contain comparatively few MEGAs, unequally distributed over different macro-regions. The urban systems of the European peripheries are often characterised by a stronger hierarchy between cities and towns, according to their size and by much lower interactions and synergy within the urban system.

[7] This section is mainly based on :

- ESPON Study 3.2. "Long-term scenarios for territorial development in Europe" 2007.
- Fourth cohesion Report of the European Commission. 2007.
- ESPON in progress. Preliminary results by Autumn 2003.Synthesis Report
- State of European Cities. Adding value to the European Urban Audit. Study contracted by the European Commission. 2007.

Figure 3.9. Urban growth and population development in Europe (1990-2000)



Source: ñUrban sprawl in Europe ï the ignored challenge ». EEA Report N°10/2006

3.4.2. Dynamics at intermediate level

In most countries, the capital city region tends to dominate. In France and the UK, Paris and London account for around 30% of national GDP, while other cities account for no more than 3ï 4%. In France, GDP per head in the Lyon region is above the national average and closest to that of Paris, though this is not the case in Lille or Marseilles. In the UK, GDP per head in Birmingham, Manchester and Glasgow is not higher than the national average and growth has been slower than in London. In Poland, despite relatively large concentrations of population in Lódz, Kraków and Wrocĝaw, economic activity is heavily concentrated in the Warsaw region (which accounts for 16% of Polish GDP but only 7% of population) and growth between 1995 and 2004 was much higher than in these other cities. In the rest of the EU, though there are examples of GDP growing faster in large non-capital cities than in the country as a whole, their share of national GDP fell by 1 percentage point between 1995 and 2004. In most cases, GDP per head remains around or below the national average.

Only in Germany and Italy are there second-rank cities with GDP per head higher than in the capital.

Concentration of economic activity takes place therefore primarily in capital cities. In 2004, capital city regions produced on average 32% of the GDP in the country where they were situated, while they accounted for just 22% of population. All capital city regions with the exception of Berlin have a higher GDP per head than the national average and in fourteen it is between 40% and 100% higher. This is due to the relative concentration of economic activity in these regions and their higher productivity levels. On average, productivity levels in capital city regions were 25% higher than the national level; Berlin was the only capital with a productivity level below the national level. Capital city regions, therefore, tend to act as growth poles, attracting business investment from outside through the range of services and amenities they have to offer as well as the large market they represent. Between 1995 and 2004, capital city regions increased their economic position within the country; on average their share of national GDP increased by 9% while the population only increased by 2%. Only Berlin and Dublin saw their share of national GDP decline (by 10% and 3%, respectively).

In only three countries in Europe secondary growth poles seem to be effective in counterbalancing the economic power of the capital city. In Spain, the Barcelona region (deýned at NUTS 3 level) was responsible for generating 14% of Spanish GDP, while Madrid generated 18% with a similar population. Madrid, however, attracted a larger share of population growth and of economic growth than Barcelona. Barcelona saw its GDP per capita decline in relation to that of Madrid between 1995 and 2004. In Italy, Milan was responsible for 10% of national GDP, similar to Rome. Naples in the south, however, accounts for a much smaller share of GDP with little sign of the gap being closed de-spite the slightly faster growth in recent years in the southern regions than in the northern ones. In Germany, there are multiple growth poles, the four largest city regions together with Berlin each accounting for around 5% of national GDP and three out of four (Munich, Frankfurt am Main and Hamburg) grew faster than Berlin over the period.

In the context of accelerating globalisation and of enterprisesô relocation towards countries with low-wages and booming markets (Asia in particular), medium-sized towns are generally more affected than metropolitan areas, both in Eastern and Western Europe. It should not be concluded, however, that only regions with very large cities are prone to growth. In present European society, the residential and tourist economy plays an ever increasing part and favours a number of rural regions, provided they are attractive and easily accessible. The increasing number of retirees is strengthening the residential economy of numerous regions in Europe. European integration is also an important factor for the development of urban systems at the intermediate scale. Networks and clusters of cities are emerging in various transnational areas such as the Baltic Sea Region or the so-called Triangle[8] of Central and Eastern Europe. The new TEN-T as well as the EU support mainly through the INTERREG programs (though this support remains limited) also enhances the potential for empowering Transnational Urban Systems in the meso-regions of the EU periphery.

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8 The recent enlargement undoubtedly enhanced the development potential of the ñTriangleò in Central Europe which covers the transnational territory between Warsaw in the east; Poznan (and possibly Berlin) in the west; and Krakow, Saxony (Dresden), Prague, Bratislava, Vienna and Budapest in the south.

3.4.3. Dynamics at local/regional level

A significant diversity of factors generates important and sometimes contradictory dynamics in urban systems considered at the local/regional scale. Despite general population ageing and decelerating population growth in Europe, large cities, especially the metropolitan areas, are still subject to population growth. This is not only a consequence of the changing structure of the European economy with its stronger emphasis on services and high-tech and R&D activities, but also of internal and international migrations. The population of large cities remains generally younger than the respective national averages and continues to grow, while numerous retirees move towards rural areas. Further suburbanisation and sprawl can be observed in and around many European metropolitan areas.

Two-thirds of cities in the EU experienced growth of population over the 5 years 1996ï 2001, while the remaining third experienced a decline. There was a major trend towards suburbanisation. In 90% of urban agglomerations, population in the suburbs grew more than in the core city. In only a few cases ð such as Lefkosia, Copenhagen, Brussels, London and Ljubljana ð did population in the core expand more than in the suburbs and in a significant number, population in the core declined despite growing overall. Moreover, even where population declined overall, there were only a small minority of cities where there was also suburban decline. This, however, was the case in many second-tier cities where heavy industry is, or used to be, located (such as Glasgow, Newcastle, Manchester, Liverpool, Shefýeld, Birmingham in the UK, Bremen in Germany, ĞódŦ, Katowice, Bydgoszcz in Poland, Ostrava in the Czech Republic, Miskolc in Hungary, Liepaja in Latvia, Maribor in Slovenia, and BrŁila, Sibiu, CŁlŁraкi, Giurgiu and Alba Iulia in Romania). Relative decline of population in the core coupled with growth in the suburbs was particularly marked in Dublin, Lisbon, Berlin, Munich, Vienna, Rome, Athens, Prague, Bratislava, Budapest and Warsaw.

There is evidence that population growth in the suburbs is being accompanied by the suburbanisation of economic activity. In 16 of the 20 cities in which GDP can be measured at NUTS 3 level in the core and suburban areas, the share generated in the latter increased between 1995 and 2003, in some cases, substantially, especially in the new Member States (in Budapest, Prague, Soýa and Warsaw), though also in Munich.
Population growth around second tier cities with population loss in the centres is evident in most cases in Austria, Poland, Slovakia and Italy. This was also the case in cities in eastern Germany, while in the western part, suburban population growth was associated with either little change in the centre or some increase. Suburbanisation and the growth in economic activity means increasing pressure on the environment often accompanied by decline in the centre, with shops and other businesses closing down. This calls for effective management of land-use and public transport as well inner-city renewal to slow down or even reverse the trend.

Mobility at regional scale is an important characteristic of modern society, comprising commuter flows related to home-work journeys, but also to education, culture and leisure activities. Mobility has generally increased and has become more diversified in nature and in time. Increasing motorisation generates larger flows of car traffic, in particular in the countries of Central and Eastern Europe where a clear catching up process is taking place. In western cities, the development and modernisation of public transport cannot completely compensate for the growing demand in mobility. Increasing car traffic and related emissions is also therefore an important issue. ICTs are playing an ever increasing part in the provision of public and private services (e-commerce, e-administration etc.) and in home-working. There is however so far no clear evidence that ICTs have positively contributed to curb physical mobility. The strong and sustained increase of energy prices (oil and gas) is already having impacts on urban settlements at the local/regional scale. Stronger use of public transport and increased car-sharing can be observed. The need to shorten commuting distances through different choices in residential location can also be perceived. Much stronger impacts can be expected in this field in years to come, with a general evolution towards more compact cities or settlements and better integrated urban functions, even if driving forces towards suburbanisation are not eliminated.

According to the Urban Audit (European Commission) European cities are becoming more international and cosmopolitan. While 84% of the cities have experienced a decline in the proportion of national citizens between 1981 and 1996, the average proportion of people of foreign citizenship - and especially non-EU nationals - increased from 4,6% to 6,6% in the same period. This is a trend characterising all European cities of today. According to the findings of this survey the attraction of cities as settings for migrants and ethnic minorities can also be explained by factors such as the extended supply of services available in the cities and access to housing. Furthermore, to a higher degree than smaller cities and towns, larger cities enable migrants and ethnic minorities to live close to family and kin, which can be an important point of departure for integration in everyday life. In that sense, cities and larger urban areas constitute a kind of safety net for migrant and ethnic minority groups.
A growing issue in a number of European cities is that of the economic, socio-cultural and educational integration of population groups (in particular the young) and often originating from immigration. Although the origin of the problems is often economic in nature (very high unemployment rates caused by lower educational level and greater difficulties of integration in the labour market), the impacts are being felt more widely in the socio-cultural sphere with the strengthening of ethnic or religious communities and trends towards radicalisation. The social divide in cities is growing; cities become more fragmented and various forms of segregation are progressing. This issue can be considered as a very serious one with strong impacts in the years to come.

In 75% of the Urban Audit cities, employment rates are lower than in the country as a whole, reflecting the fact that many of those working there commute from outside while many residents especially those with low levels of education do not have jobs. A significant proportion of the people concerned are foreign-born, migrants and ethnic minorities in general tending to concentrate in inner city areas in many parts of the EU. In addition, the evidence indicates that even those migrants with higher levels of education have more difficulty in finding employment than the rest of the population.

Low employment rates in inner city areas are reflected in high rates of unemployment. In many cities across the EU, not only are unemployment rates high but there are huge disparities in rates. Disparities are particularly large in France, Belgium and Southern Italy, in cities like Marseille or Catania, as well as elsewhere, such as in Pecs, in Hungary, where the highest unemployment rate (55.6%) in 2005 was nearly 10 times the lowest (6.2%), Koģice in Slovakia, Derry in the UK or Malmö in Sweden. In some cities, the highest concentrations of unemployment are in central areas, such as East London, while in others, they are in the outskirts, for example in large housing estates built 20 or 30 years ago or more. In these areas, there is not only high unemployment but other aspects of deprivation, such as low quality housing and inadequate public transport and other services as well as low income levels and high crime rates. High concentrations of unemployment in particular areas, however, are not limited to large cities but can also be found in smaller cities of under 250,000 people.

Summing up, while economic polarisation takes place mainly in and around large cities, demographic dispersal can be observed around an even larger number of cities, comprising also medium-sized towns. Various factors are contributing to this important trend: the deterioration of the quality of life in inner-city areas as well as in large, dense suburban housing estates, the growing concentration of low-income groups in cities, generating social segregation and feelings of insecurity, increasing housing prices in cities, growing motorisation, especially in the new member countries etc. The dispersal trends around cities are generally not spatially uniform and favour corridors along main transport infrastructure. They result however in significant pressure on open spaces.

3.5. The dynamics of rural Europe[9]

3.5.1. Characteristics of rural Europe

Rural regions are generally identified according to the typology of OECD[10] which makes a distinction between three categories of areas: predominantly rural regions, significantly rural (intermediate) regions and predominantly urban regions.

In the EU-27, rural areas (predominantly rural and intermediate regions) represent 91% of the territory and 56% of the population. The corresponding shares for predominantly rural areas are 53% of the territory and 19% of the population. Rural areas are therefore particularly important in terms of territory. Among the Member States, the importance of rural areas varies from the more "Urban" ones (BE, NL, MT) to the more "Rural" ones (IE, FI, SI) along a continuum where Intermediate Regions can play a major role (BG, CZ, EE, CY, LT, LU, SK).

In most rural areas, a first characteristic is the low level of concentration of the population: at EU-27 level, population density varies from 40 inhabitants/km² in predominantly rural areas to 558 inhabitants/km² in predominantly urban areas. This range is of course even larger when looking at national or regional levels. At EU-27 level, the age structure of the population does not vary significantly between different types of areas, even if the proportion of old people (65 years old and more) is often slightly higher in predominantly rural areas. It seems that age structure is more influenced by differences in demography between Member States. For instance, in rural areas, there is generally a larger proportion of old people in EU-15 whereas there are relatively more young people (less than 15 years old) in the New Member States. In the New Member States, the share of population between 15 and 64 years old is also significantly higher in urban areas.

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[9] This section is mainly based on :
ESPON Study 3.2. "Long-term scenarios for territorial development in Europe" 2007.
Fourth cohesion Report of the European Commission. 2007.
Rural Development Report of the European Commission. 2007.
Scenar 2020. Scenario study on agriculture and the rural world. ECNC/LEI/ZALF/IfL/CEU. Study commissioned by DG Agri. 2006.

[10] At local community level (LAU2), the OECD defines rural areas as communities with a population density below 150 people per square kilometre. At regional level (mainly NUTS 3), the OECD distinguishes larger functional or administrative units by their degree of rurality, defined in terms of the share of population living in rural communities. Regions are then grouped into three types:

- predominantly rural regions: over 50% of the population living in rural communities;
- significantly rural regions: 15 to 50% of the population living in rural communities;
- predominantly urban regions: less than 15% of the population living in rural communities.

At EU-27 level, the income per habitant is 25% to 30% lower in rural areas and generally increases with a higher urban character. In the New Member States where the general level of income is about half of the EU-27 average, the gap between predominantly rural areas and predominantly urban areas is accentuated. Even if economic activity tends to be concentrated in more urban areas, rural areas nevertheless generate 43% of the Gross Value Added (GVA) in EU-27 and provide 55% of the employment, these shares being larger in the new Member States. The primary sector (agriculture, hunting and forestry) is no more the economic driver of numerous rural areas, but still represents 13% of the employment and 5% of the value added in rural areas of EU-27. This situation is more marked in the New Member States, with the corresponding shares standing at 20% and 7% respectively. With around 14 million persons employed in 2004 in EU-27, the primary sector represented an important part of the EU economy in terms of employment: 6.4% for EU-27, ranging from less than 1% in United-Kingdom to 33% in Romania).

Agriculture and forestry represent 78% of land use in the EU-25, ranging from 50% in Malta to 95% in Poland. In the Mediterranean countries, the British Islands and Scandinavia, natural areas also cover a large part of the territory. Artificial areas represent a significant part of the territory only in Malta, Belgium and The Netherlands. Agriculture and forestry therefore play a major role for the environment and landscapes in Europe. In 2005, agriculture utilised 172 mio ha in EU-27 of which 61% were dedicated to arable crops, 33% to permanent pastures and 6% to permanent crops. As the distribution depends mainly on natural conditions, there are major variations between (and generally within) Member States. Typical examples are the importance of permanent crops (vineyards, olive trees) in dry areas of Mediterranean countries (e.g. EL, CY, IT, PT, ES) or the major share of permanent pastures in mountain or rainy areas (e.g. IE, UK, SI, AT, LU, NL). A considerable part of the agriculture area is located in regions where conditions are difficult for this activity, for instance in mountains. Extensive farming covers at least 8.5% of area for arable crops and 21% of area for grazing animals in EU-27. It is estimated that high nature value farming systems cover more than 10% of agricultural area in most Member States (even more than 30% in some of them). In the EU-27 the forest available for wood supply covers around 126 mio ha. Whereas it represents 73% of the total forest area for EU-27, the share of productive forest is much lower in Mediterranean countries.

There were 14.5 mio farms in EU-27 in 2005, with an average size of 12 hectares, varying from 1 hectare in Malta to 84 hectares in Czech Republic. In general, farm sizes are higher than the average in EU-15 (with the exception of EL, IT and PT) and lower in the New Member States (with the exception of CZ, EE and SK). Variations in structure among regions of the same Member State are in general much lower in New Member States (with the exception of CZ and HU) than in old ones, with the largest differences observed in Germany (from 13 ha in Hamburg to 266 ha in Dessau). Variations between Member States and regions are even greater when measuring the economic size of farms: on average, the economic size of farms in the New Member States is ten times lower than in EU-15 (the Czech Republic is the only New Member State above the EU-27 average economic size that stands at 10.5 Economic Size Units). The total labour force in agriculture represents around 12.7 mio annual work units for EU-27. The basic feature of agriculture in the EU is family farming with 1 to 1.5 full-time jobs, though there are significant variations between Member States. In southern countries of EU-15 and in most New Member States, there are many holdings with less than 1 full-time job (the minimum being 0.4 in Malta). On the other extreme, in some regions, agriculture production is based on very large agricultural holdings organised in legal entities and mainly based on non-family labour force. It is clearly the case in the Czech Republic but also in Eastern Germany, in French "Ile de France" and in Dutch "Holland", for instance. Very small farms that could be considered as based on semi-subsistence activities are very important in some Member States, particularly in the New Member States. In several of these, half of the farms have a potential gross value added per year of less than 1 200 euros (i.e. with an economic size of less than 1 European Size Unit). This is confirmed by the information available on the importance of production self-consumed by the family members. In 2007, there were around 6.4 mio holdings (44% of EU-27) in which more than 50% of the production was self-consumed. These farms covered 12 mio hectares (23% of EU-27) and used 3.8 mio annual work units (52% of EU-27). Around half of this phenomenon takes place in Romania, but is also predominant in the agricultural sector of Bulgaria, Estonia, Latvia, Hungary, Slovenia and Slovakia, and is also significant in the other New Member States. In 2005, only 20% of farmers in the EU-27 had a basic or full training in agriculture, ranging from less than 1% in Malta to 71% in The Netherlands.

The labour productivity of farming differs considerably across the EU, particularly between the old and the new Member States. On average, for the period 2003-2005, labour productivity in the EU-15 was around 90% higher than the EU-27 level, whereas it was five times lower in the new Member States. Exceptions are Malta and Cyprus with labour productivity above EU average. The highest labour productivity is observed in Denmark and The Netherlands (more than 3 times the EU-27 average) and the lowest in Latvia, Bulgaria and Poland (less than 5 times the EU-27 average). However, over the last years (between 1999-2001 and 2003-2005), labour productivity increased more rapidly in the New Member States than in EU-15. Average annual change rate in the new Member States varies between 5.5% and 17.7% and in the old Member States between - 3.6% and 9.3%.

Around 60% of the forest belongs to private owners, this part being in general lower in the new Member States. In most Member States, the average size of the forest owned by private owners is low (for instance lower than the average farm size). Forest productivity varies significantly among Member States, from 1 m^3/year/ha in Cyprus to 8.8 in Germany (4.9 for EU-27). Due to the relatively low importance of the forestry sector, the economic information is very limited in many Member States.

At EU-27 level there is approximately 1 farmer of less than 35 years old for 8 farmers of more than 55 years. In some Member States (Portugal, Italy, United-Kingdom), the proportion of "young" farmers is very low (less than 1 "young" farmer for every 20 "older" farmers) whereas in some others (Poland, Germany, Austria) there is more than 1 "young" farmer for every 3 "older" farmers.

Rural areas where agriculture dominates can be divided into two subcategories: areas with a highly productive agriculture and in which the processing industry plays an important role, which have a high or moderate socio-economic viability, and areas with low productivity in which agriculture is traditional and which have a low socio-economic viability. In the first category, intensive large-scale agriculture generally puts the environment under high pressure, while in the second category, the environment is under lower pressure. Another category of rural areas can also be identified, which are highly dependent on agricultural activities but where additional activities, like service for out-door recreation and manufacturing generate additional incomes. Socio-economic viability here is moderate: in some areas agriculture survives; in other areas the economic structure becomes more diversified. Landscape elements are developed to some extent in these areas. A number of these areas are attractive for the location of retirees and so develop a residential economy. Rural areas with low accessibility, e.g. mountain and peripheral areas are characterised by large natural landscapes and/or small cultural landscapes dominated by marginalised agriculture. The out-migration of young people results in the ageing of the population. Many such areas loose the critical mass which is necessary for the maintenance of services.

3.5.2. Dynamics of rural regions. Part I: Main processes in rural regions over the past decade

In most Member States, population density did not evolve significantly in rural areas between 1995 and 2004. On the contrary, important changes occurred in the urban areas of some Member States such as increases of more than 100 inhabitants/km² in Ireland and Poland and decreases of more than 100 inhabitants/km² in Latvia, Hungary and Romania. Rural out-migration is not everywhere a dominant trend; on the contrary, it is a fact that urban regions are losing population in many countries, and the migratory balance is positive not only in predominantly rural regions but even in significantly rural ones. Among the three OECD categories of region, the highest population growth is in intermediate rural areas (0.34%) as a result of the extent of migration þows (adding 1.4% a year to population). While young people are moving to urban areas to work or to university, people who are slightly older are moving to more rural areas to live and sometimes to work. In several parts of France and the UK, this has led to the revival of more remote rural areas as well as those closer to cities.It is however true that the situation is complex, nevertheless, for the southern and eastern parts of Europe have experienced, and are likely to continue to experience, relatively high levels of population decline. Significant outward migration from rural areas is still the prevailing trend in large parts of the EU, with damaging effects on their prospects for economic development. This is the case in rural areas in the South of Italy, the North of Finland, Sweden and Scotland, eastern Germany and in the eastern parts of Poland and others new Member States). The lack of suitable jobs and lower living standards drive people, especially the young and better-educated to move elsewhere. This has cumulative effects on the areas concerned, leaving them with an ageing population, shrinking basic services and even fewer employment possibilities. Whereas the relative income per inhabitant in rural areas of the EU remained globally unchanged between "1996"and "2003", it has particularly deteriorated in rural areas of New Member States (the relative position falling from 63% to 50% of the EU average).

Rural areas are diversifying more and more. Rural areas in urbanized regions situated on the periphery of important agglomerations (especially in the pentagon) and near large cities often benefit from the presence and development of residential areas, industrial estates, and recreational amenities. They are affected by intense socio-economic dynamics in terms of population density and urbanisation. This reinforces the scattering of settlements and the pressure on land-use. Many coastal areas have a well developed tourist industry and can be characterized as rural areas attractive for tourism. The same is true for mountain areas. The tourist industry contributes to a high economic viability and to the in-migration of many young people from surrounding areas. A more complex pattern of development has been emerging. Many intermediate rural areas are characterised by industrial restructuring (or the need for it), high unemployment and population and economic decline, while there are examples of predominantly rural area with growth in almost every respect ð population, employment and GDP ð including some of the more remote areas. Marginalisation of a number of rural areas is however more than just one problem. It is a combination of employment potential in all sectors, specific to each region, in a context where the employment rate in both agriculture and industry is declining throughout Europe; there are also very strong migratory currents, with out-migration affecting all of the three OECD regional types, with some zones in a critical population situation (especially along the eastern border of the EU).

An increasingly important feature of agriculture as an industry is that the production of agricultural commodities on family farms takes place in units that are operated by people who also engage in other activities (part-time farming). This differs among Member States from 40% in Belgium, Ireland, Luxembourg and the Netherlands to about 80% in Greece, Spain, Italy and Portugal.

3.5.3. Dynamics of rural regions. Part II: Quantitative appraisal of rural dynamics.

Demography

According to the SCENAR 2020 Study[11], the pattern of demographic evolution from 1990 to 2003 for the three OECD types of regions[12] has been the following:

Table 3.1. Total population development in % per 5-year-period

Scenar Regions (HARM2)	1990-1994	1995-1999	2000-2003
All regions	1.02	0.27	0.69
Most rural	0.61	0.24	0.55
Intermediate rural	2.10	1.19	2.00
Most urban	1.41	0.14	1.10
BG, RO	-2.08	-2.18	-3.98

The period 1995-99 was in general less favourable to the demographic development of rural regions than the two other periods in the EU-25. In Bulgaria and Romania, population decline has continuously increased. Since 2000, the intermediate rural regions had the strongest rate of population increase. The downward trend in natural reproduction continues. Since 2000 the negative rate of reproduction is not only registered in the most rural but also in the intermediate rural and in the total of all regions. Only the most urban regions show a small surplus. On widening the perspective from annual to 5-year steps, one has to state that the birth-death-ratio is constantly sinking towards 1.0 in all types of regions, while in the most rural regions it had sunk below 1.0 before 1990, i.e. there is a natural decline as the number of deaths exceeds the number of births. The small population growth must mainly be the result of a surplus in migration. After a relatively stable phase between 1993 and 1999 the migration pattern changed noticeably . There is a steady increase in the absolute average numbers of migrations in intermediate rural areas whereas in predominantly rural and urban areas the average of net migration per annum regresses since 2003. As intermediate rural regions profit most from migration, one can conclude that sub-urbanisation and counter-urbanisation are still very strong drivers for population development in rural regions.

[11] Scenar 2020. Scenario study on agriculture and the rural world. ECNC/LEI/ZALF/IfL/CEU. Study commissioned by DG Agri. 2006.

[12] In the Scenar 2020 Study, slight modifications of the OECD typology were made in order to reach a better harmonisation of data (HARM2)

Economy:

The importance of the primary sector in EU-27 is declining. Between 2000 and 2004, its share diminished by 1.4 percentage points in terms of employment and by 0.2 percentage points in terms of value-added. The number of jobs decreased by 2.7 mio persons or 4.5% per year, ranging from 10.7% in Poland to 2.7% in Malta. However, the value-added increased by 11.8 bio euros corresponding to an increase in volume (at constant prices) of 1.45% per year, ranging from -5.8% in Luxemburg to +12.7% in Hungary.

Although only 23% of predominantly rural areas have GDP per head above the EU average, growth of GDP over the period 1995–2004 exceeded the average in 43% of them as against 36% of urban and 39% of intermediate regions. Rural areas, therefore, cannot automatically be associated with decline or intermediate areas with expansion. Between 2000 and 2005, employment in agriculture in the EU-25 declined from 5.7% to 4.9%, though it remains high in a number of Member States (Romania, 32%, Poland over 17%, Lithuania 14% and Latvia, Greece and Portugal, around 12%).

The diversification of the economy of rural areas to other sectors than agriculture is progressing:

- 36% of European farmers had another gainful activity than agriculture in 2005, this percentage being even higher than 50% in many countries and regions (particularly in Slovenia, Sweden, Cyprus, Malta, Denmark and Germany);
- 86% of employment and 95% of value added in predominantly rural areas of EU-27 came from the non-agricultural sectors, resulting from respective average annual increases of around 0.9% and 2.2% per year between 2000 and 2004.

One of the key opportunities in terms of potential growth for rural areas comes from tourism. With nearly three quarters of bed places in EU-27 in rural areas, this sector already plays a major role in most of them. Due to their rural amenities, rural areas are attractive as a place to live, even if remoteness and peripherality remain a major problem in some of them. However, some aspects of quality of life need to be improved in many rural areas. For instance, broadband internet infrastructure and take-up by population are significantly lower than in urban areas.

The development of services is also lower (and is developing slowly) in the rural areas of many Member States: at EU-27 level, services represent 63% of the economic activity in predominantly rural areas in comparison with 75% in predominantly urban areas. In general, even in rural areas, the majority of the economic activity depends however more and more on the service sector. This trend should increase in the coming years as, between 2000 and 2004, the relative importance of the primary sector in the economy of the rural areas in EU-27 decreased by 0.3 percentage points in terms of employment and by 1.3 percentage points in terms of value added. The employment rate is slightly lower in rural areas for EU-27 as a whole (61% against 63% for all areas in 2005) and has developed at approximately the same rate as in other areas over the last years (+1 percentage point between 2000 and 2005). However, this is not a systematic feature at Member State level.

Environment:

The designated Natura 2000 sites cover over 10% of agricultural area of the EU-25 and even 20% or more in five Member States. Natura 2000 sites also cover 7% of forestry area that also contributes to the biodiversity, particularly in mixed broadleaved-coniferous forest (around 14% of forest and other wooded land in EU-27). Taking into account other programmes to protect forestry, around 17% of EU-27 forestry area is covered by environment protection schemes. This share even reaches 63% in Germany. However, a decline in the population of farmland birds, largely attributed to intensive farming, is observed in many Member States even if, over the last decade, the situation is rather stable at EU level.

Defoliation of trees also reveals the strong environmental pressure on the forestry ecosystem (23% of sample trees at EU-27 level in 2006). The development of this phenomenon between 2000 and 2006 varies among Member States, with significant increases in Portugal, France, Luxemburg and Cyprus and steep decreases in Romania, Poland and Bulgaria. In 2006, it was particularly important in the Czech Republic, Luxemburg, Bulgaria and France. However forestry area in EU-27 increased by nearly 500 000 hectares per year between 2000 and 2005, the largest increases having taken place in Spain and Italy.

Even if several human activities influence water quality, agriculture plays an important role for some of its features. Concentration of nitrates in surface water decreased over the last years in most Member States even if significant surpluses of nutrients (+89 kg/ha for Nitrogen and +13 kg/ha for Phosphorus at EU-15 level and much more in some Member States) reveal that farming practices are still too intensive. The pressure from agriculture on water use is also critical in some regions of the European Union as, for instance, the share of irrigated area can be higher than a fifth of the agricultural area in some Member States.

Soil erosion persists in many areas as it is estimated that a soil loss by running water can amount to more than 2 tons/ha/year. However, an increasing part of agricultural area is devoted to organic production. For the whole EU-27, organic area was higher than 6.2 mio ha in 2005, i.e. 3.6% of the agricultural area, and is developing rapidly: for the period 2000-2004, the average annual growth rate was higher than 9% for EU-27 and even reached 22% for the New Member states.

With 477 mio t of CO2 equivalents, agriculture produced 9.2% of the EU emissions of greenhouse gases in 2004, resulting from an average annual decrease of 0.61% per year between 2000 and 2004. However, with a production of renewable resources of 3.4 mio t of oil equivalent in 2005 and an area in 2005 estimated between 2.6 and 2.8 mio ha, EU agriculture also contributes increasingly to the mitigation of climate change.

3.6. Urban-rural interactions[13]

Interactions between urban and rural areas are intense and manifold. They concern in particular the commuter flows from rural residential areas to urban employment and service areas, the flows of urbanites towards rural recreation and leisure areas, the supply of cities with food products and water, the development of second homes in rural areas and numerous other processes. Urban-rural interactions are responsible for a significant amount of land-use changes, especially in rural areas situated at proximity of cities and metropolitan areas. The following analysis will attempt to present a typology of areas showing those where urban-rural interactions are most developed, a representation of the polarization potential based on the intensity of urban-rural

[13] This section is mainly based on :

- ESPON Study 3.2. "Long-term scenarios for territorial development in Europe" 2007.
- Fourth cohesion Report of the European Commission. 2007.
- "Urban sprawl in Europe – the ignored challenge ». EEA Report N°10/2006

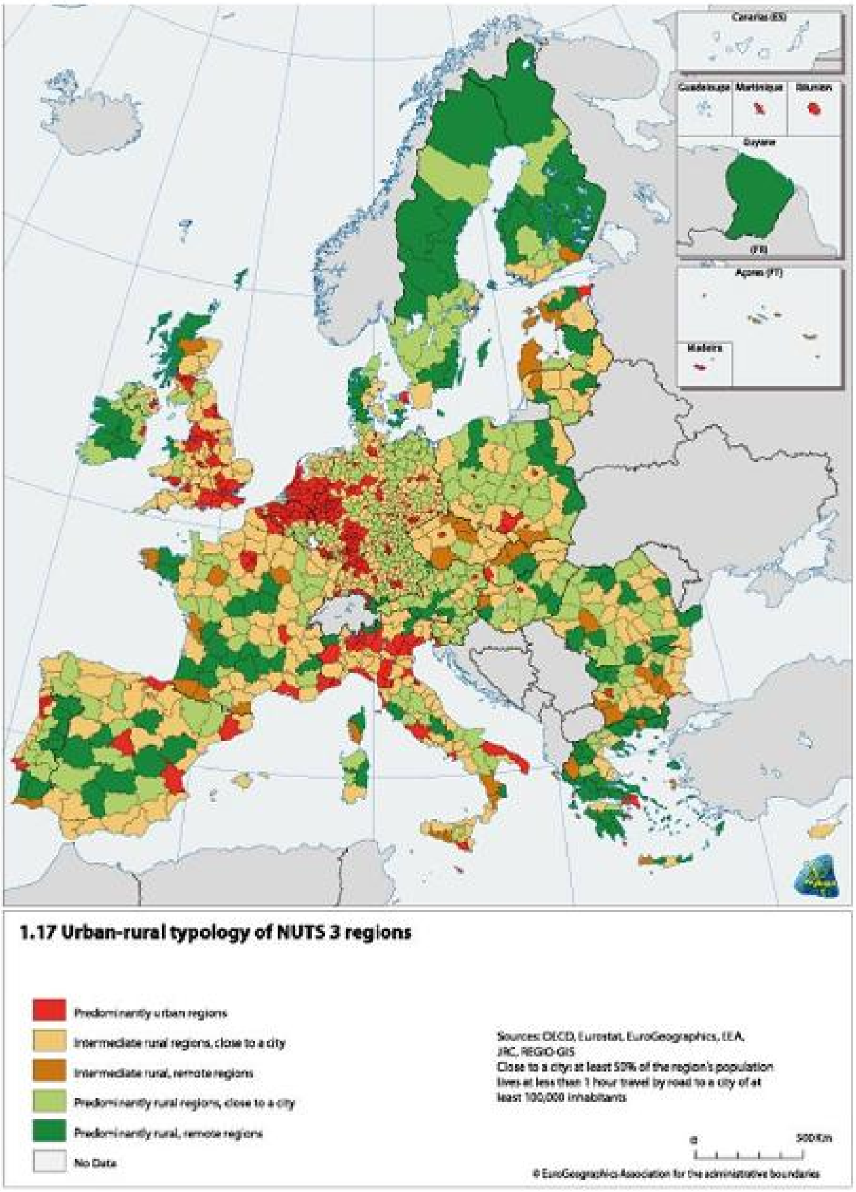
contrasts, an overview of suburbanization and urban sprawl trends as well as urban-rural complementarities as potential for urban-rural cooperation.

Rural regions with substantial urban-rural interactions (Map: Urban-rural typology of NUTS3 regions from the Fourth Cohesion Report of the European Commission 2007)

The typology elaborated by the European Commission (DG Regio) identifies, in addition to the predominantly urban regions, four types of rural regions, three of which are characterized by substantial urban-rural interactions:

- Intermediate rural regions close to a city
- Intermediate rural, remote regions
- Predominantly rural regions close to a city

Figure 3.10. Urban-rural typology of NUTS3 regions



Source: Fourth Cohesion Report of the European Commission. 2007.

The first category of regions is widely spread throughout Europe. It can be observed in most countries, both in the EU-15 (mainly in Spain, France, Italy, Germany) and in the new Member States (Baltic States, Poland, Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Slovenia). The countries where this category of areas is less represented are Ireland, the Nordic countries, Greece and the Benelux countries. These have either wide areas with low population density or, on the contrary, most regions with very high population density (Benelux). It is likely that intermediate rural regions close to a city are subject to active urban influence generating substantial land-use changes. Pressure on open spaces is probably significant in a large number of these regions.

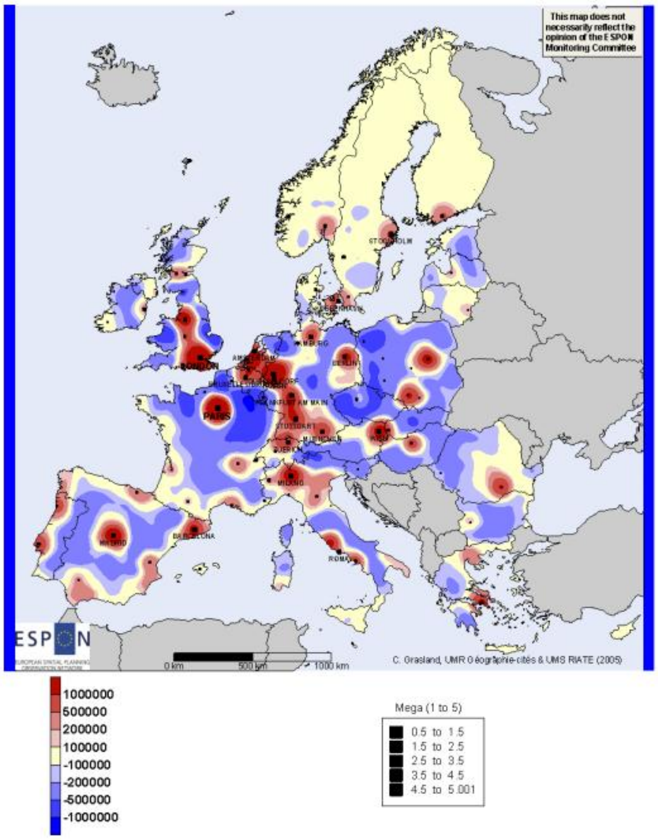
The second category is much less represented in Europe. Various countries of EU-15 have no or few region(s) in this category (Spain, Portugal except Algarve, Ireland, UK except a part of Scotland, Benelux countries, Germany, Nordic countries except a district in eastern Finland). In France and Italy, only few regions belong to this category. More regions of this category are to be found in central and eastern Europe (mainly in the Baltic States, Czech Republic, Slovakia, Bulgaria). Most of these regions are traditional rural areas with substantial population density where agriculture plays an important part in the economy, but without significant city. A few of them (for instance Algarve and other coastal areas) have important tourist activities. In these regions, urban-rural interactions are limited to the influence of small and medium-sized towns on the surrounding rural areas. The risk of significant pressures from urban functions on open spaces is relatively limited.

The third category is typical for countries with wide rural areas and low population density surrounding important cities. This category of regions is quite will widespread throughout Europe, both in the EU-15 (except the Benelux countries and the UK) and in the new Member States of central and eastern Europe (except Estonia, the Czech and the Slovak Republics). Although the processes taking place in these regions are not uniform, it is likely that pressures on open spaces are likely to emerge there where the cities are subject to specific demographic and/or economic dynamics. This is of course not the case in every region of this category.

Rural regions under the polarization influence of large cities (Map of UMS-RIATE Paris from ESPON Study 3.1.)

Taking into account the fact that major economic drivers are located in large metropolitan areas, their influence on surrounding areas in terms of polarization forces is highest there where the contrast between the metropolitan area and the surrounding areas is largest.

Figure 3.11. Regions under the polarization influence of large cities



Source: ESPON 3.1. UMS-RIATE Paris

In applying the methodology developed in the Final Report of ESPON project 3.1, it is possible to measure the economic and demographic polarisation, based on a multi-scalar computation of economic and demographic potential using various spans of ógaussian smoothingô The map is the synthesis of 4 criteria: Local demographic polarisation (LDP), Medium demographic polarisation (MDP), Local economic polarisation (LDP), Medium economic polarisation (MEP). A synthetic index of polarisation is then calculated.

The map shows strong contrasts ï and therefore a high polarisation potential in Spain, France, UK, Germany, Italy, Poland and Austria. Contrasts are generally lower in a number of peripheral countries or regions (Nordic countries, Baltic States, Sicily). It can be assumed that strong polarisation forces favour metropolitan growth and therefore the physical expansion of metropolitan areas in the surrounding suburban and rural areas. It is likely that there is a positive correlation between strong polarisation forces and pressure on surrounding open spaces.

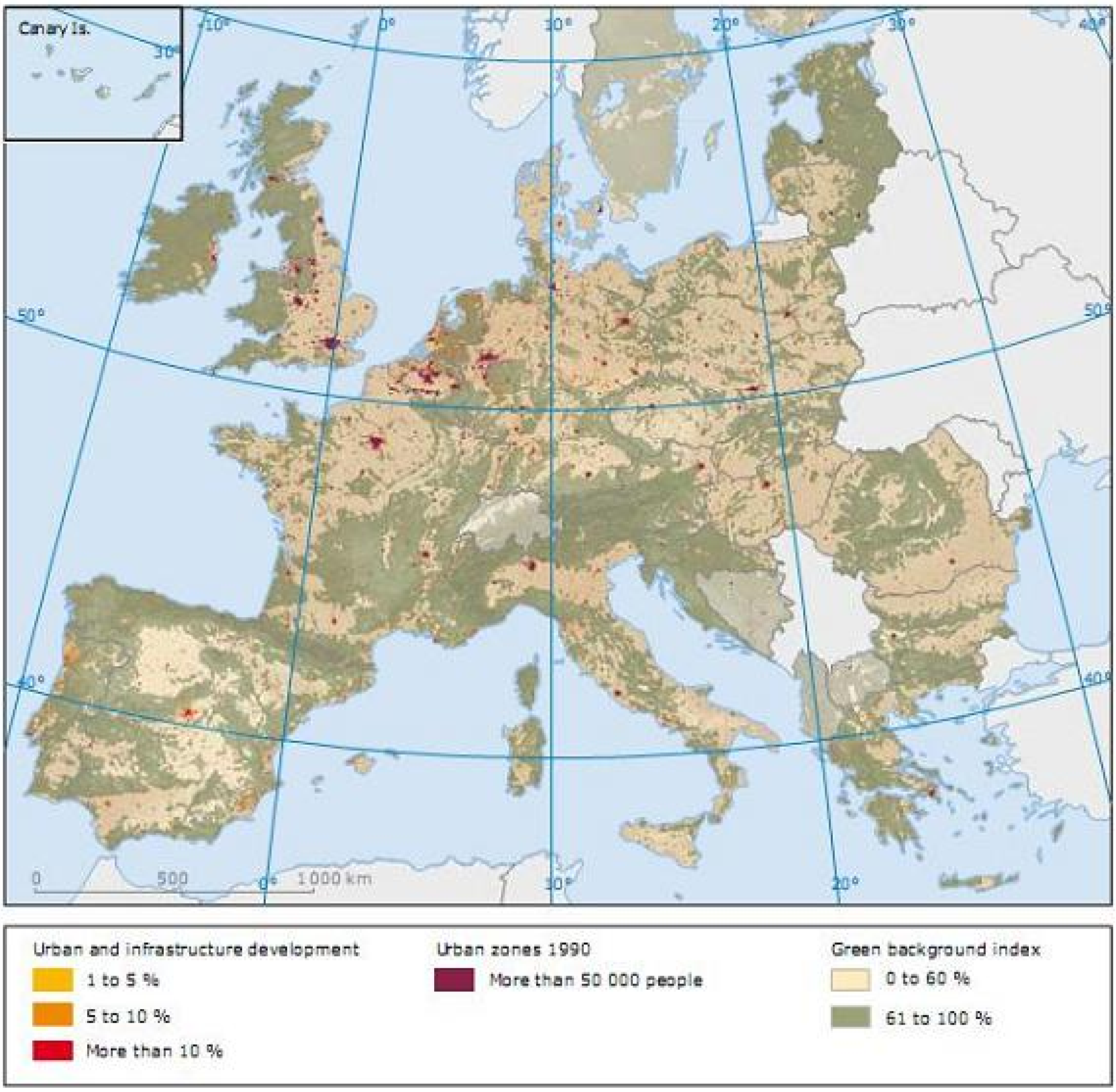
3.6.1. Suburbanisation and urban sprawl

Urban sprawl is synonymous with unplanned incremental urban development, characterised by a low density mix of land uses on the urban fringe. In Europe, cities have traditionally been compact, developing a dense historical core shaped before the emergence of modern transport systems. However, European cities were more compact and less sprawled in the mid 1950s than they are today, and urban sprawl is now a common phenomenon throughout Europe. Historical trends, since the mid-1950s, show that European cities have expanded on average by 78 %, whereas the population has grown by only 33 %. A major consequence of this trend is that European cities have become much less compact. Trends towards new low density environments are also evident in the space consumed per person in the cities of Europe during the past 50 years which has more than doubled. In particular, over the past 20 years the extent of built-up areas in many western and eastern European countries has increased by 20 % while the population has increased by only 6 %.

Moreover, there is no apparent slowing down in these trends. The urban areas particularly at risk are in the southern, eastern and central parts of Europe are particularly at risk. Historically, the growth of cities has been driven by increasing urban population. However, in Europe today, even where there is little or no population pressure, a variety of factors are still driving sprawl. These are rooted in the desire to realise new lifestyles in suburban environments, outside the inner city. Global socio-economic forces are interacting with more localised environmental and spatial constraints to generate the common characteristics of urban sprawl evident throughout Europe today. At the same time, sprawl has accelerated in response to improved transportation links and enhanced personal mobility. This has made it possible either to live increasingly farther away from city centres, while retaining all the advantages of a city location, or enabled people to live in one city and work in another.

The mix of forces include both micro and macro socio-economic trends such as the means of transportation, the price of land, individual housing preferences, demographic trends, cultural traditions and constraints, the attractiveness of existing urban areas, and, not least, the application of land use planning policies at both local and regional scales.

Figure 3.12. Urban expansion in Europe (1990-2000)



Source: "Urban sprawl in Europe – the ignored challenge ». EEA Report N°10/2006

All available evidence demonstrates that urban sprawl has accompanied the growth of urban areas across Europe over the past 50 years. This is shown from a recent European perspective. The areas with the most visible impacts of urban sprawl are in countries or regions with high population density and economic activity (Belgium, the Netherlands, southern and western Germany, northern Italy, the Paris region) and/or rapid economic growth (Ireland, Portugal, eastern Germany, the Madrid region). Sprawl is particularly evident where countries or regions have benefited from EU regional policies. New development patterns can also be observed, around smaller towns or in the countryside, along transportation corridors, and along many parts of the coast usually connected to river valleys. The latter is exemplified by the so-called 'inverse T' of urban sprawl along the Rhône valley down to the Mediterranean coast. Hot spots of urban sprawl are also common along already highly populated coastal strips, such as in the case of Spain where the artificial areas may cover up to 50 % of the total land area. Sprawl may also follow from the expected rapid economic development in many parts of the new Member States, as internal economic dynamism, greater access to EU markets, and Cohesion Fund and Structural Funds investments drive economies.

The growth of built-up areas in Europe reached its peak in 1950s–1960s, when the average annual growth rate reached 3.3 %. In subsequent decades the main wave of urban growth has moved farther away from the city centres allowing urban sprawl to extend the urban footprint into the adjacent countryside. Indeed during the ten year period 1990–2000 the growth of urban areas and associated infrastructure throughout Europe consumed more than 8 000 km2 (a 5.4 % increase during the period), equivalent to complete coverage of the entire territory of the state of Luxembourg. This is equivalent to the consumption of 0.25 % of the combined area of agriculture, forest and natural land. These changes may seem small. However, urban sprawl is concentrated in particular areas which tend to be where the rate of urban growth was already high during the 1970s and 1980s. Moreover, they run alongside the emerging problems of rural depopulation. On a straight extrapolation, a 0.6 % annual increase in urban areas, although apparently small, would lead to a doubling of the amount of urban area in little over a century (EEA, 2005).

Sprawl is greater, and in many cases significantly greater, than would be expected on the basis of population growth alone. Out of the sample of cities investigated, only in Munich and Bilbao has population grown more rapidly than in the built-up area. Palermo with 50 % growth in population generated more than 200 % growth in the built-up area.

Although the population is decreasing in many regions of Europe, urban areas are still growing in those areas. Moderate increases of population accompanied by a large expansion of urban areas can be observed in Spain, Portugal, Ireland and the Netherlands. Major gains of population (> 10 %, through immigration) can only be observed in western Germany, where the average annual expansion of built-up areas is 47 000 ha/year, growth equivalent over 5 years to the area of Greater Copenhagen.
Southern European cities have a long urban tradition in which the urbanisation process has been slower, with fewer periods of rapid growth and the cities have been very compact. In recent decades, however, urban sprawl has started to develop at unprecedented rates, and it is most probable that unless land use planning and zoning restrictions are more rigorously applied the gap between northern and southern cities will rapidly narrow.

Clusters of compact cities are also evident in the former socialist countries of central and Eastern Europe. The compact urban form and high densities mainly reflect the strong centralised planning regimes and substantial reliance on public transport that prevailed during the communist era. Today, these cities are facing the same threats of rapid urban sprawl as the southern European cities as the land market is liberated, housing preferences evolve, improving economic prospects create new pressures for low density urban expansion, and less restrictive planning controls prevail. In northern Italy, small and medium sized cities are also special cases as the whole region has experienced very strong urban sprawl in the past decades and the process continues.
In general cities in northern and Western Europe have less of an urban tradition, and have been more strongly influenced by traditions in which the planning ideal has supported spacious, less compact, garden suburbs. This has resulted in much lower densities and more suburban development, particularly as individual housing preferences in north and west European cities have also favoured semi-detached and detached houses.

Along the coastal regions of Europe major population growth is accommodated by continuous sprawling development. During the period 1990–2000, urbanisation of the coast grew approximately 30 % faster than inland areas, with the highest rates of increase (20–35 %) in the coastal zones of Portugal, Ireland and Spain. Many of the mountainous regions of Europe are also under threat from urban impacts, especially where transport routes provide good communications with adjacent lowland regional centres.

The impacts of sprawl on natural areas are significant. Land sustains a number of ecosystems functions including the production of food, habitat for natural species, recreation, water retention and storage that are interconnected with adjacent land uses. The considerable impact of urban sprawl on natural and protected areas is exacerbated by the increased proximity and accessibility of urban activities to natural areas, imposing stress on ecosystems and species through noise and air pollution.
But even where the direct advance of urban land on natural and protected areas is minimised, the indirect fragmentation impacts of transport and other urban-related infrastructure developments create barrier effects that degrade the ecological functions of natural habitats. Immediate impacts such as the loss of agricultural and natural land or the fragmentation of forests, wetlands and other habitats are well known direct and irreversible impacts.

Urban land fragmentation, with the disruption of migration corridors for wildlife species, isolates these populations and can reduce natural habitats to such an extent that the minimum area required for the viability of species populations is no longer maintained. The environmental impacts of sprawl are evident in a number of ecologically sensitive areas located in coastal zones and mountain areas. Along the European coastal regions urban sprawl is endemic. Moreover, there is little prospect of relief over the next two decades, especially with a predicted increase in population of around 35 million people.

The growth of European cities in recent years has primarily occurred on former agricultural land. Typically, urban development and agriculture are competing for the same land, as agricultural lands adjacent to existing urban areas are also ideal for urban expansion. The motivations of farmers in this process are clear as they can secure substantial financial benefits for the sale of farmland for new housing or other urban developments. In Poland, for example, between 2004 and 2006 the price of agricultural land increased on average by 40 %. Around the main cities and new highway developments, increases in price are often much higher. All these characteristic impacts of urban sprawl are well illustrated by the Mediterranean coast. Throughout the region 3 % of farmland was urbanised in the 1990s, and 60 % of this land was of good agriculture quality.

3.6.2. Drawbacks and complementarities in urban-rural interactions; potential for cooperation

Metropolitan growth may generate a number of drawbacks as indicated above. Population growth in urban areas is increasing congestion and land prices, while the demand for quality food, local produce and a rural way of life, on the one hand, and space for housing, public amenities and increased environmental protection, on the other, is giving rise to development opportunities and pressure on land at the same time. Improved accessibility creates new job opportunities for rural as well as urban populations, as long as they can commute and have the necessary education and skill levels. The arrival in rural areas of increasing numbers of people from towns and cities can alter the rural character of areas. While it might push up income and tax receipts and so help to maintain public services and expand the local market, it can lead to widening social disparities and new tensions by increasing house prices to levels that locals cannot afford. In some of the more remote rural areas, especially in the UK, the growing number of non-permanent residents in second homes and the declining number of locals is causing local service providers to close down, so encouraging more locals to leave and initiating a downward spiral. Offices and factories tend to locate along transport routes, in out-of-town business parks and in towns easily accessible by car inducing even more commuting and pressure on accessible rural areas. Public transport has usually not kept pace with the building of new roads, which has led to more use of private cars and a further deterioration in public transport services, hitting low income groups without access to a car and excluding them from new employment opportunities.

These trends increase the importance of spatial development policies and the coherent management of land use. Small and medium sized towns can have an important role to play in this regard. Around 21% of the population in the EU lives in towns of between 5,000 and 100,000. Such towns provide important services and facilities for both their inhabitants and surrounding areas. Towns can benefit rural areas through the services they provide, while people living in towns can equally benefit from being close to rural areas. Towns can, therefore, serve as centres of development for rural areas, as markets for the products produced there and a focus for employment services of all kinds and cultural and recreational activities. There is a mutual dependence between rural towns and the surrounding areas since the viability of the services the former provide is partly dependent on the demand in these surrounding areas. Consequently, cooperation between rural and urban authorities is important for spatial planning and development. Towns are important in strengthening territorial cohesion either by supporting polycentric development or by offering key services to surrounding rural areas. There are a number of examples of towns in reasonable reach of each other cooperating by sharing the functions they perform and between them providing a range of services and amenities. Such cooperation contributes to less spatial concentration and to more a balanced pattern of regional development.

Chapter 4: Land use changes in EU and their impact in the integration of Natura 2000 Network in to a wider countryside

Content

Chapter 4: Land use changes in EU and their impact in the integration of Natura 2000 Network in to a wider countryside

Assessment of land use change in Europe

The objective of this work is to assess the historic land use changes in Europe based on Corine land cover data at 1 km resolution,

4.1. Analysis of historic land use changes

4.1.1. Methodology

For the analysis of historic land use changes we look at developments that have occurred between 1990 and 2000 in the Corine land cover (CLC) maps. The results of the historic analysis will be used in the next step to provide information for parameter settings of the calibration as well as the future developments in the baseline scenario. For this reason the analysis focuses on those land use classes that will be modelled explicitly in the land use model. The selected land use model is METRONAMICA, which is incorporated among others in the LUMOCAP Policy Support System (PSS). This land use model is applied to EU-27 at a 1 km resolution, consistent with the resolution of this analysis. As part of the LUMOCAP project[14], it is already calibrated with a single parameter set that applies to EU-27 as a whole. From this experience we learned that there are regional differences that cannot be discarded. Therefore in the current project we have divided Europe in a few major regions (described further below) for which different parameter settings will be applied.
To be able to build on the existing calibration from the LUMOCAP project, the land use categories that will be analysed for the period 1990-2000 and that will be modelled dynamically in the land use model are:

- Residential areas,
- Industry & commerce,
- Tourism & recreation,
- Agriculture,
- Forest, and
- Natural vegetation.

Understanding land use change is more than merely looking at the total area of certain land uses that appeared or disappeared. Intensity of agricultural or forest land use can not be taken in account because there is no such kind of land use classes in CLC. Also the change in structure and the underlying reasons of this change are important. It is the complete picture of different elements that provides insight in land use changes. For this reason we have focused on three particular ways to measure the change:

1. *Appearance and disappearance:*

In this part of the analysis we provide an overview of observed changes in area in the 6 classes mentioned above. Results from this analysis are:

a) Total area per land use in 1990,

[14] www.riks.nl/projects/lumocap

b) Total area per land use in 2000,
c) Absolute change in area per land use from 1990 to 2000,
d) Surface share per land use in 1990,
e) Surface share per land use in 2000,
f) Increase or decrease from 1990 to 2000 per land use function, expressed relative to the original (1990) amount of land use for that function,
g) Increase or decrease from 1990 to 2000 per land use function, expressed as a percentage of the total land area.

2. *Growth and shrink of different land use categories:*

In this part of the analysis we provide an overview of observed changes in area in the 6 classes mentioned above. Results from this analysis are:

a) For locations in which in 2000 **new land use functions appear** we analyse what land use this location had in 1990 and what the neighbouring land use of this location was in 1990, both representing pull factors.
b) For locations in which in 2000 **land use functions have disappeared** we analyse what land use this location had in 1990 and what the neighbouring land use in this location was in 1990, representing push factors.

3. *Cluster size change of different land use categories:*

We use two different measures for analysing the cluster size change:

c) For the residential clusters we calculate the cluster size – frequency distribution which shows the distribution of the different residential cluster sizes in a certain area.
d) For all six classes we calculate the clumpiness index[15] as landscape metric, which can be used to characterize the landscape pattern in an area.

The analysis has been carried out at two different spatial scales, at NUTS-2 level and at the level of groups of countries that we expect would have similar behaviour. Based on geographical location and history we have selected the following groups of countries[16]: Western Europe (Austria, Belgium, Denmark France, Germany, Ireland, Luxembourg, the Netherlands); North-eastern Europe (Czech Republic, Poland, Slovakia,); South-eastern Europe (Bulgaria, Hungary, Romania, Slovenia); Mediterranean (Italy, Greece, Portugal, Spain); and the Baltic states (Estonia, Latvia, Lithuania).

Data

Land use maps

[15] More information about the clumpiness indicator can be found on: http://www.umass.edu/landeco/research/fragstats/documents/Metrics/Contagion%20-%20Interspersion%20Metrics/Metrics/C115%20-%20CLUMPY.htm.

[16] Originally we had planned to have UK and Ireland as a separate category as well as Scandinavia (Denmark, Finland and Sweden). Moreover we had planned to divide the Mediterranean in an Eastern and a Western category. However, because CLC90 data was not available for Cyprus, Finland, Malta, Sweden and the United Kingdom, the remaining countries in those groups were too limited to be used as a representation for the intended categories.

For the analysis of historic developments, Corine land cover (CLC) maps for 1990 and 2000 are used to assess the trends of land use and cover change over this period. For this analysis the original CLC maps were aggregated to a spatial resolution of 1 km^2 using an adjusted majority aggregation. For this method an additional constraint was added to the aggregation procedure to make sure that the total area per land use function remains the same before and after the aggregation.
CLC 1990 is not available for Cyprus, Finland, Malta, Sweden and United Kingdom. Hence for the land use change analysis for 1990 to 2000, no results can be obtained for these countries.

Land use classification

For this analysis we reclassified the CLC land use classes to more aggregated ones. Those are the classes that are currently modelled in a dynamic manner in the **METRONAMICA** land use model included in the **LUMOCAP PSS**. The reclassification of CLC classes is shown in table 4.1. This table also shows a categorisation of land use classes into functions, features and vacant states, which is required for **METRONAMICA**[17]. In the **METRONAMICA** application for the current project, natural vegetation is considered as vacant state; agriculture, industry & commerce, residential areas, tourism & recreation and forest are functions; the rest of the land cover classes are considered features.

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Table 4.1 Corine land cover classes (level 3) and LUMOCAP land cover classes. *Construction (133) is converted to the land use class of the surrounding build-up area.

LUMOCAP classes	Type	CLC code	CLC classes
Natural vegetation	Vacant	321	Natural grasslands
Natural vegetation	Vacant	322	Moors and heathland
Natural vegetation	Vacant	323	Sclerophyllous vegetation
Natural vegetation	Vacant	324	Transitional woodland-shrub
Agriculture	Function	211	Non-irrigated arable land
Agriculture	Function	212	Permanently irrigated land
Agriculture	Function	213	Rice fields
Agriculture	Function	221	Vineyards
Agriculture	Function	222	Fruit trees and berry plantations
Agriculture	Function	223	Olive groves
Agriculture	Function	231	Pastures
Agriculture	Function	241	Annual crops associated with permanent crops
Agriculture	Function	242	Complex cultivation patterns
Agriculture	Function	244	Agro-forestry areas
Agriculture	Function	243	Land principally occupied by agriculture, with significant areas of natural vegetation
Residential areas	Function	111	Continuous urban fabric
Residential areas	Function	112	Discontinuous urban fabric

[17] Features are land use classes that are not supposed to change in the simulation, like water bodies or airports. Functions are land use classes that are actively modelled, like residential or industry & commerce. Functions change dynamically as the result of the local and the regional dynamics. Vacant states finally are classes that are only changing as a result of other land use dynamics. Computationally at least one vacant state is required. Typically abandoned land or natural land use types are modelled as vacant state, since they are literally vacant for other land uses or the result of the disappearance of other land use functions.

Industry and Commerce	Function	121	Industrial or commercial units
Tourism and Recreation	Function	141	Green urban areas
Tourism and Recreation	Function	142	Sport and leisure facilities
Forest	Function	311	Broad-leaved forest
Forest	Function	312	Coniferous forest
Forest	Function	313	Mixed forest
Open spaces with little or no vegetation	Feature	332	Bare rocks
Open spaces with little or no vegetation	Feature	333	Sparsely vegetated areas
Open spaces with little or no vegetation	Feature	334	Burnt areas
Open spaces with little or no vegetation	Feature	335	Glaciers and perpetual snow
Infrastructure	Feature	122	Road and rail networks and associated land
Port Area	Feature	123	Port areas
Airports	Feature	124	Airports
Mineral extraction sites	Feature	131	Mineral extraction sites
Dump sites	Feature	132	Dump sites
Inland wetlands	Feature	411	Inland marshes
Inland wetlands	Feature	412	Peat bogs
Marine wetlands	Feature	421	Salt marshes
Marine wetlands	Feature	422	Salines
Marine wetlands	Feature	423	Intertidal flats
Inland water bodies	Feature	511	Water courses
Inland water bodies	Feature	512	Water bodies
Marine water bodies	Feature	521	Coastal lagoons
Marine water bodies	Feature	522	Estuaries
Marine water bodies	Feature	523	Sea and ocean
Beaches, dunes, sands	Feature	331	Beaches, dunes, sands
*		133	Construction sites
Land outside modelling area	Feature	990	UNCLASSIFIED LAND SURFACE
Water outside modelling area	Feature	995	UNCLASSIFIED WATER BODIES

4.1.2. Land use change analysis

This section provides the results of the different parts of the historical analysis described in the methodology section (1.1):

- Appearance and disappearance of different land use categories
- Growth and shrink of different land use categories
- Cluster size change of different land use categories

Most of the analysis is carried out at NUTS-2 level (see appendix I for an overview of all 261 NUTS-2 regions in EU-27) and at the level of the country groups (see table). We found that most NUTS-2 regions contain only a small number of cells per land use class that actually change. Results of an analysis based on only a few cells are not

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significant and therefore not meaningful for the current purpose. For this reason we describe below the results for the groups of countries.

Table 4.2 Group of countries list

NUTS-0	Name	Group of countries
EE	Estonia	Baltic states
LT	Lithuania	Baltic states
LV	Latvia	Baltic states
CZ	Czech Republic	North-eastern Europe
PL	Poland	North-eastern Europe
SK	Slovakia	North-eastern Europe
BG	Bulgaria	South-eastern Europe
HU	Hungary	South-eastern Europe
RO	Romania	South-eastern Europe
SI	Slovenia	South-eastern Europe
ES	Spain	Mediterranean
GR	Greece	Mediterranean
IT	Italy	Mediterranean
PT	Portugal	Mediterranean
AT	Austria	Western Europe
BE	Belgium	Western Europe
DE	Germany	Western Europe
DK	Denmark	Western Europe
FR	France	Western Europe
IE	Ireland	Western Europe
LU	Luxemburg	Western Europe
NL	The Netherlands	Western Europe
CY	Cyprus	Excluded
FI	Finland	Excluded
MT	Malta	Excluded
SE	Sweden	Excluded
UK	United Kingdom	Excluded

Appearance and disappearance of land use

The result of appearance and disappearance analysis shows the overview of observed changes in the 6 classes mentioned above. Results for group of countries include:

- Total area per land use per group of countries in 1990
- Total area per land use per group of countries in 2000
- Absolute change of area per land use per group of countries from 1990 to 2000
- Surface share per land use class per group of countries in 1990, which is calculated by its total area in 1990 divided by the total area of the group of countries
- Surface share per land use class per group of countries in 2000, which is calculated by its total area in 2000 divided by the total area of the group of countries

- Increase or decrease from 1990 to 2000 per land use function, expressed relative to the original (1990) amount of land use for that function

- Increase or decrease from 1990 to 2000 per land use function, expressed as a percentage of the total land area

There was an increase in residential and industrial & commercial locations in the period 1990-2000 in all 5 groups of countries. On the other hand, there was a large decrease in agricultural areas in the same period. The only exceptions are the Baltic States, where we observe a large increase. This increase comes at the cost of forested areas, which indicates that forests are being cleared for agriculture. In this region we also see an emergence of natural vegetation over the period 1990-2000 which could be the result of forest harvesting.

Some new forest appears in 2000 in North-eastern Europe and South-eastern Europe, while there is a small decline in the Mediterranean and Western Europe. But more than that, we see a large relocation of forests in these countries. For example, the Mediterranean had a net loss of only 28 km² of forest between 1990 and 2000. But in the same period, there was 8865 km² of forest reallocated. Since changes of a similar extend are visible for natural vegetation, it could very well be that these changes are due to classification errors, since there is a thin line between forest and natural vegetation. Finally, we see an increase of tourism & recreation over the period 1990-2000 in most countries, with Western Europe and the Mediterranean the countries where we observe the largest growth.

Table 4.3 Surface share per land use per group of countries in 1990

	Natural vegetation	Agriculture	Residential	Industry & Commerce	Tourism & Recreation	Forest
Baltic states	5.37%	47.60%	1.44%	0.41%	0.13%	39.93%
North-eastern Europe	1.61%	61.72%	3.07%	0.40%	0.20%	30.91%
South-eastern Europe	5.97%	56.73%	4.65%	0.57%	0.13%	28.60%
Mediterranean	22.63%	49.41%	1.73%	0.30%	0.05%	21.30%
Western Europe	4.38%	59.56%	4.62%	0.54%	0.31%	25.77%

Table 4.4 Surface share per land use per group of countries in 2000

	Natural vegetation	Agriculture	Residential	Industry & Commerce	Tourism & Recreation	Forest
Baltic states	6.97%	47.73%	1.45%	0.42%	0.13%	38.16%
North-eastern Europe	1.68%	61.55%	3.12%	0.42%	0.21%	30.95%
South-eastern Europe	5.87%	56.59%	4.67%	0.58%	0.14%	28.78%
Mediterranean	22.44%	49.19%	1.95%	0.39%	0.07%	21.30%

Western Europe	4.52%	59.06%	4.86%	0.67%	0.37%	25.76%

Table 4.5 Increase or decrease from 1990 to 2000 per land use function, expressed relative to the original (1990) amount of land use for that function (Remarkable changes are made bold).

	Natural vegetation	Agriculture	Residential	Industry & Commerce	Tourism & Recreation	Forest
Baltic states	**29.82%**	0.29%	0.60%	1.11%	-0.44%	**- 4.43%**
North-eastern Europe	4.68%	-0.28%	1.57%	4.09%	0.78%	0.12%
South-eastern Europe	-1.74%	-0.24%	0.36%	2.12%	1.45%	0.66%
Mediterranean	-0.85%	-0.45%	**12.28%**	**31.95%**	**37.59%**	- 0.01%
Western Europe	3.20%	**-0.84%**	**5.32%**	**24.66%**	**18.29%**	- 0.06%

Table 4.6 Increase or decrease from 1990 to 2000 per land use function, expressed as a percentage of the total land area function (Remarkable changes are made bold).

	Natural vegetation	Agriculture	Residential	Industry & Commerce	Tourism & Recreation	Forest
Baltic states	**1.60%**	0.14%	0.01%	0.00%	0.00%	**- 1.77%**
North-eastern Europe	0.08%	-0.18%	0.05%	0.02%	0.00%	0.04%
South-eastern Europe	-0.10%	-0.14%	0.02%	0.01%	0.00%	0.19%
Mediterranean	-0.19%	**-0.22%**	**0.21%**	0.10%	0.02%	0.00%
Western Europe	0.14%	**-0.50%**	**0.25%**	0.13%	0.06%	- 0.02%

From table 4.5 it also shows that there is an increase of all urban land uses (residential, industry & commerce and tourism & recreation) in all groups of countries, but it also indicates the larger differences between the groups of countries. Western Europe ï and even more so the Mediterraneanï shows the largest relative increase. Since residential land use is the largest urban category, an increase of over 12% results in a substantial urban expansion (over 2000 km^2). Agriculture shows exactly opposite changes. It experiences the largest decreases, both relatively and absolutely, in Western Europe followed by the Mediterranean. It is very likely that this will partly be the result of urban expansion.

Eliminado: ta
Con formato: Sin Negrita

Table 4.3 to table 4.6 show that there is a higher increase in natural vegetation in the Baltic States than in other groups of countries in the period 1990-2000, while the Baltic States experience a decrease in forest over the same period. As the bold number indicates, this development is different from the rest of Europe. Analysis of the neighbouring land uses will give more insight in the actual type of land use changes.

Eliminado: T
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Con formato: Negrita
Eliminado: ta

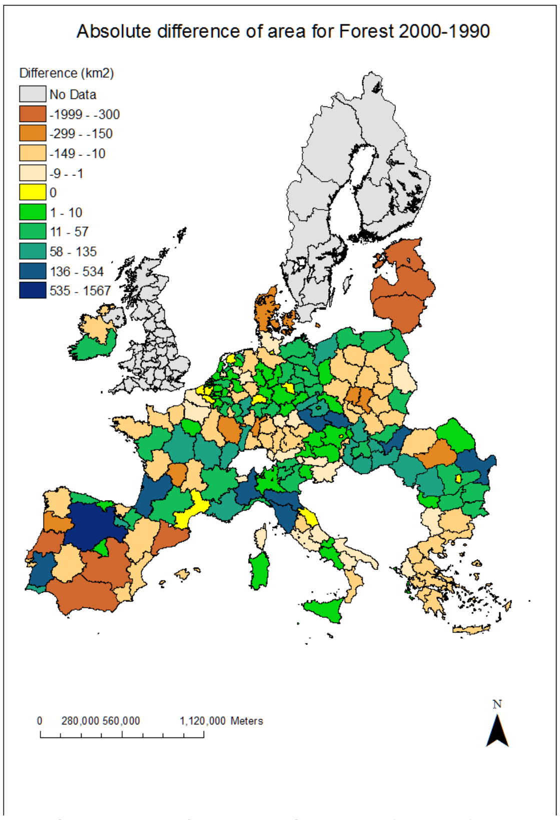

Figure 4.1 Absolute change of area for Forest from 1990 to 2000

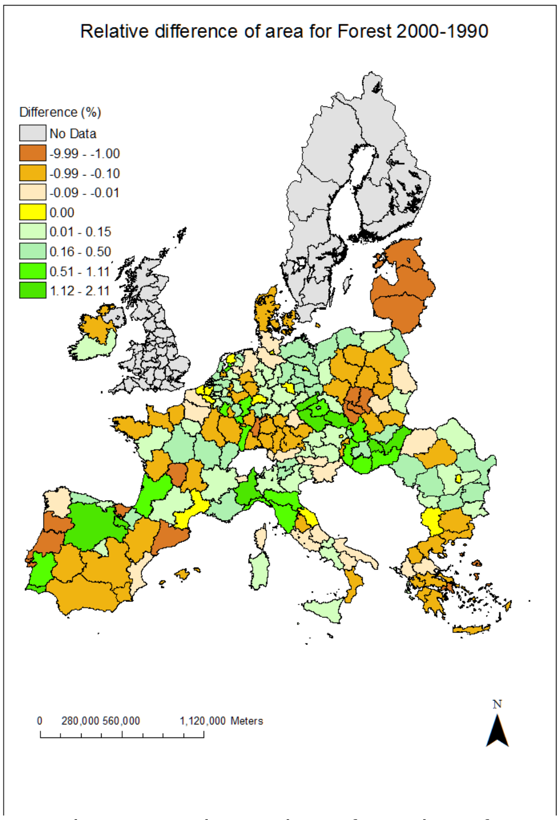

Figure 4.2 Change in surface share for Forest from 1990 to 2000

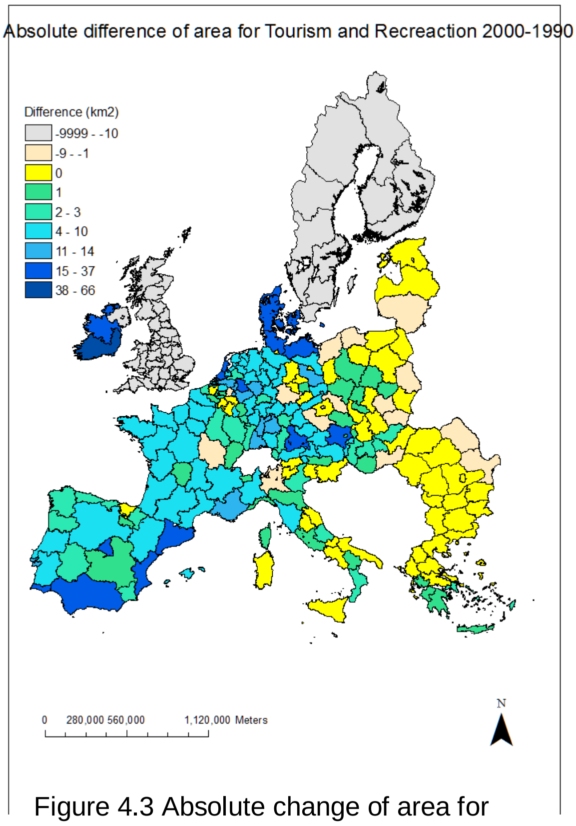

Figure 4.3 Absolute change of area for Tourism and Recreation

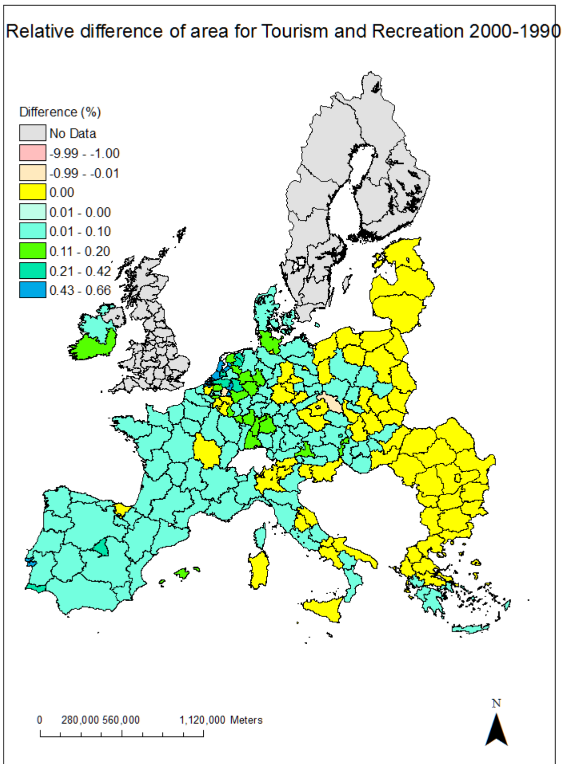

Figure 4.4 Change in surface share for Tourism and Recreation from 1990 to 2000

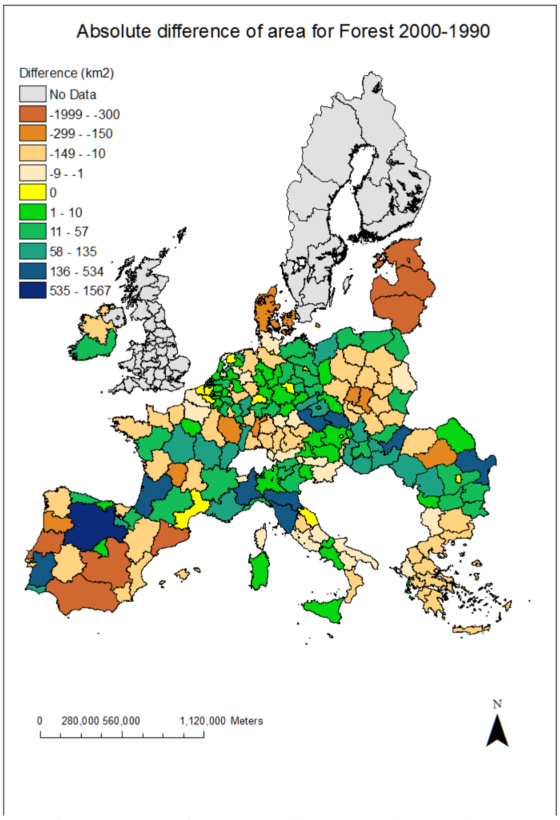

Figure 4.5 Absolute change of area for Forest from 1990 to 2000

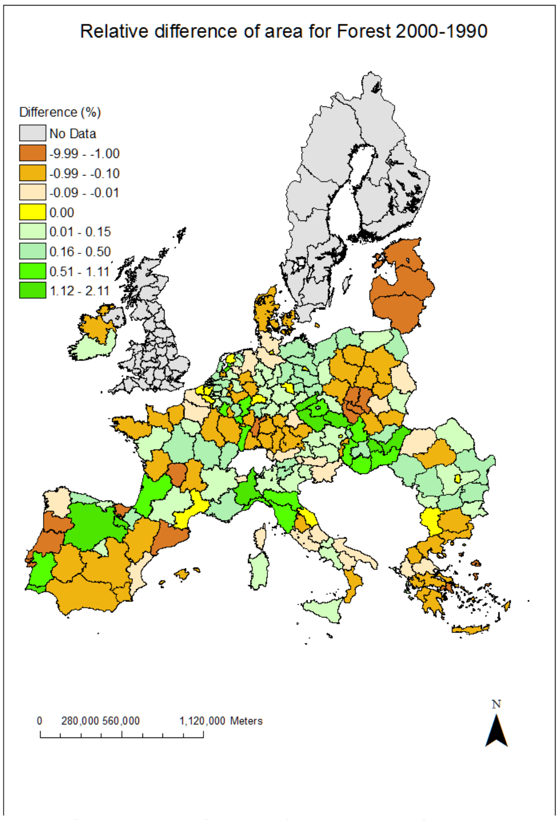

Figure 4.6 Change in surface share for Forest from 1990 to 2000

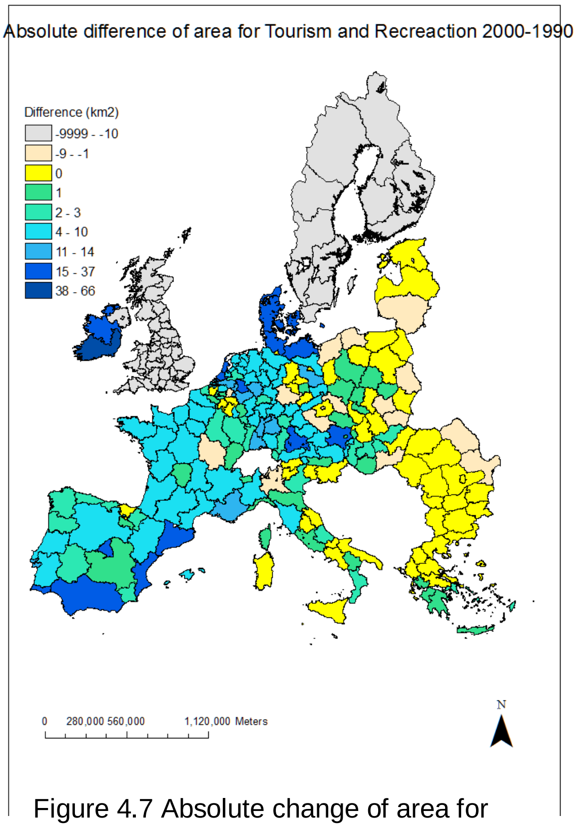

Figure 4.7 Absolute change of area for Tourism and Recreation

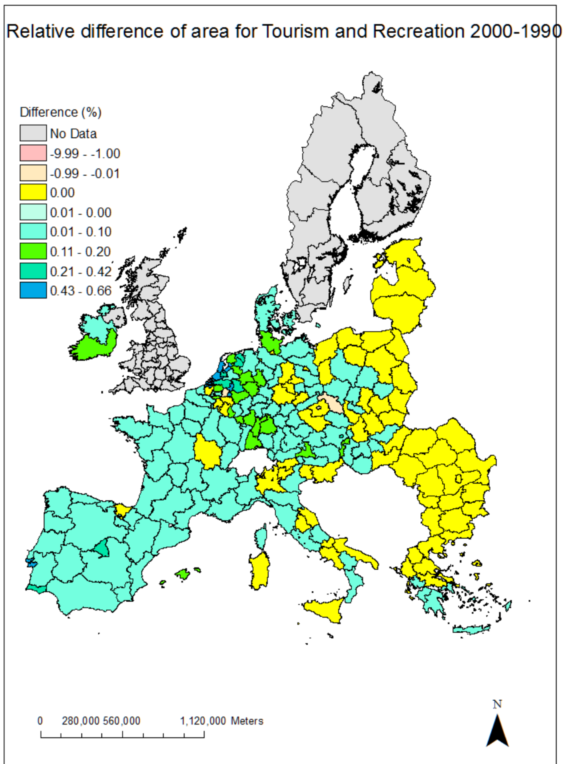

Figure 4.8 Change in surface share for Tourism and Recreation from 1990 to 2000

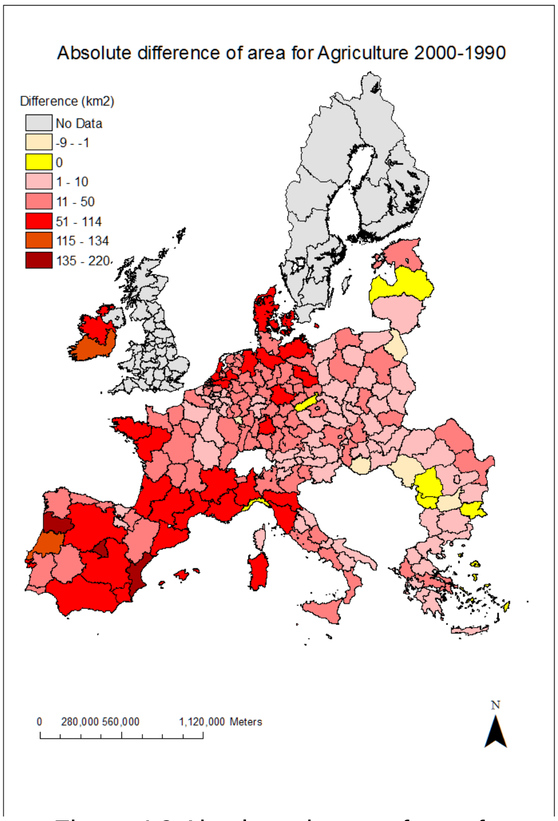

Figure 4.9 Absolute change of area for Residential areas from 1990 to 2000

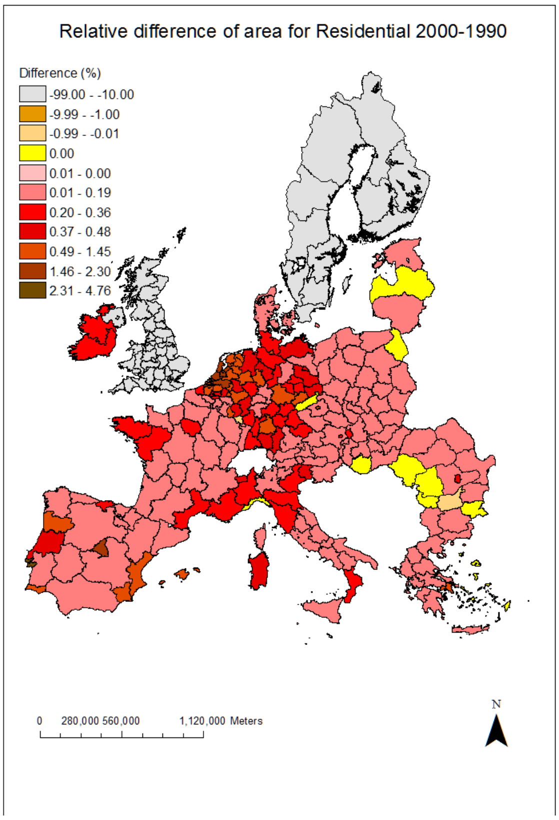

Figure 4.10 Change in surface share for Residential areas from 1990 to 2000

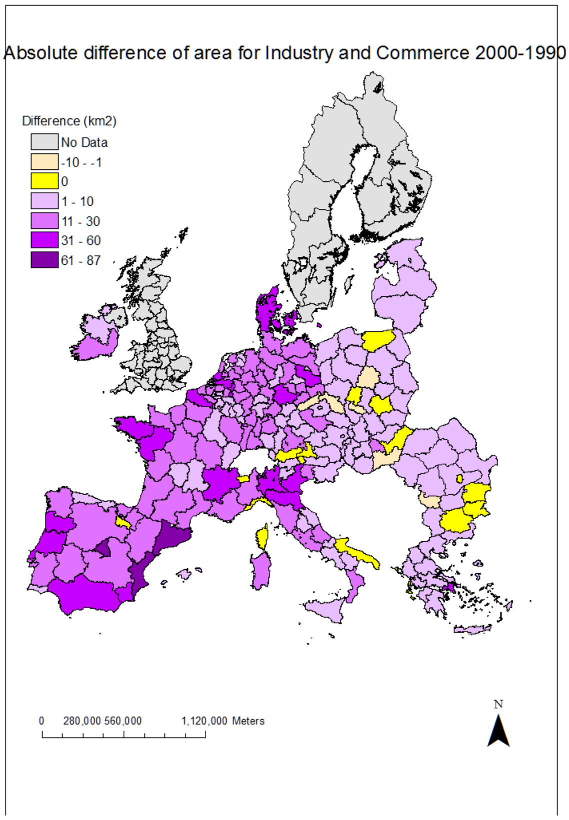

Figure 4.11 Absolute change of area for Industry and Commerce from 1990 to 2000

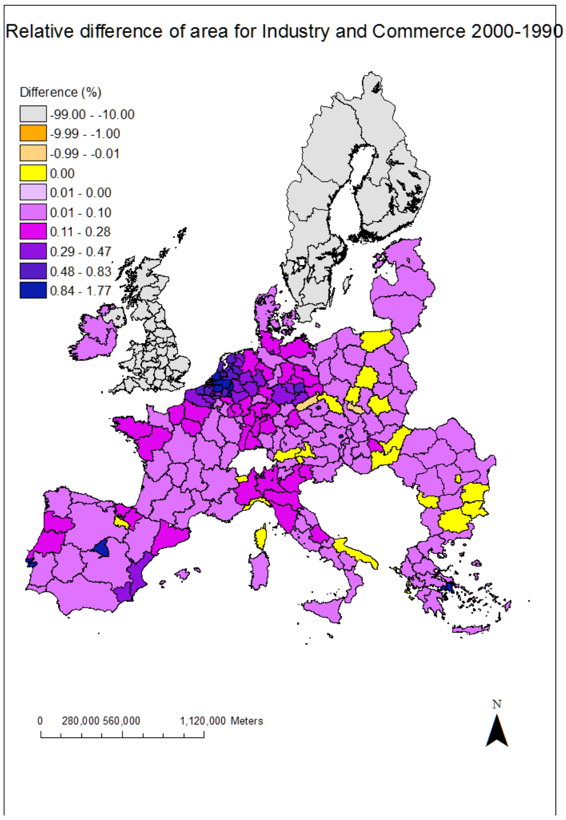

Figure 4.12 Change in surface share for Industry and Commerce from 1990 to 2000

Increase and decrease of land use

In order to analyse characteristics of the increase and decrease of the 6 land use classes specified earlier in this report, RIKS has developed the **NEIGHBOURHOOD ANALYSIS TOOL**. This tool measures the neighbourhood relations of locations that change land use. From these spatial relations we deduce location characteristics of appearing and disappearing land uses. The tool is explained in more detail in the next section.

Although the characteristics of the neighbourhood can be measured for all changing land uses, we focus this discussion on the analysis of the land use classes residential areas, forest and agriculture. We analyse:

- the **new residential** locations in 2000 in relation to the land use category on this location and its surroundings in 1990,
- the **new forest** locations in 2000 in relation to the land use category on this location and its surroundings in 1990,
- the **new agriculture** locations in 2000 in relation to the land use category on this location and its surroundings in 1990,
- the **agriculture locations that have disappeared** in 2000 in relation to the land use category on this location and its surroundings in 1990,
- the **forest locations that have disappeared** in 2000 in relation to the land use category on this location and its surroundings in 1990.

Results of the neighbourhood analysis

New residential in 2000 and its surroundings in 1990

There is a relative attraction for new residential locations in 2000 per group of countries. In general, new residential land uses have replaced industry & commerce, tourism & recreation and agriculture in all groups of countries. The latter is the strongest in the Mediterranean and Western Europe and indicates urban expansion at the cost of agriculture. From the graph we see no attraction of new residential areas (2000) to allocate on areas occupied by natural vegetation or forest in 1990.

In most of the groups of countries there is a high number of new residential locations and from this we can conclude that the statements made above are reliable. In the Baltic States, there was only an increase of 20 new residential cells over the period 1990-2000. Thus, although the result of the analysis points in the same direction of that of the other groups of countries, the result for this region might not be significant.

The observed values for industry & commerce and tourism & recreation could be the result of classification differences, since both are urban fabric. Minor changes can cause the classification to change from the one in the other. Very often urban land uses are difficult to distinguish and it happens that in one year a location is classified as residential and in the next as tourism & recreation. To make hard statement on the allocation of residential areas in 2000 on locations previously occupied by industry & commerce and tourism & recreation we would have to carry out more research. From experience we know that in some countries (especially in Western Europe) industry is relocated away from city centres and the space that becomes available is taken in by

other urban classes (very often residential). But, as said, this knowledge is not sufficient to make overall statements on the observed conversion.
We should also take into account in this analysis the fact that tourism & recreation covers a very small share of surface of the whole region. Therefore very few cells of that land use can cause a relatively strong effect in the overall figures.

Tourism & recreation, industry & commerce and residential areas have a higher than average attraction on new residential land use to allocate in their surroundings. This effect becomes clear because of the positive value for the urban land uses at x=1 to x=8. Forest and natural vegetation seem to provide an attraction less than average and agriculture around the average. From this we can conclude that people prefer to build new residential locations close to existing urban land clusters. Forest and natural areas do not seem to have a special attraction and this can be because of a lack of infrastructure, accessibility and services, or because of zoning regulations that prohibit new residential development in certain locations and stimulate them in other locations.

The results include the attraction of inland water bodies and marine water bodies. These are not the main studied land use categories in the current project, but these figures do provide us with extra information about the relation between the urban land categories and water bodies. They show various attractions per group of countries. In South-eastern Europe and Western Europe, inland water bodies were attractive for new residential in 2000. In Mediterranean and Western Europe, marine water bodies were attractive for new residential in 2000. This effect is probably due to the historical preference of cities to locate next to the coast, the river or the lake and does not so much reflect current preferences.

The attraction of new residential developments to marine waters is in the Mediterranean already present at a direct distance (x = 1), while in Western Europe we observe this only at distances from the sea that are greater than 3 kilometres.

New Agriculture in 2000 and its surroundings in 1990

Agriculture is often allocated on areas previously occupied by natural vegetation and to a lesser extent on areas previously occupied by forests. In the Baltic States we observe a different relation. Here, we see that agriculture has primarily replaced forested areas. This indicates the clearing of forests to provide space for agriculture. This conclusion underpins the conclusion made in the previous section where we noticed an increase in overall agricultural area and a decrease in overall forested area.
At larger distances (in the surrounding) agriculture seems to have a preference to allocate next to natural vegetation and ï to a lesser extentï to forest, as opposed to urban land uses. The only exceptions are (1) the Mediterranean, where there is a clear preference to allocate near natural vegetation, while forest has an attraction less than average and (2) the Baltic States, where natural vegetation does not seem to be a land use that attracts agriculture, while forest has a strong attraction.
In North-eastern Europe we see an attraction of new agricultural areas to industry & commerce, while in the Baltic States and the Mediterranean we experience the opposite effect.

New forest in 2000 and its surroundings in 1990

There is a relative attraction for new forest in 2000 per group of countries. We see that new forests often take in locations previously occupied by natural vegetation. Generally speaking, we do not see forest appear in 2000 on cell occupied by urban classes in 1990.

At a small distance (from 1 kilometre onwards), natural vegetation and forest were more attractive than average. Residential, industry & commerce and agriculture were less attractive than the average one. Agriculture was about the average attraction. Tourism & recreation was around the average attraction except for in Mediterranean. That's because the surface share of tourism & recreation of total region in Mediterranean was very small which causes small deviations to stand out. As for forest we can conclude from this that new forest appears on locations that are far from urban areas. Mainly existing forest areas grow, rather than new ones appearing.

Disappeared agriculture in 2000 and its surroundings in 1990

There is a repelling effect of land uses on agriculture per group of countries. In general, industry & commerce, tourism & recreation, residential are repelling agriculture. Partly this effect is not strictly repelling, but rather a stronger attraction to other land uses that replace agriculture, such as other urban land uses. This is particularly well visible in the vicinity of large urban areas that show a considerable increase, such as Rome and Lisbon. Forests and natural vegetated areas show less repulsion to agriculture in most groups of countries. Agriculture itself has an average effect. This conclusion confirms earlier observation that urban land uses primarily take over agricultural areas.

Disappeared forest in 2000 and its surroundings in 1990

In general, forest and natural vegetation were less attractive for forest in. That means, forest and natural vegetation were more attractive to other land uses than to itself. This is remarkable, since it indicates that not only small isolated patches disappear, which are surrounded by other land uses, but instead that typically the edges of larger patches are changed, or even holes in these patches.

This effect can to a large extend be explained by the appearance of new agricultural land use on locations that were previously covered by forests. Moreover it shows that it is not directly the expansion of urban areas that is repelling forested areas.

<u>Changes in land use patterns</u>

To analyze changes in land use patterns we use two different spatial metrics. For urban clusters we use a cluster size – frequency distribution, a measure that is closely related to Zipf's law. This metric indicates the way urban areas are developing. The direction of the change shows whether large clusters are growing or whether more small clusters appear. Since this distribution reflects the self organizing behaviour that is typical for urban land uses, it is not appropriate for other land use classes. Therefore we use the clumpiness index for the other land use classes. This metric measures to which extend these land use classes are clustered together or scattered apart. Hence from the two datasets we can analyse the development in these patterns.

Cluster size frequency relationship for Residential land uses

there are strong regional differences between the groups of countries in which Europe was subdivided. There were relatively much small cities in South-eastern Europe in both years compared with other group of countries, and there were many big cities in Western Europe and Mediterranean in compared with other group of countries.

The difference between the slope in 2000 and the one in 1990 indicate the trends of urban development per group of countries from 1990 to 2000. In Western Europe, the difference was almost zero. That means the cluster size distribution remained largely unchanged between 1990 and 2000. That can be explained because Western Europe is already very urbanized in 1990. In the Mediterranean, the difference of slopes (see annex III) is the highest among all groups of countries. The cities tend to increase into larger urban areas.

In general, all groups of countries show an increase in urban fabric over the analysis period, but in South-eastern Europe the number of small cities increases and in the Mediterranean this is true for the metropolitan areas. The graphs below show the results for each of the groups of countries. It should be noted that the graphs are shown on a logarithmic scale. Hence the differences are much larger than they appear.

Analysis of the clumpiness index for landscape patterns

The clumpiness index was used to analyse the characteristics and changes in landscape patterns. Although the results were measured for several land use categories, the analysis mainly focuses on the natural and agricultural land uses. Those classes are of prime importance in this study, and dynamics in residential patterns are already evaluated with the cluster size frequency distribution.

First of all we analyze the clumpiness for natural categories (forest and agriculture) per group of countries. The results of clumpiness analysis for urban categories (residential, industry & commerce, tourism & recreation) are available per group of countries as well. Larger values for the clumpiness index show that the patches of this specific land use is more compact. The difference of clumpiness of CLC2000 and CLC1990 shows the trend of change of patch for that land use type. If the difference is positive, it means that patches of this specific land use became more compact between 1990 and 2000. Otherwise, the patches of this specific land use are less compact in 2000 than in 1990.

Residential land use became more compact in 2000 than in 1990 for all groups of countries. That shows again the cities trended to urbanize development for all groups of countries. We derived the same conclusion from the analysis of cluster size and frequency for residential in previous section. Industry & commerce became more compact in 2000 for most groups of countries except for in Baltic States which have very slight decreased value. Agriculture became less compact in 2000 in most groups of countries except for in North-eastern Europe.

Agriculture in North-eastern Europe has the highest relative share of surface among other land uses. The agriculture areas were decreased in 2000 but agriculture clusters itself grew bigger .We can interpret that at the border of agriculture and other urban land categories, some small agricultural patches disappeared and were taken over by other urban land uses in 2000.

Forest became more compact in 2000 for most groups of countries except for Baltic States because in general, the forest areas were decreased a lot in this region in 2000. Some forest locations became natural vegetation in 2000 after cutting forested areas. Natural vegetation was on top of these forest locations. It caused the forest patch becoming less compact in 2000.

4.1.3. Conclusions for land use change analysis

At here, we only conclude the analysis results for groups of countries. Based on the analyses we mentioned above, we can conclude:

1. From the overview of appearance and disappearance, in 2000,

- Urban land categories (residential, industry & commerce, tourism & recreation) increase in all groups of countries; the urban land categories increased the most in Mediterranean.
- Agriculture appeared in Baltic States while disappeared in other groups of countries; agriculture decreased most in Western Europe, and then in Mediterranean.
- Forest appeared in North-eastern Europe and South-eastern Europe while disappeared in other groups of countries (especially in Baltic States); In the Baltic States, forests were mainly changed into natural vegetation.
- Natural vegetation disappeared in South-eastern Europe and Mediterranean while appeared in other groups of countries.

2. From growth or shrink analysis, in 2000,

- In general, new residential land use is allocated on areas that were agricultural land before. Moreover, urban land use classes show a stronger dependency with other urban land uses in their allocation then agriculture, forest and natural vegetation.
- In South-eastern Europe and Western Europe, inland water bodies were attractive for new residential; in Mediterranean and Western Europe, marine water bodies were attractive for the allocation of new residential land uses. We suspect this is due to the historical preference of cities to locate next to coasts or to rivers for their transportation function.
- New agriculture mainly appears on top of natural vegetation and forests in most areas. Moreover, agriculture is hardly, if at all attracted to urban land use functions. Instead it is attracted by forest and natural vegetation. This is probably for the availability of land; still it is remarkable since it is opposite to what neo classical economists predict as a result of transport costs to a central market. Agricultural areas close to cities again are often taken over by suburbanization.
- New forest was mainly found on locations with natural vegetation for all regions. Also new forested area are attracted to existing forested an natural land uses, than other land uses, which indicates that existing natural areas and forests are growing rather than new ones appearing.

3. Cluster size analysis in 1990 and in 2000,

- Although the log linear relation between city sizes and the frequency with which they occur is clearly apparent in all country groups, the actual distribution differs considerably among regions. South-eastern Europe shows an abundance of small sized cities, while both Western Europe and the Mediterranean are skewed towards the larger urban areas.
- The log linear relation was preserved over time, when measured from 1990 and 2000; however, the regions show a development towards larger urban centers. This is indicated by the positive change in slope in the cluster size frequency distribution over time.
- The exception to this is Western Europe, where the distribution remains largely constant, probably since this area is already very urbanized by 1990 compared to the other country groups. At the other hand, even though the

Mediterranean was already heavily inclined towards larger metropolitan areas too, this preference increased over time from 1990 to 2000.

- From the analysis of the land use patterns by means of the clumpiness analysis we can say that urban land use became more compact over time in all areas.
- Patches of forest show the same trend, since they also became more compact over time, except for the Baltic States. The latter can be explained by the clear cutting that takes place there to allocate new agricultural areas. At the other hand, agriculture shows an opposite trend, since the distribution thereof became more scattered over time.

4.2 - Integration of socio-economic trends with land-use trends and defining hypothetic scenarios based on trends detected

4.2.1. Comparison between the results of the socio-economic analysis and those of the land-use analysis (trends during the 1990s)

The purpose of the comparison is the search of possible inconsistencies, which would need to be explained. The comparison is subject to substantial limitations due to availability of suitable data. The study period for land-use changes is 1990-2000 while that for the socio-economic analysis is 1995-2005. This is of particular significance for the countries of central and Eastern Europe, which were subject to strong dynamics during the late 1990s and the early 2000s.

A particularly important interface between land-use changes and socio-economic evolutions is the urbanization process. The land-use analysis confirms a well-known phenomenon regarding the urbanization process which is that it takes place in various stages and there are wide differences throughout Europe as to the stage of the urbanization process which is taking place. Urbanisation started first in North-West Europe, while the process developed later in the Latin countries.

Although the land-use analysis indicates that the residential cluster size in urban development remained constant during the 1990s in Western Europe, the socio-economic analysis shows that in 90% of agglomerations of the EU population in the suburbs grew more than in the core city. As far as Western Europe is concerned, moderate increases of population accompanied by a large expansion of urban areas could be observed in Ireland and the Netherlands. A relative decline of population in the core coupled with growth in the suburbs was particularly marked in the large cities of Dublin, Berlin, Munich and Vienna, but also around second tier cities, especially in Austria and East-Germany.

There is a convergence between both analyses about the strong suburbanization process around Mediterranean cities and along the Mediterranean coastlines. This is especially true for Rome, Athens, Lisbon and a number of second-tier cities in Italy. Moderate increases of population accompanied by a large expansion of urban areas can be observed in Spain and Portugal. This is related to the fact that the wave of urbanization (development of large cities) came later in the Mediterranean countries than in North-West Europe and that Mediterranean cities were traditionally much more compact than those of northern and central Europe. The dispersal process has been strong around Mediterranean cities during the 1980s and the 1990s, although it seems to have been slowing down more recently.

With regard to eastern and southeastern Europe, clusters of compact cities are also evident. The compact urban form and high densities mainly reflect the strongly centralized planning regimes and substantial reliance on public transport that prevailed during the communist era. Rapid urban sprawl has developed in the late 1990s and early 2000s, mainly around the capital cities (Prague, Bratislava, Budapest, and Warsaw). The land-use analysis indicates that in southeastern Europe the urbanization process in the 1990s has been based on small cities, which is a slight divergence with the socio-economic analysis. This probably results from the fact that large cities are less numerous in central and Eastern Europe than in Western and Mediterranean Europe.

With regard to the land-use evolution in rural areas, if one excepts suburbanization and the development of settlements (tourism, location of retirees), the main driver of land-use change is the evolution of the agricultural and forestry sector. This evolution differs significantly between western and eastern Europe. Employment decrease in the primary sector is much stronger in Eastern Europe than in Western Europe, where it has already taken place a long time ago. The added value generated by the primary sector in Eastern Europe has however been significantly growing. This is materializing, in land-use terms, by the development of agriculture and/or forestry in former natural areas, as it is occurring in the Baltic States, north-eastern and south-eastern Europe. This trend is clearly shown by the land-use analysis which also provides evidence for the fact that the size of agricultural land is, on the opposite, shrinking in Western and Mediterranean Europe.

4.2.2. Construction of scenarios

Hypotheses for the Trend (baseline) scenario 2015 (from ESPON Project 3.2.)

By nature, a baseline scenario is based on the continuation of trends and on the principle that no major changes occur in main-stream and on-going policies applied which have played a part in shaping them. It is however important to consider that in certain fields, such as demography, the evolution over past decades (structural development of the European population, with decreasing fertility rates and mortality rates, leading to population ageing) is also valid for the coming decades, while in other fields, such as energy (particularly price), the recent developments seem much more relevant for the future than trends over a longer period. In addition, a baseline scenario has also to consider a number of policy measures adopted recently (such as the Kyoto agreement), even if the impacts of such measures are not yet well known. In other words, a baseline scenario is not identical to the extrapolation into the future of long-range past evolutions.

Demography	- population ageing as a result of lower fertility and mortality rates - Stable total European population (+ enlargement) - Increasing, but globally controlled external migration - Unchanged constraints on internal migration
Economy	- Slowly increasing total activity rate - Slowly growing R&D expenditure, but constant technological gap vis-a-vis the USA - Decreasing public expenditure
Energy	- Steady increase of energy prices - Stable or decreasing European energy consumption - Increasing use of renewables

Transport	- Continued growth of traffic, but moderately curbed by energy price with possible modal shift - Constant increase of infrastructure endowment, but below demand needs - Partial application of the Kyoto Agreement
Rural development	- Further liberalization of international trade - Increasing industrialization of agricultural production, including the production of bio-fuels - Further diversification of functions of rural areas; stronger dependence upon the residential economy and new forms of tourism - Progressive reduction of CAP budget
Socio-cultural sector	- Heterogeneous and insufficient policies related to integration - Growing ethnic, religious and social tensions
Governance	- Increasing co-operation between cross-border regions - Increase in multi-level and cross-sectorial approaches, but limited to specific programmes (rural development); - Maintenance of competition and incoherence between policies devoted to innovation and competitiveness and others devoted to cohesion
Climate change	- Moderate overall climate change (+1°) - Increase in extreme local events - Moderate emission levels due to new technologies - Few (too few) structural adaptation measures
Enlargement and related EU policies	- No further EU enlargement before 2015 - Modest impact of neighbourhood policy

Hypotheses for the long-term scenarios (2030)

The two contrasting scenarios for 2030 ("Metropolitan growth" and "Revival of rural development") are based on the following sets of socio-economic hypotheses:
Socio-economic hypotheses for the construction of scenarios

The trend analysis over the decade 1995-2005 has clearly shown the continuation of the polarization process in and around metropolitan areas which means at the same time a contraction process at large-scale, largely at the expense of areas which are not under metropolitan influence, and the dispersal process at the scale of metropolitan regions, urban sprawl being the most common characteristic of this process. It is, however, obvious that significant differences exist between the various parts of the EU territory with regard to the speed and intensity of such processes. The main driving force behind this dominating process is the progressive move of the European economy towards the production of knowledge-based added value in the context of accelerating globalisation.

Even before the economic crisis and recession of 2008/2009, a number of factors were strongly moving, such as energy prices and the need to curb down climate change. The economic crisis has brought was it not only a drop in the general economy performance, but also uncertainty about the continuation of dominating processes. Some aspects of globalization have been reduced, especially international trade and international/intercontinental travelling. New growth factors are emerging, such as those related to the "green economy". In such a context, long-term scenarios are meaningful to highlight the possible physical impacts of alternative socio-economic trajectories. In this respect, two alternative long-term scenarios have been elaborated. The first is based on the accentuation and strengthening of the well-known dominating driving forces: knowledge economy and globalisation. This scenario leads to stronger territorial contraction and to further growth of metropolitan areas, with significant urban sprawl around them. Policies support this trend, which is considered as a guarantee of European competitiveness, and neglect rural areas. Various rural areas draw, however,

benefits from metropolitan growth, especially those which are attractive for ñurbanitesò (second homes, retirement, commuting etc). The second scenario is based on a lasting crisis of the European mainstream economy which cannot maintain its competitiveness in the global context, while rural areas benefit from new development potentials related to growing global demand of food products and of renewable energy. Metropolitan areas are declining. Urban-rural migrations are developing and rural areas are intensively used.
There is not, still a Corine Land Cover model forecasting land use changes due to Climatic Change. Because of this, it is not possible to include Climatic Change in this analysis. Moreover, this analysis has been done with hypothetic scenarios up to 2030, and in this period, land use changes from human activities seem to be much more important than those coming from Climatic Change.

Metropolitan growth

- Strong development of the knowledge and intangible economy
- Further liberalization of international trade, including agricultural products;
- Growing R&D expenditures in EU and national policies; reduction of support to less developed and more rural regions (CAP; structural funds)
- Steady but limited increase of energy price
- Stronger demographic and economic dynamics in metropolitan regions than in the more rural regions and than in old industrial regions
- Stronger dependence of rural areas upon alternative income sources (residential economy; new forms of tourism; organic agriculture etc.); decline of the less attractive rural areas

Revival of rural development

- The external competition (accelerating globalization) from emerging economies hits strongly the international competitiveness of the European economy, especially of the knowledge and intangible economy. Decline of European exports in high-tech and advanced services sectors;
- Very high energy prices affect more the large urban regions which are highly dependent upon transport functions
- Decline of metropolitan growth; recession in large urban regions;
- Strong demand for renewable energy and food products at world scale
- Intensification of agricultural and forestry production in rural areas
- Revitalisation of rural areas in western and eastern Europe, partly based on external investments
- Development of migration flows from urban to rural areas

In order to carry out the scenarios study, five **METRONAMICA** applications are set up which include Cyprus, Finland, Malta, Sweden and the United Kingdom. Table 4.7 shows the list of group of countries during scenarios study. United Kingdom is in the Western Europe group. Cyprus and Malta are in the Mediterranean group. Finland and Sweden are grouped in the Scandinavia. Since there was no land use data for these countries for 1990 and 2000 they were not calibrated. Therefore we used the same parameter values as found in the Baltic States and North-eastern Europe for the application of Scandinavia.

Table 4.7 Group of countries list for scenarios

NUTS-0	Name	Group of countries for Scenarios
EE	Estonia	Baltic states and North-eastern Europe
LT	Lithuania	Baltic states and North-eastern Europe
LV	Latvia	Baltic states and North-eastern Europe
CZ	Czech Republic	Baltic states and North-eastern Europe
PL	Poland	Baltic states and North-eastern Europe
SK	Slovakia	Baltic states and North-eastern Europe
BG	Bulgaria	South-eastern Europe
HU	Hungary	South-eastern Europe
RO	Romania	South-eastern Europe
SI	Slovenia	South-eastern Europe
ES	Spain	Mediterranean
GR	Greece	Mediterranean
IT	Italy	Mediterranean
PT	Portugal	Mediterranean
CY	Cyprus	Mediterranean
MT	Malta	Mediterranean
AT	Austria	Western Europe
BE	Belgium	Western Europe
DE	Germany	Western Europe
DK	Denmark	Western Europe
FR	France	Western Europe
IE	Ireland	Western Europe
LU	Luxemburg	Western Europe
NL	The Netherlands	Western Europe
UK	United Kingdom	Western Europe
FI	Finland	Scandinavia
SE	Sweden	Scandinavia

Procedure to create scenario input

Scenarios and data

TERSYN has provided the projection of GDP and population per NUTS-2 for 3 scenarios: Baseline in 2015, Metropolitan growth in 2030 and rural development in 2030. Data for the GDP and population per NUTS-2 region in both 1990 and 2000 are available from Eurostat. The area demands per land use category for NUTS-2 regions in 1990 and in 2000 were calculated from the CLC maps.

To visualise them, it can downloaded the Map Comparison Kit from the RIKS website www.riks.nl/mck (it is a free tool funded by the Netherlands Environmental Assessment Agency) and it is possible to open and compare the maps in this tool. It allows making screenshots and it is possible to zoom in certain regions to see the details. The tools allow comparing land uses between different years and different scenarios, e.g. the forest locations in both scenarios in 2030.

<u>Demands for the Metropolitan growth scenario</u>

For the metropolitan growth scenario, the projection of GDP per NUTS-2 and population per NUTS-2 are used to calculate the industry & commerce and residential cells for 2030 per NUTS-2. The tourism and recreation demand is calculated by taking the maximum value of the number of cells of tourism and recreation in 2000 and the extrapolated trend of tourism from 1990 to 2000.

In the metropolitan scenario, there will be land abandonment that causes agriculture to convert in forest and natural vegetation. The proportions of agriculture decrease in the period 2000-2030 are various for each group of countries (see table 4.8.). First of all, a general percentage of agriculture decrease from 2000 is given. Then the adjustment is made for specific regions which is the case that there is no enough space available to allocate the industry and commerce and residential.

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Table 4.8 Agriculture and forest demand in metropolitan growth scenario

	Agriculture	Forest
Baltic states and North-eastern Europe	5% decrease in general from 2000; 10% decrease particularly for PL11, PL12, PL21, PL22, PL33, PL41, PL42, PL51, PL52, PL 61, PL62, CZ08, CE05, SK03, SI04	new forest is converted on the 5% decreased agriculture according to the ratio of forest and natural vegetation in 2000
Scandinavia	5% decrease in general from 2000; 10% decrease particularly for SE01, SE04, SE06 and SE0A	new forest is converted on the 5% decreased agriculture according to the ratio of forest and natural vegetation in 2000
South-eastern Europe	5% decrease in general from 2000;	new forest is converted on the 5% decreased agriculture according to the ratio of forest and natural vegetation in 2000
Mediterranean	5% decrease in general from 2000; 15% decrease particularly for ITC1, ITC4, ITD3, ITD5, ES30 and PT17	new forest is converted on the 5% decreased agriculture according to the ratio of forest and natural vegetation in 2000
Western Europe	10% decrease in general from 2000; 15% decrease particularly for the Netherlands	new forest is converted on the 5% decreased agriculture according to the ratio of forest and natural vegetation in 2000

<u>Demands for the rural development scenario</u>

For the rural development scenario, the projection of GDP per NUTS-2 and population per NUTS-2 are used to calculate the industry & commerce and residential cells for 2030 per NUTS-2. The demands for tourism and recreation is calculated by taking the maximum value of the number of cells of tourism and recreation in 2000 and the trend of tourism from 1990 to 2000. The following formulas are used to calculate the urban land use demand for the year

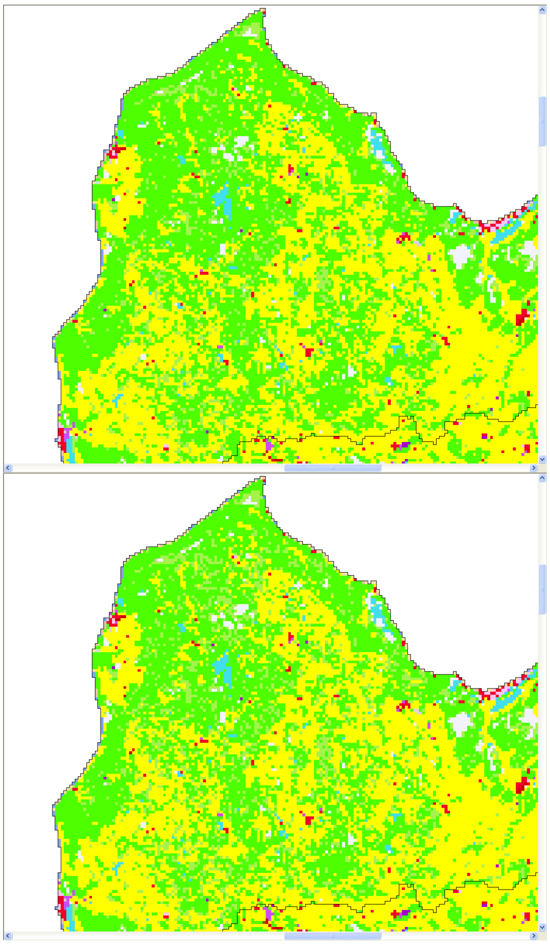
In the rural development scenario, there is an expansion of agricultural areas and forests at the cost of natural vegetation. However, for some regions in this scenario, the land use demands exceed the available space. Therefore, specific adjustments were made for some regions. The amount of change for agriculture and forests in the period 2000-2030 is given for each group of countries in table 4.9

Table 4.9 Agriculture and forest demand in rural development scenario

	Agriculture	Forest
Baltic states and North-eastern Europe	0.3% increase in general from 2000; 10% decrease particularly for PL11, PL12, PL21, PL22, PL33, PL41, PL42, PL51, PL52, PL 61, PL62, CZ08, CE05, SK03, SI04	0.3% increase from 2000
Scandinavia	0.5% increase in general from 2000; 5% decrease particularly for SE01, SE04, SE06 and SE0A	0.5% increase in general from 2000; constant forest 2000 for SE01, SE04, SE06 and SE0A
South-eastern Europe	5% decrease in general from 2000;	constant forest 2000
Mediterranean	2% increase in general from 2000; 10% decrease particularly for ITC1, ITC4, ITD3, ITD5, ES30 and PT17	0.5% increase in general from 2000; constant forest for ITC1, ITC4, ITD3, ITD5, ES30 and PT17
Western Europe	5% decrease in general from 2000; 15% decrease particularly for the Netherlands; 10% decrease for AT13, BE10, BE21, BE22, BE23, BE24, BE25, BE31, DE30, DE50, DE60, DEA1, DEA2, DEA5, FR10, LU00, UKD3, UKD5, UKI1, UKI2	0.1% increase from 2000

4.2.3. Analysis of results

The starting point for the scenario analysis is the baseline scenario, which is an extrapolation of the trends that we observed historically. This scenario was run until 2015 and we analysed the results again visually, since there is no reference result yet. An example of this is shown in the maps in figure 4.13. To closer investigate the changes per land use, figure 4.14 shows the changes for two land uses specifically, agriculture and forests. Both cases show a consistent change, both in pattern and in quantity, as expected from the baseline scenario.



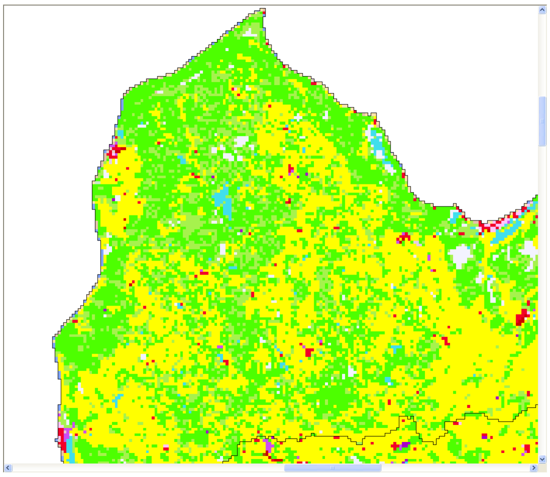


Figure 4.13 Land use maps for western Latvia for 1990, 2000, and 2015 (top to bottom). Close investigation shows a consistent decrease in forested areas that is partly taken over by new agricultural areas.

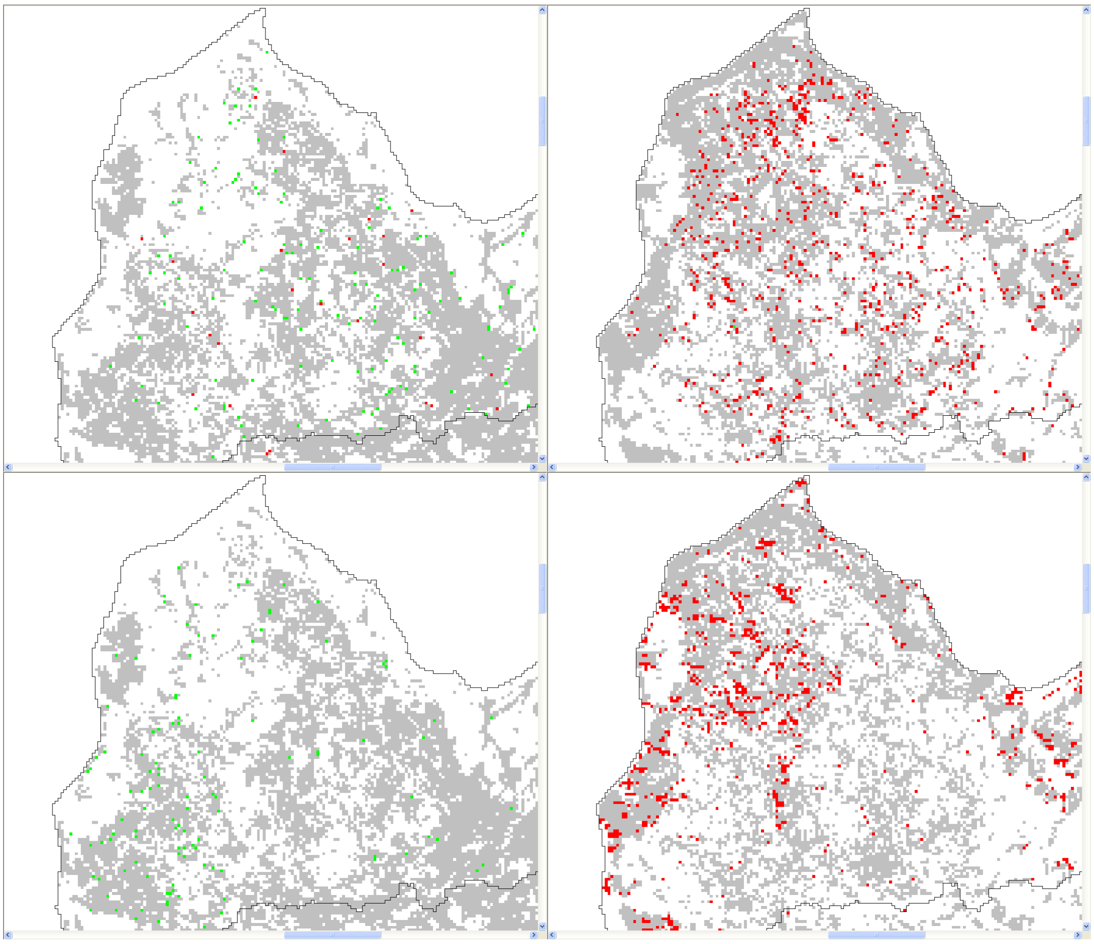


Figure 4.14: Maps indicating the difference per land use between 1990 and 2000 (top) and between 2000 and 2015 (bottom).The left two maps show the change in agricultural land and the maps on the right hand side show the difference in forested areas. For all maps, grey indicate that the land use is present in both points in time, green locations are those where the specific land use appeared over time, while red depicts the disappearance of the subsequent land uses.

The next step is the divergence into two different scenarios, the rural development and the metropolitan development scenario. Comparison of the two scenarios clearly shows a difference between the amount as well as the allocation of land use changes. This difference in allocation includes both the allocation of natural and agricultural areas as well as that of urban land uses. Moreover, the differences become clear at two levels. At first the regional demands for land use classes are substantially different in the two scenarios, also the land use patterns that are generated from these demands show different characteristics.

Generally speaking, the rural development scenario shows a much more disperse development. On the one hand this means that regions that are less central and further from the large urbanized areas are developing stronger, and at the other hand it means that the new developments within this region are less clustered, and rather focussed on small cities. This development pattern is best visible in the allocation of urban land uses, such as residential land use and industrial land use. But the allocation of these land uses largely influences the agricultural and natural land uses as well.

Figure 4.15 below shows a cut-out of the generated land use maps in the south-western part of France. The left hand shows the rural development scenario, while the right hand side shows results for the metropolitan development scenario. The maps clearly show that the allocation of new industrial land use is scattered over the region in the rural development scenario and clustered around Bordeaux in the Metropolitan scenario. Figure 4.16 shows the allocation for new land uses for to types specifically: commercial and industry and forests. This figure shows more clearly the difference in amount as well as allocation of both the urban and natural land uses.

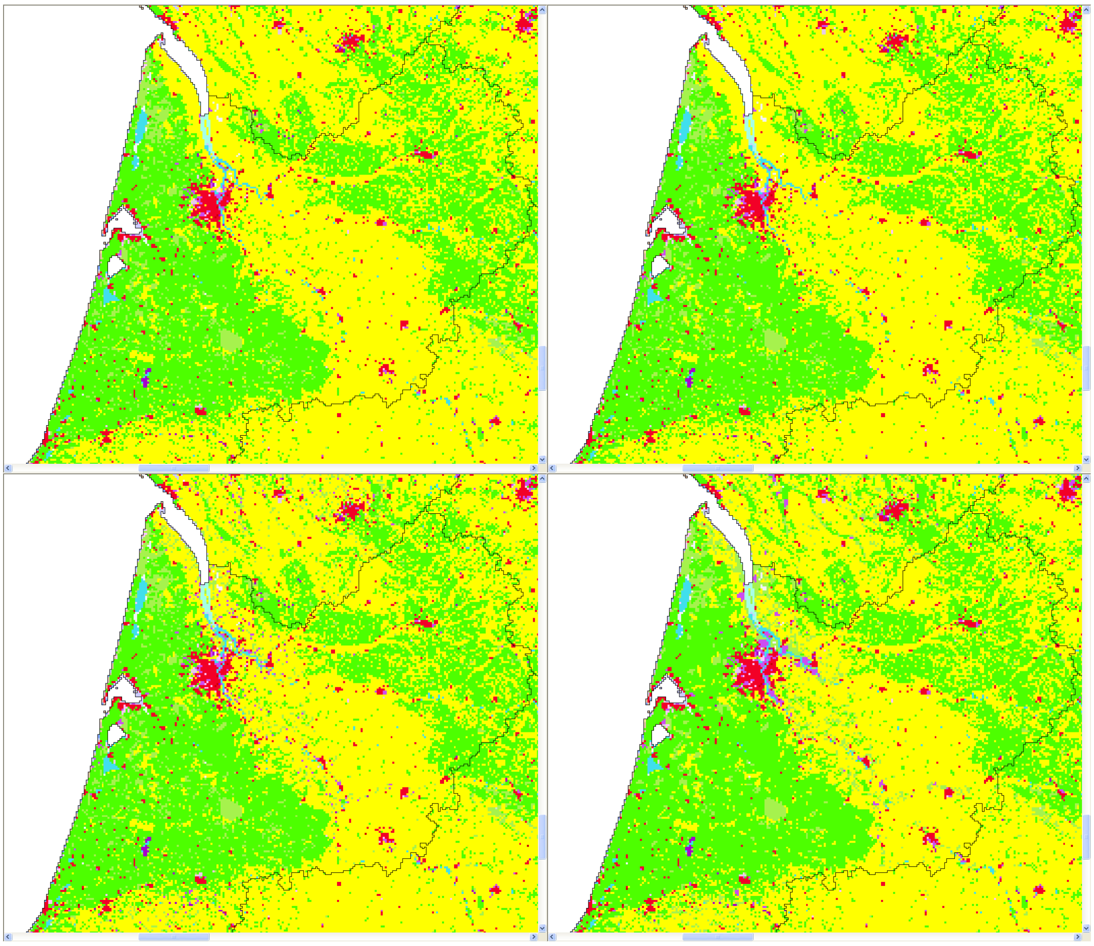


Figure 4.15 Land use maps for 2000 (top) and 2030 (bottom). The maps on the left show the results for the rural development scenario, maps on the right for the metropolitan scenario.

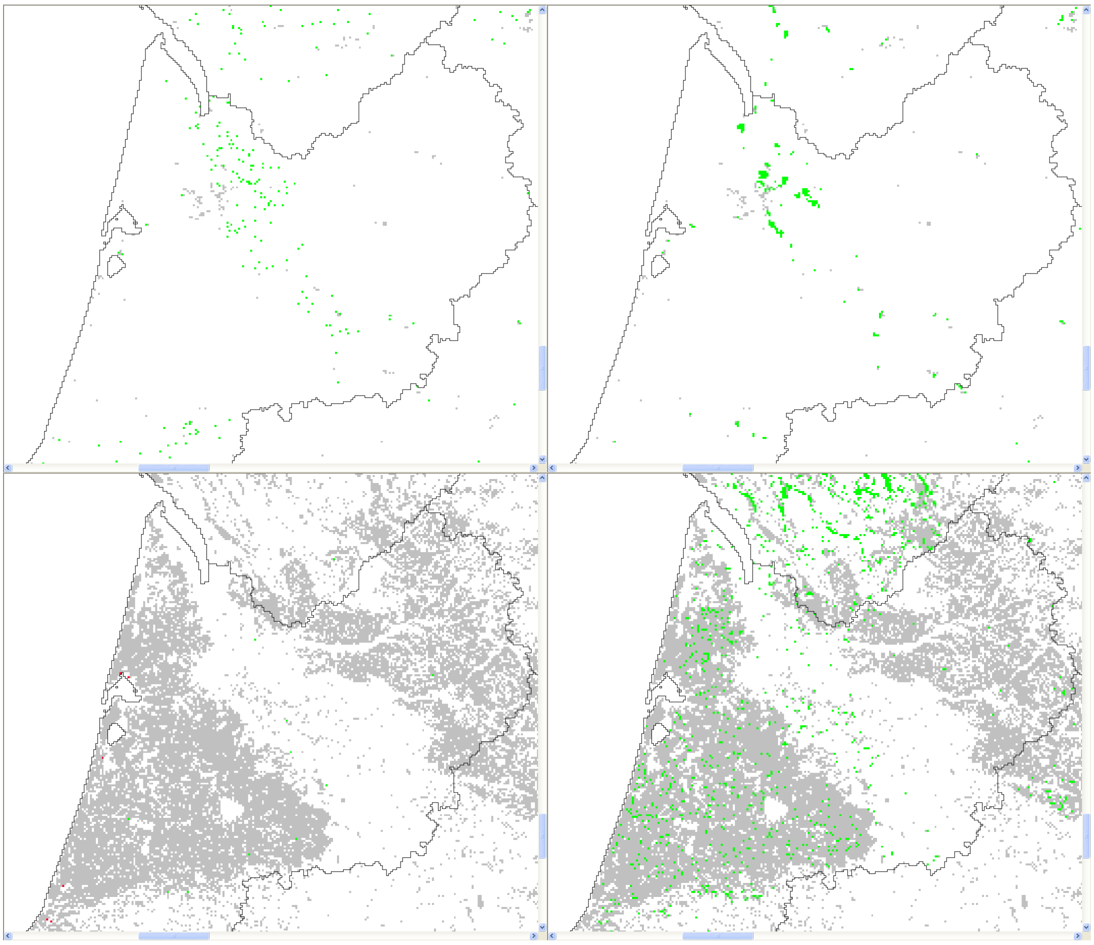


Figure 4.16 New commercial and Industrial land use (top) and forested areas (bottom) for the two scenarios. Maps on the left show the results for the rural development scenario and on the right for the Metropolitan area. Green cells depict those locations where the respective land uses appeared between 2000 and 2030.

Analysis of the land use patterns

The advantage of objective measures over human interpretation is obviously the ability to quantify results, which is helpful in the analysis of the land use patterns that are generated in the two scenarios. The cluster size frequency graphs show that indeed the type of differences that were anticipated in advance.

The rural development scenario shows an increase in the number of smaller clusters which is visible at the left side of the graphs. Of course this comes at the cost of the larger urban areas, which are not growing that much. The development in the Metropolitan scenario is exactly opposite; since it clearly shows that the largest clusters are growing more than in the other scenarios. This is visible form the rightmost point in the graphs shown below.

4.2.4. Conclusion of the scenario study

Three scenarios were used to create maps that show possible future land use. First there is the baseline scenario that is an extrapolation of current trends until 2015. Derived from that, two scenarios were used to create possible future land use maps for 2030. These are the rural development scenario and the Metropolitan scenario.
From the analysis of the land use maps we can say that the land use patterns that are generated are reasonable and realistic, for both scenarios. They show on a macro scale the type of patterns as well as differences that were anticipated in advance. However, a closer look at some specific regions raises the question if NUTS 2 regions are the appropriate scale for extrapolation of land use trends, since sometimes trends in neighbouring regions are opposite to an extend which is reasonable over small time scales but not when continued in an extrapolation.
Moreover some NUTS2 regions have little space left to make deviations from the baseline scenario. Specifically, the rural scenario predicts an increase in agricultural land, which was not feasible in every region for the lack of space. This required manual adjustment of the land use demands. As said, the land use that was generated eventually was realistic, but it required assumptions to come to that result.

4.3. Measuring the Integration of Natura 2000 Network into a Broader Countryside

4.3.1. Introduction

First question to measure the integration of protected network of natural areas is to define what we understand by integration. In this work we have interpreted the concept as the capacity of the landscape matrix surrounding the protected area to allow the flow of wild species and habitats. Then we may say that a protected area is well integrated into a wider countryside if the connectivity of the surrounding unprotected landscape is adequate for the species and habitats sheltered in the protected area.

This is a preliminary step to connectivity studies and it is addressed to know the average conditions for connectivity of unprotected landscape in the European regions. In other words, to have an idea of the boundary conditions for connectivity of European landscapes. Boundary conditions are the ensemble of external agents or factors, which have a defined effect (positive or negative) on dispersion of habitats and species. They include physical properties of the environment as climate, lithology, topography and the properties derived from human land use.

The approach of this work considers that wild species and habitats have no difficulties to flow inside the natural protected areas where they belong. The basic assumption is that, the more similarity there is between protected and unprotected landscape, the more favourable the conditions are for the populations of target species to transit across a given territory. The most direct way of measuring this integration is to compare land uses inside and outside the protected areas using statistical tools in order to know how different or similar two areas are.

So the base hypothesis is that land use differences between protected and non protected land decrease the overall ecological connectivity of a given region. The basic data are land use Corine Land Cover classes aggregated to LUMOCAP (See Table 1) categories in order to apply the selected index and 2000-SCI. The reason for using the CLC classes grouped in Lumocap Classes is that this allows us to apply the selected index in the scenarios generated by LUMOCAP to our previous assessment on land use changes in the EU (CLC) in hypothetical socio-economic scenarios.

Table 4.9 CLC level 2 classes reclassified to LUMOCAP classes and simplified for analyses purposes.

Value	LandCover	**New value**	**New LandCover**
0	Natural vegetation	**1**	Natural vegetation
1	Agriculture	**2**	Agriculture
2	Residential	**3**	**Artificial**
3	Industry and Commerce	**3**	**Artificial**
4	Tourism and Recreation	**3**	**Artificial**
5	Forest	**4**	Forest
6	Open spaces with little or no vegetation	**5**	Open spaces with little or no vegetation
7	Infrastructure	**3**	**Artificial**
8	Port area	**3**	**Artificial**
9	Airports	**3**	**Artificial**
10	Mineral extraction sites	**3**	**Artificial**
11	Dump sites	**3**	**Artificial**
12	Inland wetlands	**6**	Inland wetlands
13	Marine wetlands	**7**	Marine wetlands
14	Inland water bodies	**8**	**Water**
15	Marine water bodies	**8**	**Water**
16	Beaches, dunes and sands	**9**	Beaches, dunes and sands
17	Land outside modelling area	**0**	
18	Water outside modelling area	**0**	

4.3.2. Selecting and testing coefficients

To measure the resemblance, one statistical tool has been chosen among several statistical coefficients. Three types of coefficients have been selected for this purpose. Those types are coefficients of similarity, distance and dissimilarity. Nine coefficients have been tested: Gower, Steinhauss, Kulczynski, X^2 probability, Orloci Chord, Whittaker, X^2 distance, Gower metric and the Bray & Curtis Index. (See Annex III. - Coefficient benchmarking).

Conclusions of the coefficient benchmarking are that the selected coefficients reflect correctly the resemblance between protected and unprotected land. Both distance and dissimilarity coefficients are appropriate. Orloci and Gower metric are respectively the best ones.

The overall best performer was the Orloci chord index, which shows in a monotonous form (i.e. the values of the index are proportional to the changes in the attributes) the dissimilarity within the range 1 to 1.414. This index is sensitive enough and will be the only one used in further tasks.

4.3.3. The Orloci Chord Index

The metrics and the measuring procedure.

The method is based on the application of a dissimilarity multivariate index (Orloci Chord Index) to measure the resemblance among two vectors *Y1 &Y2,* associated, respectively, with the N2000 Network territory and the unprotected territory. The said vectors have the absolute frequencies of *p* classes of land use compiled inside a given region, which is attributed the value of the index.

Orloci chord is then formulated in this way:

$$\sqrt{2\left(1-\frac{\sum_{j=1}^{p} y_{1j}y_{2j}}{\sqrt{\sum_{j=1}^{p} y_{1j}^{2}\sum_{j=1}^{p} y_{2j}^{2}}}\right)}$$

Where, y1 & y2 are the class frequencies *j*. Said frequencies can be obtained from a land use map by simply counting the number of cells if we work in a raster format or using polygon areas in a vectorial format. They can, also, be directly specified when building a prospective scenario.

Calculated in this way, the Index, render values between a range from 0 to 0,1414 (ã2, sensu stricto) which corresponds to the lower and higher levels of dissimilarity respectively. Among the properties of the Orloci chord we should remark: i) expresses the distance among objects in a metric way and can be used to represent spatial positions in a consistent manner. ii) normalizes the incoming frequencies so it can be used with samples of different size; iii) it is asymmetric because it excludes double absences of the analysis (ie, land uses classes absent in both vectors are not taken in account); iv) it is linear because numeric results are directly proportional to the differences among the objects.

Orloci Chord Index was selected as best Index to measure the resemblance among protected and unprotected areas, however, it was considered important to check the response of the Index to different levels of administrative territories.

To analyse the response of the Orloci Chord index to different level of administrative territories, Spain was chosen for a case study, because the team involved in the work knows well the matter of nature conservation in this country, so it makes it easier to interpret results. (See Annex IV. - Spain Case Study)

The analysis was developed at three levels: 1) biogeographical regions, 2) NUTS 2, regions, 3) NUTS 3, regions.

The results of the statistical analysis showed that values of Orloci Index amongst NUTS-2 and NUTS-3 are not significantly different taking the whole territory into consideration. This is also valid if the regions of the Mediterranean, Atlantic or Alpine are analysed alone. As a result, any of the two levels NUTS 2 and NUTS 3 can be used to examine the Orloci Index in Spain. The only difference is that NUTS 3 will be more detailed than NUTS 2, but the conclusions will be identical when referred to a level NUTS 1.

Values for Orloci Index are significantly different between biogeographical regions at the level NUTS 2 and also at the level NUTS 3. When observed at both, NUTS-2 or NUTS-3, levels and referred to the upper level, NUTS 1, those differences keep their sense. Hence, the Orloci Index is sensitive to biogeographical regions, whatever the level of application (NUTS 2 or NUTS 3).

4.3.4. Conclusions for Orloci Chord Index Analysis

Before doing the analysis of the results of the Orloci Chord Index, we have made several assumptions to set the basis of the analysis and we take as given that:

a) Boundary conditions for connectivity inside the protected areas are adequate to the habitats and wild species from those areas.

b) The degree of conservation of habitats and wild species populations of the protected areas are the best possible for the harbouring region, taking in account the limitations of the region. However they might not be the optimum for the habitats and species considered. In other words, the region has protected the best-preserved examples for the habitat and wild species populations considered.

We assume that a protected area is not well integrated in the rural landscape when this protected area is isolated from other protected areas and surrounded by a completely different landscape. In this case, natural habitats and species populations of the protected area will have a lot of difficulties to flow through unprotected landscape to reach the nearest protected areas. Hence a protected area will be well integrated when it is connected to other protected areas through a landscape very similar to the landscape of the protected area.

Orloci Cord index measures dissimilarity between two groups of numbers. The higher the index is, more different will be the two groups of numbers. The lower it is more similarity between the two groups of numbers.

The two groups of numbers chosen in this analysis are the land use classes of CLC 2000, reclassified to LUMOCAP classes, inside and outside the protected areas. Highest Orloci values mean worst integration of Natura 2000 Network into a wider landscape and hence worst boundary conditions for connectivity. It means that the landscape in Natura 2000 sites for this region is very different from that which occurs in unprotected sites outside Natura 2000, so species and habitats of protected sites will have more difficulties to transit across unprotected landscape of this region.

The Orloci cord Index should be taken as a measure for the general conditions of integration in a given region, but then a deeper analysis should be done if we want to know the reasons for a given result. The Orloci Chord Index estimates the degree of isolation of the Natura 2000 network with respect to the surrounding landscape. It does not measure the overall conservation performance in a given region, but the permeability of the non-protected territory to the flow or transit of the habitats and species harboured in the protected areas. This permeability is conditioned by natural or artificial reasons.

There are regions in Europe with a very good (a lot of diversity and harbouring priority habitats and species) and even, well connected Natura 2000 network, but with no relation at all with the unprotected landscape. This means that the unprotected landscape will have bad boundary conditions for the connectivity for the habitats and species included in the protected network. Those habitats and species will have problems to transit across the unprotected landscape.

In a given region with a low Orloci Index, the protected areas network can be scattered, small and without connection amongst them, but the unprotected landscape will present a high permeability to the flow of natural habitats and wild species.

This conjoint functioning among protected sites and unprotected landscape is what we understand as integration of protected areas into a wider landscape. Then, the Orloci Chord Index is a good tool to measure the integration of Natura 2000 network into a wider countryside.

The index is like a red light system: it shows when a region or a province has a bad integration of Natura 2000 Network into a broader countryside and hence landscape permeability problems. This is valid always. Then a deeper observation should be done to determine why there are connectivity problems.

Such landscape permeability problems (high Orloci Index) may be produced due to several reasons:

1. - The network has protected the most pristine sites and the landscape outside is not related with the protected habitats. This happens in most of the European regions that harbour very big and healthy protected areas.

2. - There is a big ecological contrast among the protected sites and the unprotected sites, due to natural reasons, i.e. mountains versus plain lands.

3.-The landscape in the region is so transformed and humanised that protected sites are completely isolated even if the protected areas are not so valuable from the conservation point of view.

4. - The network is not complete and some of the unprotected landscape should be protected.

To minimize the effect of ecological contrasts the biogeographical regions at NUTS 2 levels have been taken into account. However it is very difficult at this scale, and within the same biogeographical region, to avoid ecological contrasts amongst mountain areas and lowland areas, especially when there is a lack of, or only a few protected sites, in one of the two areas. This is more evident when a third ecological environment appears, as it is coastal areas.

This level of analysis does not take into account the fragmentation of the territory produced by linear infrastructures, so this is another good reason, whatever the results of this analysis, to develop deep connectivity studies.

4.3.5. Results for European Biogeographic regions

Applying Orloci Chord Index (OCHI) to European biogeographical regions shows the following results. The region with the lowest score (an OCHI of 036971) is the boreal region, which means that on average in this region Natura 2000 network has a smooth integration in to a wider countryside.

Second best positioned is the alpine region (OCHI =0,403762). With its low human populations, pristine habitats, good protected areas and in general a rural economy based on small farms, pastoralism and tourism. This, of course is not true for the entire region, there are also highly populated regions with strong contrasts between protected and unprotected territory. As can be seen in the map 2, the best preserved Alpine region is in Sweden, and it benefits from the same situation of the Boreal region. Actually, , the alpine region in Sweden has better OCHI values than the Boreal region in this country.

Figure 4.16 Orloci Index for Biogeographic regions.

In this map, Continental, Pannonian and Mediterranean regions, show intermediate results due to different reasons. Continental and Pannonian are on average densely populated regions with heavy land uses. Panonian (OCHI = 0,610132) has large areas in intensive agricultural use on the flat plains which contrast with the surrounding mountains that encircle the region almost entirely. The Continental region (OCHI = 0,609447) is mostly a mosaic of farmlands, forests and cities scattered in a relatively uniform pattern.

On the contrary, Mediterranean region (OCHI = 0,621595) has by itself a lot of ecological contrasts. It has a long coastline, mountains of different altitudes and topographies, and large plains. Human uses are also more intense in plain lands and coastal areas, which gives a very high diversity. This is reflected in a relatively higher OCHI value compared with Pannonian and Continental regions.

The Atlantic region shows a relatively high OCHI (OCHI = 0,722358). Although it is relatively uniform from the ecological point of view, it also has a long coastline and many heavily populated areas with a heavy land take, it is the most heavily developed region of Europe. On average Natura 2000 sites are relatively small in this region and contain the last pristine habitats of the region. This is of course not true for the entire region, there are areas in the Atlantic region with lower human populations and better preserved countryside, but the weight of the most heavily used areas drives the average result to a higher OCHI value.

The worst results are for the Black Sea (OCHI = 1,024511) and the Steppic (OCHI = 0,968428), region respectively.

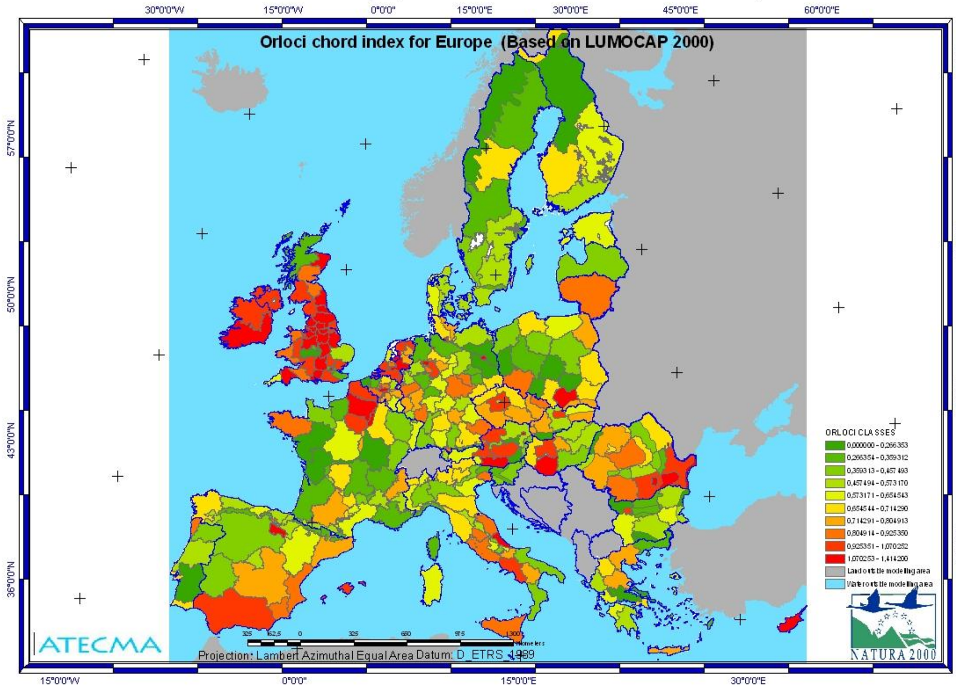
The Steppic region's high OCHI value is because the protected areas are, in general, very big and different from the unprotected territory. They include part of Danube river course, and small mountain ranges which are very different from the unprotected farmland landscape around them.

The same is true for the Black Sea region, it is a small region with a strong contrast between farmlands and big coastal populations, it also contains the vast Danube delta and some other coastal wetlands. This is valid for Romania but not for the Black Sea region in Bulgaria where the ecological contrast (not Danube delta) are smaller and also the coast have big natural areas (protected and unprotected)

4.3.6. Results for European NUTS 2 regions

The results for the European NUTS 2 regions, shown in the Map 2, give a good insight on the distribution of the OCHI values for the biogeographical regions. It should be reminded that, to minimize the effect of ecological contrast it has been taken in account the biogeographical regions at NUTS 2 levels, so, this means that some NUTS 2 regions have been subdivided in the correspondent biogeographical sub-regions. The index only shows how different are the landscapes of the protected and unprotected territory in gradient from very different (red colours, high dissimilarity index) to very similar (green colours, low dissimilarity index), and intermediate stages (orange and yellow colours, intermediate values)

Figure 4.17 Orloci Index for Europe NUTS 2 /Biogeograpic Regions



In this map it can be seen that the medium value of the OCHI in the continental region should be awarded mainly to inner and western Poland, north eastern Germany and inner France (Bourgogne, Auvergne) which have small values for the index and contribute to a lower average value for the entire region.

On the other hand the high values of the Atlantic region come from Ireland, Britain and The Netherlands. In France only four regions (Isle de France, Picardie, Nord Pas de Calais and Normandy) have relatively high OCHI values. The case of Ireland is surprising if we take in account that it has a wide and smooth rural landscape. But the reason of its high Orloci index is more related to the structure and composition of the Natura 2000 Network, which consist of coastal sites, blanket bogs and small pristine sites inland with little resemblance to the unprotected landscape.

The main responsibility for the good values in the Alpine region is due to the Alpine region in Sweden while the rest of the countries have low or mild values in this region.

4.3.7. Interpretation of Orloci Chord Index for different European regions. (See Annex V)

In order to show how these results can be further interpreted, several examples have been chosen for most of the biogeographical regions. The countries selected have been United Kingdom (Atlantic), The Nederlands (Atlantic), Finland (Boreal), Germany (Continental, Alpine and Atlantic), Romania (Continental, Steppic, Alpine and Black Sea) and Spain (Mediterranean, Alpine and Atlantic). Not all the biogeographical regions contained in each country are analysed, but those that may show more clear interpretation for the results.

In order to be have a better idea of the meaning of the OCHI values, regions with extreme values (very high or very low) of the index have been selected, and if possible, regions that are next to one another.

Again, it should be recalled that the OCHI value simply provides a first indication of where there is a strong contrast between Natura 2000 and the wider countryside. As such it can act as a warning system and help to prioritise more detailed investigations into those areas with high values. It is the detailed investigations that will determine the reasons behind the values ï whether natural or human induced.

QUESTIONS ABOUT THE MODEL AND ITS INTERPRETATION

Why this study has been developed at a NUTS 2 level?
NUTS 2 is sufficient to come to meaningful assumptions because NUTS 2 is an intermediate administrative level where a lot of decisions on land use planning are taken in most countries. For countries where decisions about land use planning are taken at national level, analysis at NUTS 2 is also very useful. NUTS 2 is a conservative level of application, and although the same method and input data could be applied to the NUTS 3 level.. On the other hand the available source of systematized socioeconomic data for all Europe was at NUTS 2. This point is essential for building hypothetic scenarios which are the basis of the analysis of vulnerability of Natura 2000 to land use changes.

Why if the protected and the unprotected areas are very similar, the boundary conditions of connectivity will be good?
Because if the protected areas have a good level of conservation (and it is supposed they have a reasonable level conservation status) wild species and habitats would no have major problems to live and flow inside the protected area and if the landscape outside is the same it will probably aloud wild species and habitats to live and flow.

Why, the intensity of agriculture or forestry is not taken in account?
It would be very good to include the intensity of agriculture an forestry but unluckily, the main cartographic of this work, Corine Land Cover, does not include data about the intensity of the agriculture or forestry. Moreover, there is not a proper definition for intensive agriculture, the same product can be cultivated in several ways including intensively or extensively. *Why using CLC as data source?*
CLC is a practical data resource. We call a practical resource, some data that is regularly updated with a harmonized level of quality for the whole EU, and that at the same time can be practically linked to modelling approaches. Results and findings of this work including the statistical tools implemented, can be used in further CLC versions or being used at a lower scale and incorporating more land use classes.

What kind of useful information renders this index?
Index is a red light to show when a region may have connectivity problems and a rough integration into a wider landscape. It is like a thermometer for the fever, it can say the temperature (amount of fever) but no the reason of the fever. It does no measure the quality of the Natura 2000 network of he region, only the integration in the un protected landscape.

It is assumed that it is easier for a species to move e.g. from extensive grassland to intensive grassland (same land cover category) than from grassland to fallow land or forest?
It is assumed that the index indicates the boundary conditions for connectivity, not the real connectivity, and this based on the look alike. This does not give answers for all the species but for the average. If a species is linked to extensive grasslands, it probably will have fewer difficulties in intensive grassland than in forest. Of course, it can be fumigated in the intensive grassland, but his can not be detected in the scale used in this work. On the other hand, if in the i9ntendsive grassland is managed with ecologically sound methods, it for sure will be permeable for the mentioned species.

4.4. Integration of the Natura 2000 network into the broader countryside under changing socio-economic trends: a scenario analysis

4.4.1. Introduction

In this project, the integration of the Natura 2000 network into the broader countryside is estimated for each NUTS2 region (further subdivided if necessary according to its intersection with biogeographic regions) in terms of resemblance of land uses between protected and unprotected land. This is done through the Orloci dissimilarity index, which is applied to a pair of vectors made from the respective frequency distributions of land use classes. Such classes are referred to as LUMOCAP and consist of a simplified definition of the CORINE Land Cover (CLC) level 3.

Integration, as defined above, can be addressed for a certain time slice to compare at once all the regions of the EU. This is reported in the preceding chapter of this document. Further to that, a prospective analysis can be undertaken to detect the sensitivity of each region to scenarios defined by the socio-economic trends identified in Chapter 3 and then explicitly represented in 4.2.2.

The Orloci index measures dissimilarity. Therefore, the higher a region scores in it, the lesser the integration of the protected territory in its surrounding matrix. The scenario analysis is consistent with this basic interpretation. An increase of index values along time (i.e. between two time slices) for a given region will be interpreted as a proportionally growing divergence between its protected and unprotected territory, and it will be called vulnerability. Conversely, if such sensitivity means decreased Orloci values, the alternative interpretation will be of a proportional convergence between protected and unprotected land, and it will be called integration. In this context, 'region' refers to a piece of land resulting from the intersection of the NUTS-2 and the bio-geographic regions of the EU-27.

4.4.2. Data and methods

Two socio-economic scenarios were specified to explore the effect of socio-economic trends on the integration of the Natura 2000 in the broader countryside, as reported earlier on in this chapter. They represent respectively different storylines leading towards rural (RU) and metropolitan (ME) population growth, as identified in chapter 3. Such scenarios aim at showing a plausible spatial realization of their respective storylines, and cannot be taken as forecastings.

The land use scenarios consisted of spatially distributed land use classes at a spatial resolution of 1 km, resulting from a land use modelling procedure (Task A3). The land use classification is referred to as LUMOCAP, and it consists of a simplification of CLC to 9 classes. The model was parameterized from real changes as from CLC 1990 through CLC 2000 (Task A2). Then, land use scenarios associated to RU and to ME were generated from 2000 through 2030 at five years time steps.

The time span 2000 through 2030 is relatively short, and the 5-year working temporal resolution is more associated to the internal mechanics of the land use modelling procedure than to the envisaged magnitude of changes. A conventional time series analysis was not advised here because it might reflect that internal mechanics to a large extent. Therefore, the scenario analysis was based on pairwise comparisons performed for each storyline between the baseline time slice of 2000 and the final one of 2030. An intermediate slice at 2015 was further used to check trend monotony, rather than to detect respective effects on the Natura 2000 network. The observed evolution from 1990 to 2000, as detected using LUMOCAP classes on the respective CLC data sets, was also included in the analysis as a reference.

Values of the Orloci index were computed for each region and time slice as reported in the preceding chapter (Task A4). Then, changes between time slices were explored through their absolute differences consistently with the straightforward interpretation described above.

Two initial aspects were accounted for in the development of that analysis. On the one hand, the computation of the Orloci index for a region raises the abstraction level of the information because spatially distributed land use classes are processed to a single, lumped index that is homogeneously attributed to the whole piece of land. The index is itself non spatial because only frequencies are used irrespectively of the land uses spatial arrangement. The ensemble of Orloci index differences for the EU-27 regions is likely to have a severed spatial structure and it is therefore unsuitable for any further spatial statistics assessment. However, some spatial dependence might still remain, especially at shorter lags, which would prevent the application of most statistical tests which require independent samples. This aspect was checked by taking each region's central point (in ETRS-LAEA coordinates) as a proxy to its location, and then using the Moran's *I*, an index to assess spatial autocorrelation, on the resulting pattern of Orloci index differences associated to each storyline. On the other hand, preliminary trials determined that most of the frequency distributions of Orloci values across the EU-27 depart from normality particularly because of kurtosis. For that reason, we decided to use non parametric statistical methods in significance tests.

The first step of the analysis was to assess the significance of differences between time slices at the EU level through the Wilcoxon Signed Ranks Test. This method is appropriate for related samples, for example a set of individuals before and after a treatment, whenever the sign and magnitude of changes is available. In this case, each region formed a pair of related samples, the values of which corresponding to two scenario time slices. The essence of the method consists of computing the difference for each region, and then to rank all the differences found in the EU by their absolute value. Rank numbers are then attributed a sign according to the sign of their associated difference. If the sum of positive ranks (T^+) is different of that of negative ranks (T^-), then the two analyzed time slices are considered as different. When the number of samples is larger than 15, as it is the case here, a normal distribution can be used to find the probability of occurrence of T^+ values under the null hypothesis that there are no differences. In spite of that, the method is non parametric and hence it does not assume normality in the distribution of input values.

Significant differences were subsequently interpreted. There are not identified index thresholds or any other precise relationship between the index scale and the function of the Natura 2000 network. For that reason this analysis was made in relative form, either comparing regions within a given storyline, or comparing a given region between equivalent time slices of the two storylines.

The analysis of change in the Orloci index was facilitated by defining classes of response for each storyline. This was done by using quartiles of the concerned map of differences at the EU-27 level acccording to the interpretation in Table 1.

Table 4.10 Definition of classes of change for a given storyline, where (t_1-t_0) is the difference for a given region in the Orloci index between the scenario under consideration at year 2030 (t_1), and the baseline scenario at year 2000 (t_0), and Q refers to the corresponding quartile of the distribution of differences in all the regions for that storyline.

Allocated class	**Interpretation**	**Condition**
1	Adapted	(t_1-t_0) Ò*Q1*
2	Mildly adapted	*Q1* < (t_1-t_0) < 0
3	No change	(t_1-t_0) = 0
4	Mildly vulnerable	0 < (t_1-t_0)) < *Q3*
5	Vulnerable	*Q3* Ò(t_1-t_0)

The resulting differences of Orloci index for each region and storyline are themselves a main outcome of this work, as it should allow a prospective insight at a policy relevant organization level. Further to that, some efforts were made to obtain more synthetic facts at a higher organization level, such as NUTS-1 (country) or biogeographic region. The reader is reminded that the elementary regions used here as sampling units result from the intersection of the NUTS-2 and the biogeographic definitions. Therefore, the set of regions could be grouped according to either countries or biogeographic regions.

Then, a Kruskal-Wallis one-way analysis of variance by ranks was used to test whether or not the respective factor could explain the differences of Orloci index found for each storyline. Technically, the Kruskal-Wallis test is used with independent samples to decide if the subsets defined by the groping factor are drawn from truly different populations or should be rather considered as chance extractions of a single population. This is done through testing the equivalence of the respective group medians, which requires ranking all the data and then to compute the sum and average of ranks of each group. The significance of the Kruskal-Wallis statistic (*KW*) for relatively large samples as it is the case here is determined by using probability values from a chi-square distribution.

Whenever significant groups were detected using countries or biogeographic regions as a factor, it was necessary to assess the contribution of each individual group to the overall significance. This was done through multiple comparisons between groups for determining which pairs were significantly different. The procedure is an extension of the Kruskal-Wallis test by which the probability of the absolute difference between the mean ranks of two groups is obtained from a corrected normal distribution.

4.4.3. Results

Figure 1 shows the analysis of spatial dependence made for each storyline. The basic idea of this analysis was to explore how different two observations may become as the distance between them increases. The Moranõs *I* reflects such ódifferenceô for distance classes (named lags) in terms of autocorrelation (named so because a variable is correlated to itself at a given distance). It was decided after some experimentation that using a lag resolution of 100 km for a maximum separation distance of 2000 km would provide with a realistic application for the European continent.

The three storylines show a similar pattern (or absence of) in the Moranõs *I*. The ranges of values are relatively narrow, meaning weak autocorrelation. Also, values oscillate around zero with no periodic or trend shape that might be related to the size or distribution of patches in the respective maps All that suggests that there is no spatial dependence relationships within the set of regions, and therefore they can be safely assumed as independent samples.

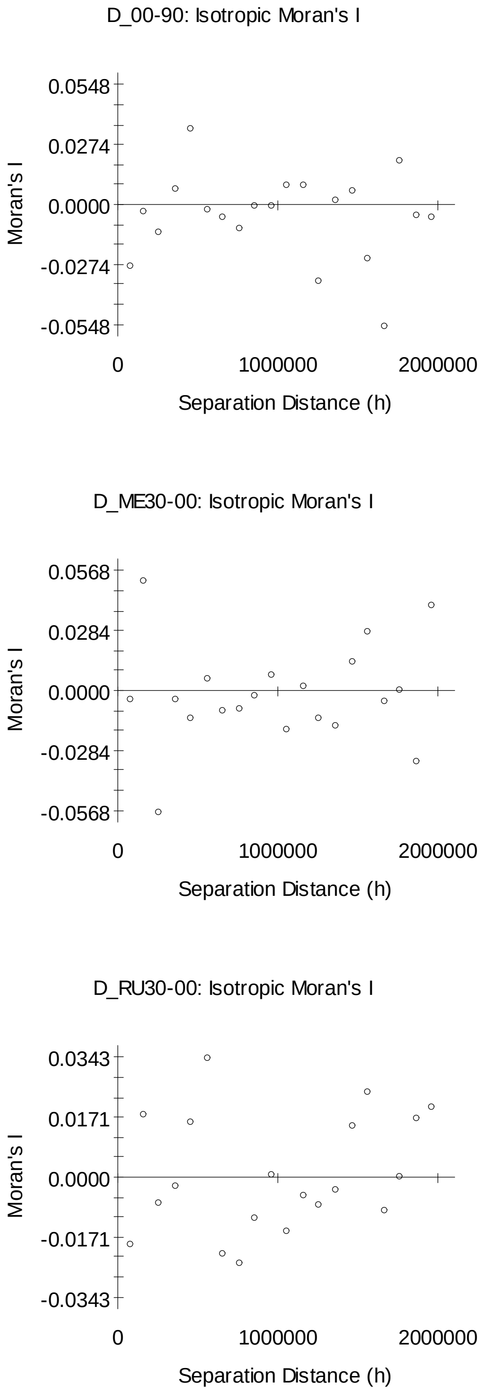


Figure 4.18. Moranôs *I* autocorrelation index for the three storylines considered in this work: D_00-90, D_ME30-00 and D_RU30-00. The index (y-axis) is approximately bounded to -1 to 1, expressing respectively negative and positive auto correlation. Values close to zero mean no autocorrelation. The index was computed at increasing separation distances (x-axis) up to 2000 km, at fixed lag intervals of 100 km.

The statistical protocol proceeded subsequently. Table 2 shows the test results for differences in the Orloci index between scenario time slices. Significance levels are apparently associated to storylines. The evolution from the baseline (LU2000) through the rural storyline (RU2015 and RU2030) yields the most different time slices at significance above 99%. However, the equivalent evolution through the metropolitan storyline does not produce significant changes at the 2015 time slice (ME2015), and it is necessary to reach 2030 (ME2030) to generate a scenario that is different from the baseline just at 90% significance. The rural and the metropolitan story lines are very different among them, both at the 2015 and the 2030 time slices, with significances exceeding 99%. In contrast, the observed evolution from 1990 (LU1990) to the baseline at 2000 shows a less drastic change at 95% significance.

Table 4.11 Results of the Wilcoxon Signed Ranks Test for differences in the Orloci index between selected scenario time slices. ***N***: number of NUTS-2 regions used in the analysis. $\boldsymbol{T^+}$: sum of positive ranks of differences; ***z***: standard transformation of T^+; ***p***: probability of occurrence in a normal distribution of a value of *z* under the null hypothesis that there both time slices are equivalent. Conventional significance levels are indicated by asterisks: n.s. (non significant) * (90%), ** (95%), *** (99%). See the text for an explanation of the method.

Compared scenario time slices	***N***	$\boldsymbol{T^+}$	***z***	***p***
LU1990 & LU2000	314	16169	3.194215	0.001402**
LU2000 & ME2015	373	22407	1.258530	0.208201 n.s.
LU2000 & ME2030	373	26844	2.777873	0.005472*
LU2000 & RU2015	373	20283	5.643018	0.000000***
LU2000 & RU2030	373	20004	5.856498	0.000000***
ME2015 & RU2015	373	20934	5.646249	0.000000***
ME2030 & RU2030	374	17053	7.929483	0.000000***

Given the result that only the intermediate stage of ME2015 did not depart significantly from the baseline scenario, differences in the Orloci index between the final stage of each storyline and the baseline were elaborated for interpretation. Figure 2 shows the median and quartiles of such differences at the EU level for each storyline.

The ME storyline shows the largest quartile range of the three storylines, with a median value that is slightly negative. On the contrary, the RU storyline yields a distribution of differences clearly centered on positive values, with the largest median. It is remarkable that the quartile ranges of these storylines encompass in both cases that of the observed storyline between 1990 and 2000, which is the narrowest of the three.

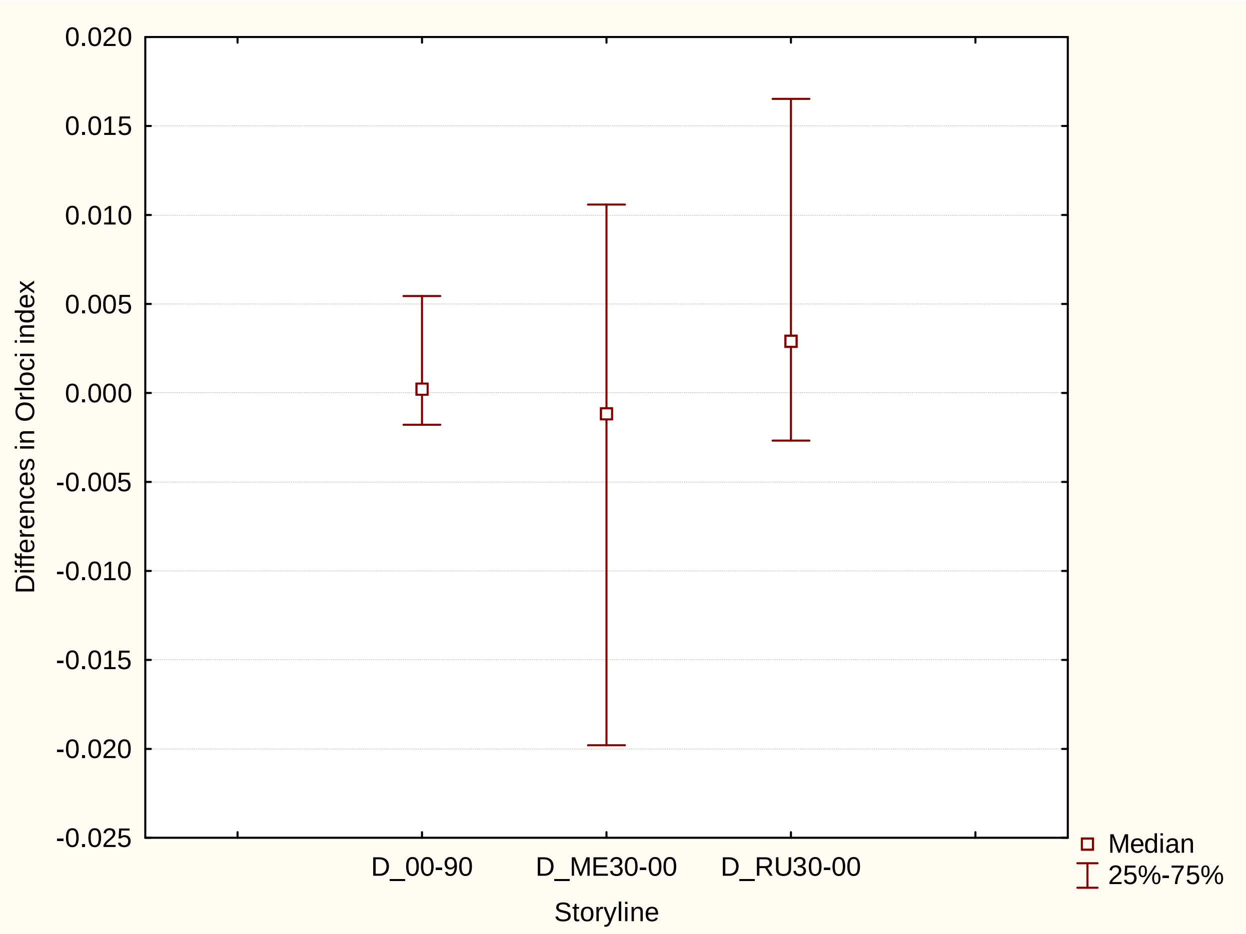


Figure 4.19 Differences of the Orloci index between two time slices along storylines. Median and quartiles at the EU level are represented. **D_00-90**: observed differences between 2000 and 1990, based on LUMOCAP-CORINE LC; **D_ME30-00**: differences between 2030 and the 2000 baseline for the metropolitan storyline; **D_RU30-00**: differences between 2030 and the 2000 baseline for the rural storyline.

Those quartiles were used as thresholds following Table 1 to produce maps of change of the EU regions for each storyline. Figures 4.20, 4.21, 4.22 show those maps with attached pie charts that are consistent with Table 1. While the number of regions in the outer quartiles is constant by definition, the insertion of a no change class in the centre of the distribution enables some insight on the overall effect of each storyline on the EU. Only a few regions are mentioned in the descriptions below, where they are referred to using their NUTS-2 allocation. Please see the Appendix for the full set of results.

Observed evolution from 1990 to 2000

The D_00-90 storyline (Fig, 3) could not be assessed for all the regions because the CLC of 1990 lacks full EU coverage. In that decade, 52% of the regions increased their dissimilarity between protected and unprotected land and are classified as vulnerable or slightly vulnerable to land use changes. Extreme changes in this sense include Toscana (IT), Flevoland (NL), Bratislavisky kraj (SK) and Groningen (NL). At the opposite end, 39% of the regions improved their integration of the Natura 2000 network in the broader countryside. This trend is exemplified by Nord-Est (RO), Noord-Holland (NL), Severozapaden (BG) and Piemonte (IT). 9% of the regions did not show any change, including Bretagne (FR), Languedoc-Rousillon (FR), Corse (FR) and Yugoiztochen (BG).

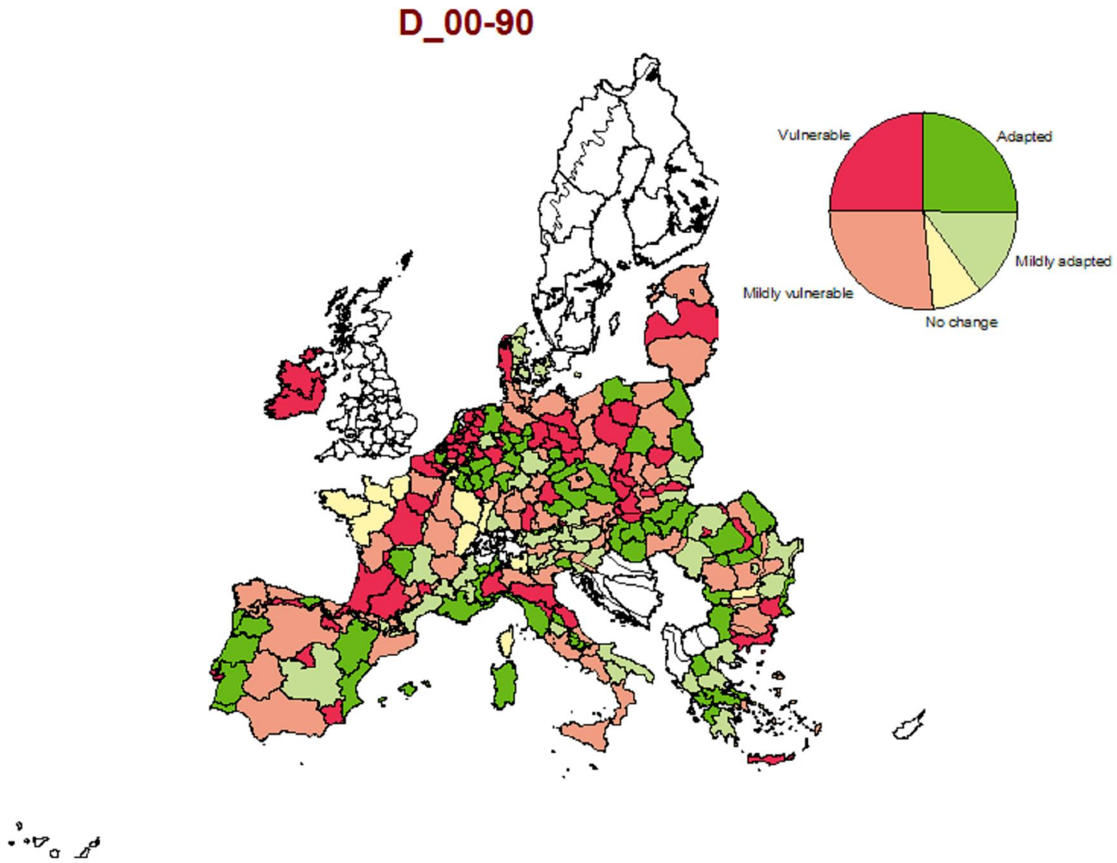


Figure 4.20 Absolute differences in the Orloci index for EU regions computed using the observed CLC / LUMOCAP datasets (LU2000-LU1990). Classes of change are defined as from Table 1 using the following thresholds: *Q1*: -0.001790, *Q3*: 0.005450.

The Orloci index differences associated to D_00-90 could be significantly grouped by countries, but multiple comparisons demonstrated that only pairs of countries involving NL, which did show the greatest trend to vulnerability, were beyond a significance of p=0.05. The other countries in such pairs were HU, IT, PT and RO (Fig. 4).

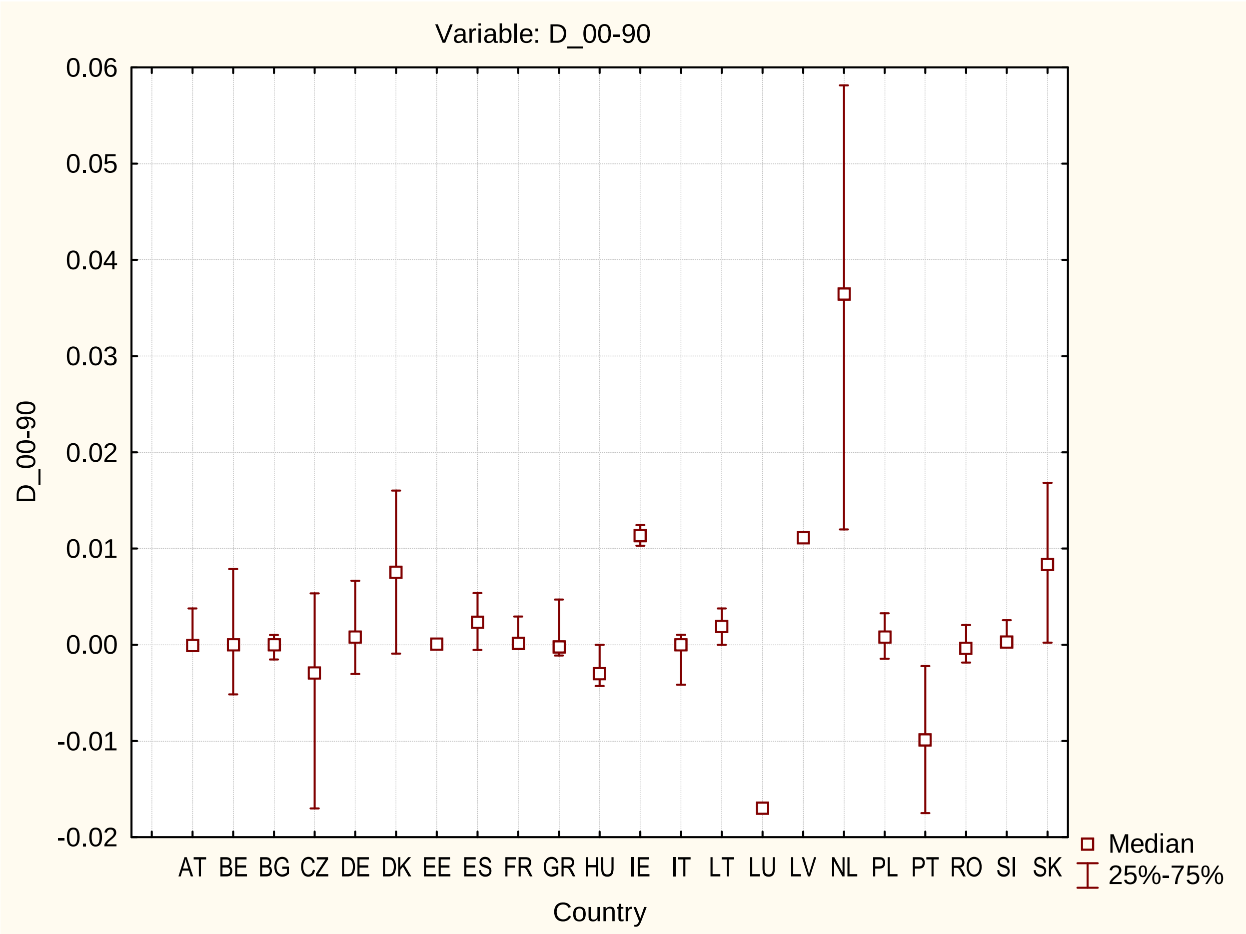


Figure 4.21 Medians and interquartile ranges of Orloci index differences for regions grouped by countries in the observed land use evolution 1990-2000 (*KW*=46.74, *N*=314, *d.f.*=21, *p*=0.0010).

Biogeographic regions were also a significant factor for D_00-90 (Fig. 5), with the Pannonian and the Black Sea showing larger trends to integration, and the Atlantic and the Boreal the larger trends to vulnerability. However, in this case only the pair formed by the Atlantic and the Mediterranean did reach a significance beyond *p*=0.05.

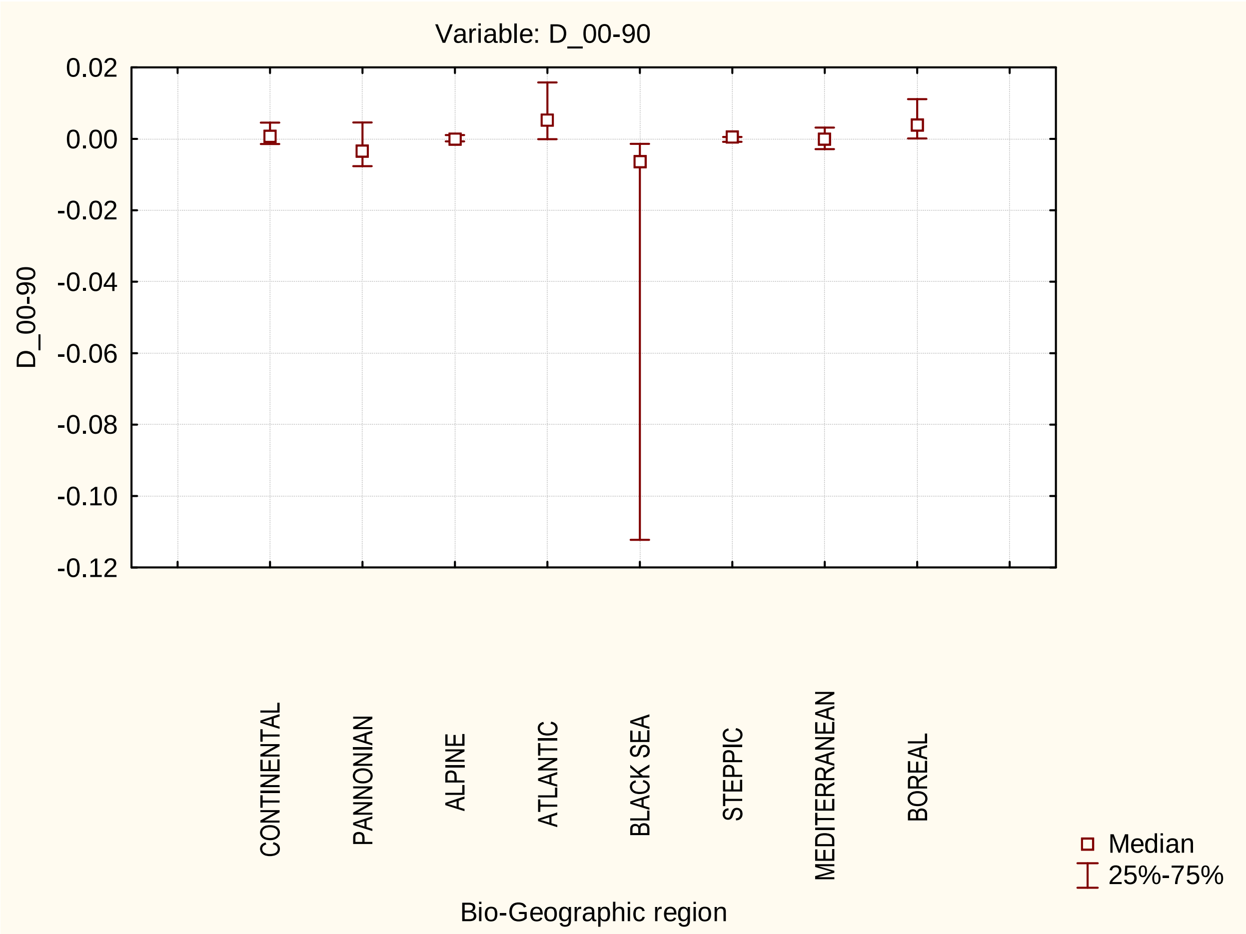


Figure 4.22. Medians and interquartile ranges of Orloci index differences for regions grouped by biogeographic regions in the observed land use evolution 1990-2000 (*KW*=24.28, *N*=314, *d.f.*=7, *p*=0.0010).

Metropolitan storyline

The D_ME30-00 storyline (Fig. 6) shows a decrease of Orloci index values in the majority of the regions (55%), the largest adaptations corresponding to Bruxelles-Capitale (BG), Toscana (IT), Finström (FI) and Weser-Ems (DE). Regions with positive increment of dissimilarity account for 41% of the total and include Arnsberg (DE), Noord-Holland (NL), Haute-Normandie (FR) and Basse-Normandie (FR). Only 4% of the regions are not affected by this line, for example Lubuskie (PL), Yugoiztochen (BG), Limousin (FR) and Vest (RO).

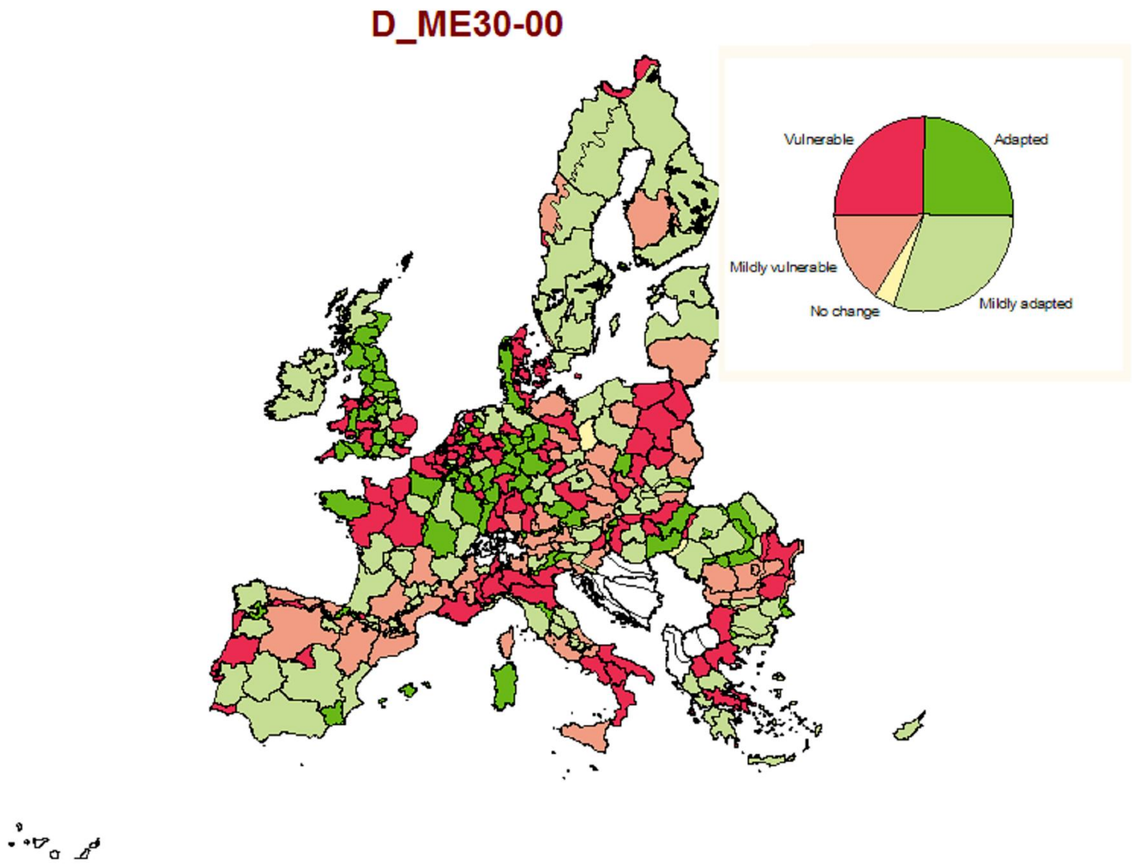


Figure 4.23 Absolute differences in the Orloci index for EU regions under the metropolitan storyline (ME2030-LU2000). Classes of change are defined as from Table 1 using the following thresholds: *Q1*: -0.019800, *Q3*: 0.010590.

The D_ME30-00 resulted to be statistically drawn from a single population when tested against the country factor (*KW*=25.04, *N*=373, *d.f.*=25, *p*=0.4600), but it did show a significant response to biogeographic regions (Fig. 7). The Steppic and Arctic regions show larger positive differences than the others, and the Alpine and the Boreal regions span over negative differences. However, the multiple comparisons procedure did not yield any single pair of regions being different at a significance of *p*=0.01 or better.

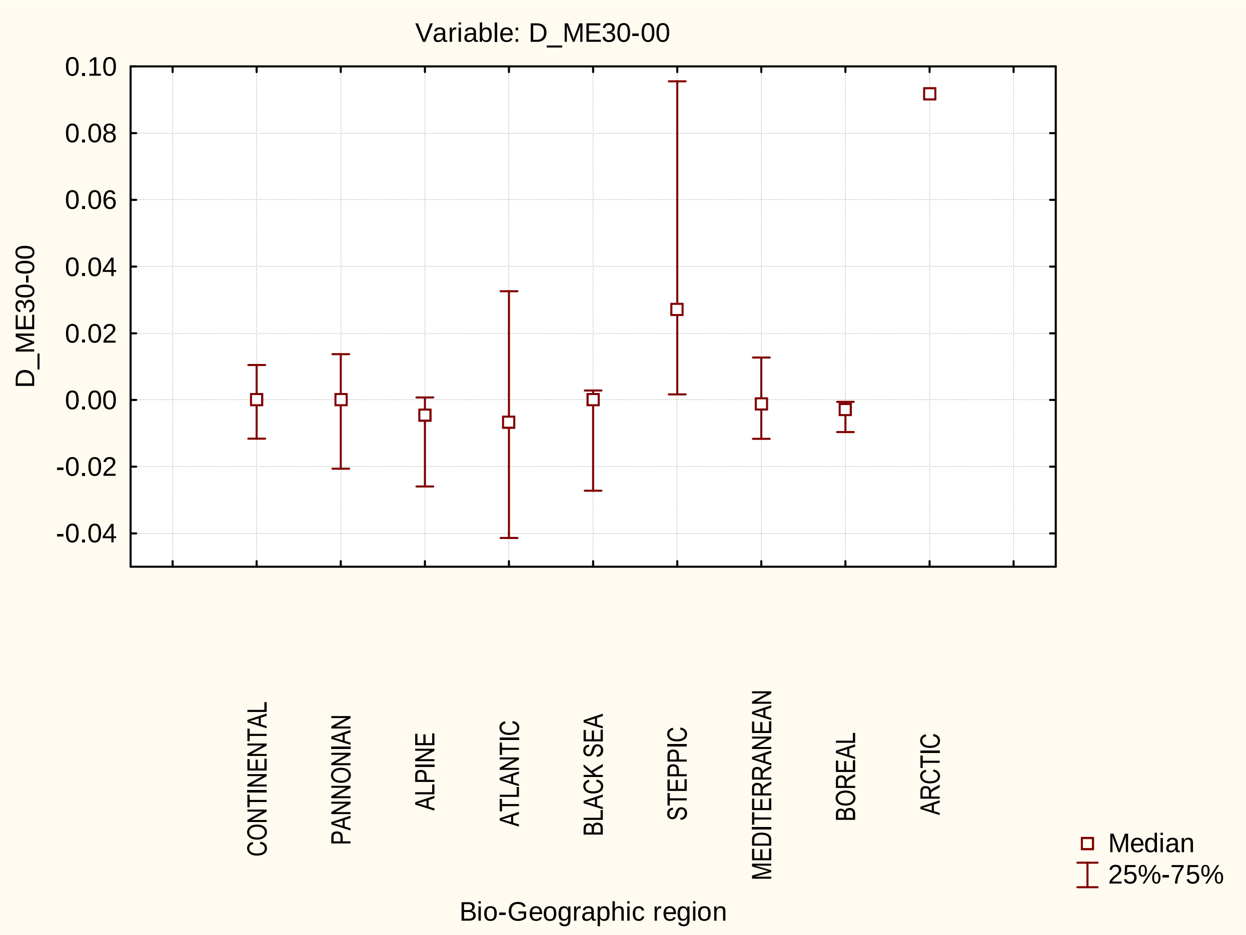


Figure 4.24. Medians and interquartile ranges of Orloci index differences for regions grouped by biogeographic regions in the metropilitan storyline (ME2030-LU2000) (*KW*=17.56, *N*=373, *d.f.*=8, *p*=0.0248).

Rural storyline

The rural storyline (Fig. 8) shows opposite trends to the metropolitan one: 55% of the regions increase their vulnerability, and 40% of them increase their adaptation, also with a relatively small fraction not showing changes. The most vulnerable regions are Yugoiztochen (BG), Noord-Holland (NL), Arnsberg (DE) and Zeeland (NL). The most adapted ones are Bretagne (FR), Bruxelles-Capital (BG), Toscana (IT) and Finström (FI). Examples of no change are Languedoc-Rousillon (FR), Limousin (FR), Magdeburg (DE) and Lietuva (LT).

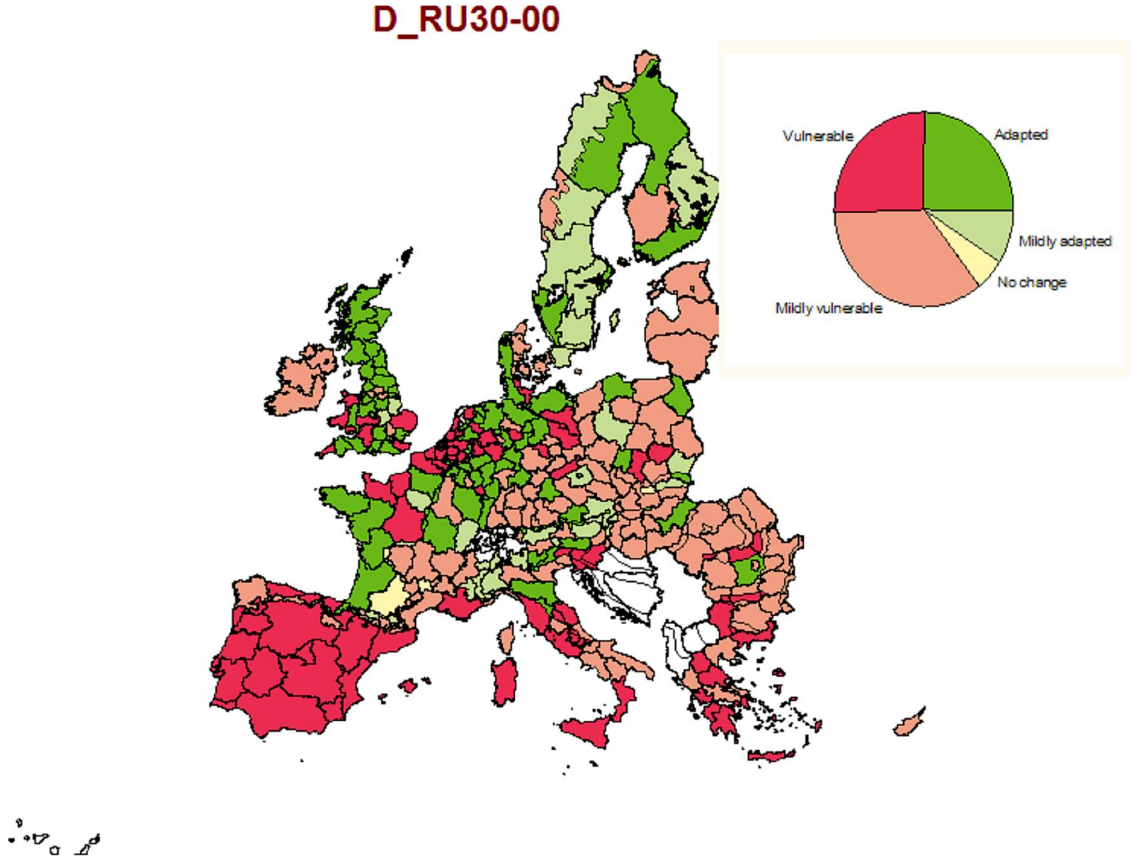


Figure 4.25 Evolution of absolute differences in the Orloci index for EU regions under the rural storyline (RU2030-LU2000). Classes of change are defined as from Table 1 using the following thresholds: *Q1*: -0.002680, *Q3*: 0.016530.

Both the country and the biogeographic region were highly significant factors to define groups in the D_RU30-00 set of Orloci differences. The former (Fig. 9) yielded AT, DK, SE and UK as countries containing mostly negative differences, while many others such as BG, ES, HU and PT have their interquartile range almost entirely over positive differences. This was confirmed by the multiple comparisons exercise, where pairs including the mentioned countries were significantly different in between in many instances.

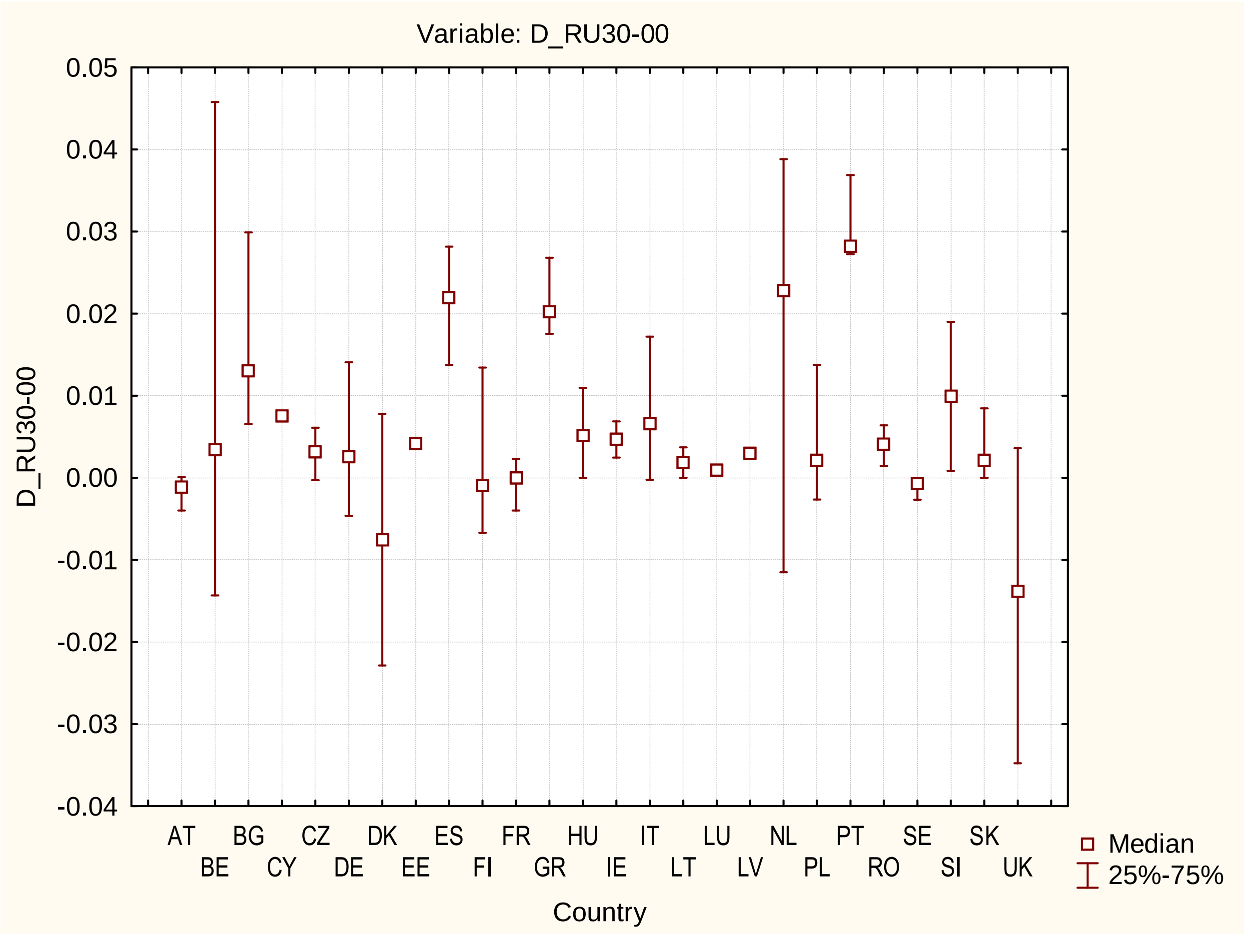


Figure 4.26. Medians and interquartile ranges of Orloci index differences for regions grouped by countries in the rural storyline (RU2030-LU2000) (*KW*=85.71, *N*=373, *d.f.*=25, *p*=0.0000).

Groups defined by biogeographic regions (Fig. 10) were significant too. Most of such groups show a trend towards vulnerability, which is well exemplified by the Mediterranean, and only the Boreal region contains a relevant number of samples with negative differences. All the pairs of regions including the former, and many of the pairs including the latter, were significant at *p*=0.05 or better.

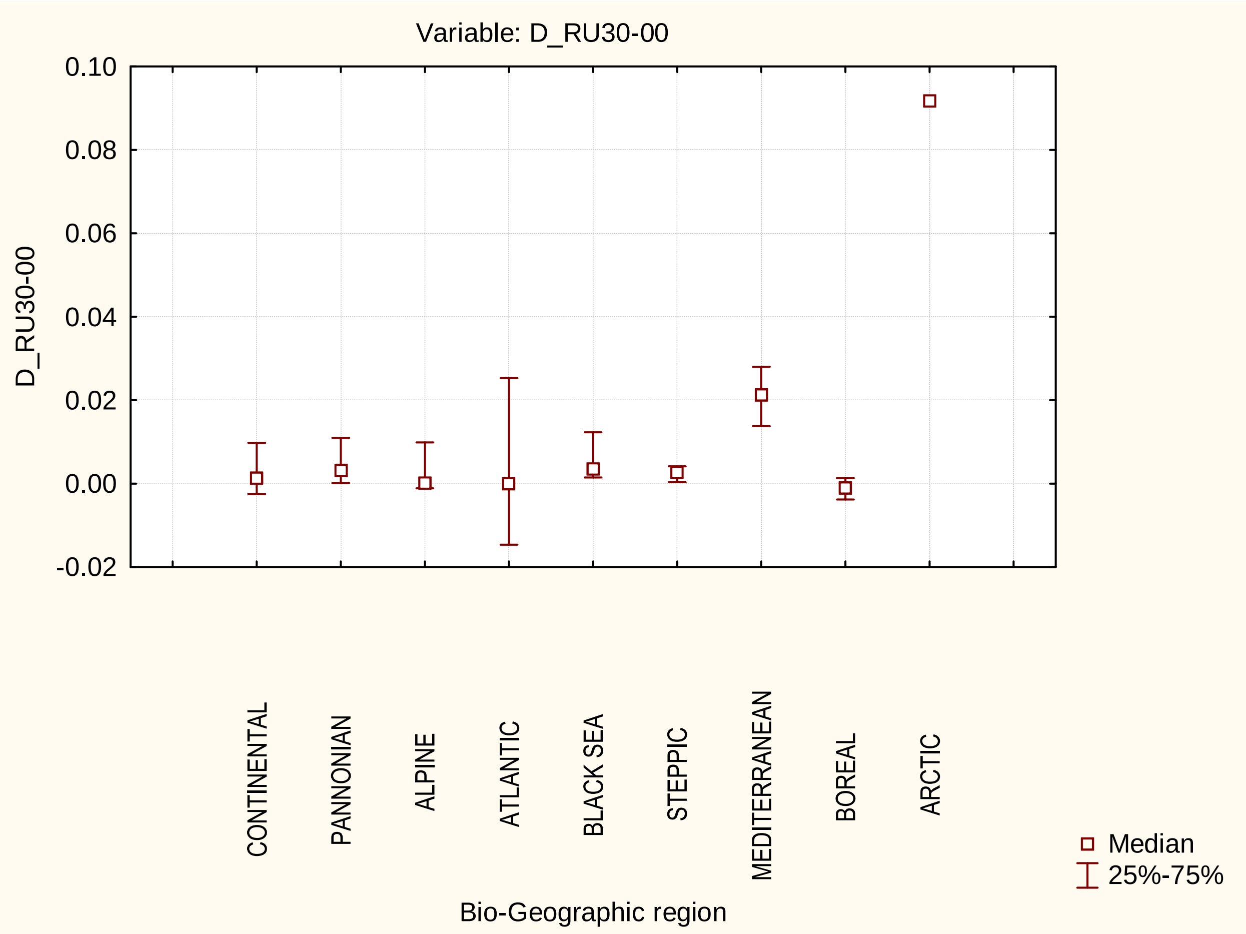


Figure 4.27 Medians and interquartile ranges of Orloci index differences for regions grouped by biogeographic regions in the rural storyline (RU2030-LU2000) (*KW*=59.60, *N*=373, *d.f.*=8, *p*=0.0000).

Interpretation of scenario results related to land use changes and vulnerability of nature areas from a socio-economic perspective

The physical impacts of metropolitan growth are generally concentrated in and around metropolitan regions. Long-distance impacts are not excluded, but they are generally less intensive, with the exception of traffic flows on inter-metropolitan corridors. In numerous cases, Natura 2000 areas and also valuable nature areas are not located at proximity of metropolitan areas, so that metropolitan expansion does not significantly increase the vulnerability of nature areas. There are, however, exceptions. The scenario on "metropolitan growth" shows increasing vulnerability in regions where metropolitan areas and other cities are located close to each other, such as in the Benelux countries, in northern Italy and along the French Mediterranean coast. Other exceptions are regions and countries where metropolitan areas and large cities are surrounded by forests, such as in the Nordic countries. There, the expansion of metropolitan areas does not affect significantly the vulnerability of nature areas because of their large amount. The continuation of metropolitan expansion is likely to have in general limited negative impacts on the vulnerability of Natura 2000 and other valuable nature areas, except in regions with several metropolitan areas and other cities and in areas affected by transport infrastructures and their further development.

The situation will be very different if a strong socio-economic revival of rural areas takes place, accompanied by a densification process. Not only the intensification of agricultural production will occur in the most fertile rural areas, but less fertile and already abandoned areas will also be subject to more or less substantial production. It is not unlikely that a certain amount of nature areas will be transformed into productive areas for agriculture and forestry. Population increase in villages, small and medium-sized towns will lead to densification processes and urban expansion as well as to dispersed settlement activities. Not only houses will be built, but also buildings and premises for the processing of agricultural and forestry products and facilities for the production and storage of renewable energy. Significant pressures on nature areas are likely to result from this scenario and the vulnerability of a number of them will increase. As in the former scenario, regions with a small amount of nature areas, as in the Mediterranean regions, will be more affected than sparsely populated regions with large amounts of nature areas, as in the Nordic countries.

In terms of probability, it seems that the economic crisis has not put an end to the further development of metropolitan areas, even if the growth rates in the years to come will be more modest than they were in the past. The progressive move towards a õgreen economyò will also be beneficial to the economy of metropolitan areas because of new emerging technologies and related manufacturing activities. In addition, the new priorities related to climate change are likely to moderate the physical expansion of metropolitan areas, especially in areas with significant natural value, and to favour the greening of cities. This does not exclude, however, that, in probabilistic terms, a number of rural areas will be subject to economic revival because of growing energy needs related to possible oil depletion and of the move towards renewable energy sources. In addition, food needs at global scale are likely to further increase. The economic revival of rural areas will, however, be rather selective. A number of factors will be discriminating, such as climatic conditions, soil fertility, land prices, the availability of manpower and the potential for investments.

The most probable evolution, according to present circumstances and to the impact of the economic crisis, is a combination of both scenarios, with significant differences between the various parts of the European territory.

Chapter 5. Integrating Green Infrastructure into other sectors

Contents

Chapter 5. Integrating Green Infrastructure into other sectors

The analysis and the conclusions presented in chapter four shows, in a general way, how land use changes affect the integration of Natura 2000 sites into a wider landscape and the vulnerability of those sites to such changes. The results illustrate the status at a regional level and demonstrate how this would change if the two scenarios we have predicted through socio-economic and land use analyses - Metropolitan Growth and Rural Growth - were to occur.

The level of detail of the analysis does not however allow us to know exactly where a certain land use class will appear or disappear nor does it tell us in detail the types of land uses involved, but it is very useful as an indicator of how socio-economic factors influence land use changes which are promoted by other activity sectors. It also provides an early warning mechanism for identifying areas where the integration of Natura 2000 is poorest and where further in depth investigations should be given priority.

To complete the picture, this chapter looks in greater detail at the integration of the Green Infrastructure concept into a range of other land use sectors and reviews the role, relations and impacts of these different sectors on the green infrastructure. The sectors considered are: Agriculture, Forestry, Water Management, Linear Infrastructures, Extractive Industry, Urban Environment, Nature Tourism and Recreation, Invasive Alien Species and Climatic change.

5.1. Agriculture

More than a half of the European Union is devoted to agriculture, so most of the Green Infrastructure relies on farming lands. This means that agriculture is the activity with the biggest territorial impact on the landscape matrix between protected natural and semi natural areas, hence, has the highest responsibility in maintaining the connectivity among those protected areas. The role of agriculture in maintaining valuable semi natural habitats is recognized as a key issue for the conservation of European biodiversity nowadays.

5.1.1. Interaction between agriculture and the permeability of the landscape

Interactions between agriculture and biodiversity are multiple and complex and they depend on the type of agriculture, where it is undertaken and the way it is developed. On the one hand there are positive relations from some farming practices. Without them, some living systems would suffer a remarkable simplification, as well as species and habitats loss. On the other hand, there are a lot of farming practices which generate a strong negative impact on the ecosystems.

It seems evident that the more intensive the agricultural practices are, the less will be the permeability of the landscape. Perhaps it would be important to find a correct definition for intensive agriculture but this is not the objective of this document. For the purpose of this document we will talk about environmentally friendly agriculture as the kind of agriculture which has a low or no input of pesticides and agrochemicals. Irrigation should not be considered as intensive agriculture except when it is linked to a change in land use. Traditionally irrigated areas can be very rich in wild species which are more limited by the use of agrochemicals (pesticides and fertilizers). On the other hand, changes in land use from extensive dry farmland to irrigated land bring negative changes to the existing wild fauna and flora which are adapted to the former conditions.

Farming practices which generate a greater negative impact are, first, the use of chemical pesticides, second changes in land use practices towards greater intensification, as well as it can be the land consolidation (reallotment) which eliminates borders and field margins, transformation of orchards into herbaceous cultivation, and destruction of old structures integrated in the landscape (as it can be stonewalls, hedgerows, groups of trees and old ruins). Another impact come from chemical fertilizers, which impoverish soils and life associated with them (bacteria, fungi, invertebrates) and pollute water tables and courses. Over-fertilization with chemicals or manure is also a common problem for water quality. Other impacts come from overgrazing which, depending on the site, may cause different types of damages, namely in dry pasturelands.

Land abandonment has as also been considered as having a negative impact on biodiversity. This may be true for the conservation of some species associated with agriculture or pastureland as it can be some invertebrates, birds and floristic associations, but land abandonment can also be positive in terms of landscape connectivity because it reduces the human presence in the countryside, increases the shelter for wild species and allows managers to restore natural habitats. CAP used to finance set aside lands, but this policy has been changed and now subventions are more linked to cultivated land. First results of this new policy show that cultivating set aside land is not so positive for wildlife.

All transformations and land uses from agriculture which have a negative effect on the ecosystems are powered by pressures from the markets and from wrong polices which do not take in account (or they do it wrongly), the integration of human activities in the ecosystems, because they promote a maximization of benefits on a short term instead maintaining a lower income for a longer period of time. Then, it is necessary to work on the application of the policies, but also in the final markets, by increasing the request for organic products and labels associated with nature conservation and environmental friendly production.

In the current policy framework, it will be important to apply the existing legislation, funds and initiatives in the best way possible for nature and biodiversity conservation, which takes account of the concept of connectivity between protected areas. This means a deeper approach to terrain and the analysis of the situation case by case in order to apply in the best way possible the regulative and financial resources.

It is responsibility of member states to find and develop the best agro-environmental measures for increasing the permeability of the agricultural landscape. The main concept proposed in this document is to enhance the connectivity and permeability of the landscape matrix in order to assure the correct functioning of the whole green infrastructure.

There are a lot of farmland types which present suitable characteristics for maintaining wildlife and for supporting permeability to help the flow of biodiversity. Wide cereal landscapes are the main European habitat for steppic bird species, rice fields offer a stepping stone for migrating birds, home and feeding grounds for some others and are the home of amphibians, reptiles and some fish species *(Anguilla anguilla, Lepia ibera*), with a high economical or biological value. Orchards are distributed all across Europe with different types of production. Some times they are distributed following a patchy design, mixed with other cultivations and in some countries may cover hundreds of hectares as it happens with olive groves in southern Europe. Orchards have fauna and flora associated with them and presents good permeability for a lot of species which may hide when migrating from protected sites.

Maintaining connectivity among natural areas depends strongly in the way farmland areas are managed. The same type of cultivation can be developed in very different ways, and those ways may have a positive or negative impact in wild species and hence on the permeability of the landscape.

A key issue is to provide a clear definition of intensive agriculture for the different European farmland landscapes and its compatibility with the conservation of natural values. It is not always clear that an agriculture which uses irrigation and chemical fertilizers is incompatible with the conservation of natural values. It is necessary to study the issue case by case.

Up to date there are a lot of well known framing practices which minimize the impact or have a beneficial effect on wild species survival and maintain the connectivity of natural and semi natural areas. It is not possible to summarize in this document all relevant environmental practices in this respect. A good compilation of agro environmental measures that would support connectivity has been done by the initiative *ñWildlife and Sustainable farming initiative: Good Practice Guideò*

In 2006, the European Commissionõs Directorate General for the Environment launched a ô*Wildlife and Sustainable Farming Initiative*ö to consolidate information on the relationship between the conservation needs of selected species and compatible farming or forestry practices. The overall objective of the Initiative is to encourage a greater integration of provisions of the Habitats and Birds Directives into the new Rural Development Programmes (RDP) (2007-2013) and to demonstrate how this can be achieved in practice for certain species. The Commission contracted the elaboration of a report to provide it with technical support in delivering outputs under this Initiative during the period 2006-2008.

The results of this study fit well with the studies already available on other species set a wide and provide a solid base to work towards the integration of policies and management of agriculture and wildlife and nature conservation both inside and outside the protected sites of Natura 2000 network.

Another good reference on assessments is found in ñ*Guidance on the maintenance of landscape connectivity features of major importance for wild flora and fauna. Guidance on the implementation of Article 3 of the Birds Directive (79/409/EEC) and Article 10 of the Habitats Directive (92/43/EEC)*ò (IEEP Aug 2007). This work provides a good compilation of issues related with the connectivity of landscape, including references to agriculture and all matters related with the management of the landscape towards connectivity. It provides also a good sample of existing initiatives, legislation and financial sources.

Bird life international has also published in 2009 a report with the indicative title of: ñHow is EU Rural Development policy delivering for biodiversity?ò (Birdlife 2009). This report makes a detailed analysis of the problems and results of the implementation of the Rural Development policy in several countries, pointing out the problems that have arisen from the application of Community Funds in agriculture livestock and forestry. It includes a set of recommendations for the correction of perverse effects.

5.1.2. Conclusions and recommendations

Related to General Policy

- Most part of the Green Infrastructure is devoted to agriculture and forestry. As a result, the green infrastructure cannot work correctly and render appropriate environmental services if there is not an environmental friendly agriculture and forestry.

- There is enough European legislation and regulation to implement an agrarian system that is largely friendly with nature and biodiversity conservation. It should be compulsory to promote and support the application of this legislation in most of the agricultural territory, especially in those areas identified as key areas for connectivity among Natura 2000 protected sites.

- Member States should apply European policies and funds in the most adequate way for the conservation and amelioration of the Green infrastructure and this is particularly important in the implementation of the CAP.

- It is compulsory to integrate the concept of ecological connectivity in agrarian policies, and taking it to ground through practical implementation on the countryside.

- The permeability of the landscape should be counted as one of the basic environmental benefits rendered by agrarian landscape. Without this permeability, protected areas become bubbles and will, progressively, lose diversity and the qualities that led to their protection.

- Softening farming practices usually brings a reduction in the economical income for farmers, European policies are aware of this issue, but it is important to put the account of the farmers to the service of connectivity that a well managed farmland landscape may render.

Related to farmers and land owners

- Maintaining permeable and harmonious farmland landscapes is a direct issue of the farmers, but the ecological and aesthetic benefits and the quality of the products influence the whole society. Is very important to find adequate ways for compensating the farmers for the collateral benefits rendered by environmentally friendly farming practices.

- Any policy or action that wants to be efficient should adopt a bottom- up approach. The work should take into account farmers and land owners because they are the direct actors in managing agricultural land use.

- It is important to bear in mind that it will be not efficient to work with the stakeholders if, previously, there is not a clear definition of the problem, at spatial and conceptual level. This is why it is essential to develop connectivity assessments related to the natural protected (and unprotected) areas network. Taking the results of these assessments as a planning basis, one could define the unprotected areas which are important for maintaining the connectivity and define the most appropriate agro environmental measures for each particular case. Those measures can be different and even contrary, from one place to another. In some cases, it should be desirable to have reforestation but in some other cases it will be necessary to avoid trees encroaching. Particular measures for each case should be designed and agreed by farmers and managers supported by scientific assessment.

- It is important to increase the ecological awareness of the farmers and personnel responsible of agriculture in public and private bodies. It is very important to remark that the role of farming is much more than producing food or other raw materials, farming has a key role in maintaining biodiversity, in the proper functioning of ecosystems and have a very strong impact in public health and general welfare.

Related to Markets and Consumers

- It would be a good measure to influence markets and consumers to claim for products with an environmental friendly origin (ecological labels, awareness rising).

- Promoting ecological labels among producers has a good economical and environmental impact on high natural value farmlands.

Related to Pests and pesticides (Pesticides Directive)

- The use of pesticides is a problem for a big number of wild species, both, animals and plants. In the case of invertebrates, pesticides attack directly or indirectly to predators which regulate the populations of the plague species, hence, destroying the natural pest control mechanism.

  This affects the permeability of the landscape, because wild invertebrates get killed when they abandon protected sites or in the case of vertebrates they find a landscape without prey or plants for feeding. Moreover, pesticides, even carefully done, may affect adjacent ecosystems and habitats.

- Fight against agriculture pests should be done through biological methods (pheromone traps, breeding predators of the pest). This has the advantage of being directly addressed to the pest species avoiding most of collateral damages to other species and to the whole system.

- Herbicides against weeds should be changed by mechanical means whenever possible (mowing, ploughing or using cattle).

- A diversified farmland landscape with a diversified production is preferable, in general terms and in terms of biodiversity to a farmland of big areas covered by monocultures due to several reasons:

  - Pests in monocultures get dispersed easier and quicker and this increases the demand of pesticides and generates more expenses for the farmer and a higher environmental impact. In diversified cultures, pests have more difficulties for dispersion and find more natural enemies which may collaborate to control the pest.

  - A landscape of small allotments has more field borders which is favourable for the development of wild fauna and flora.

  - Diversified farmland landscapes are usually permeable for a higher number of wild species than big monoculture farmland landscape.

- Even in big cereal cultivation areas, prone to monoculture, the model of small allotments is preferable to the land consolidation scheme. This combined with rotation of cultures and set aside land is the best habitat for European steppic birds.

Related to fertilization and fertilizers

- Soil is the physical base of the Green Infrastructure. Soil behaves as a complex living being, the use of fertilisers both organic and chemicals should be very well proportioned and applied. Excessive fertilising can kill the living part of the soil and may pollute water tables and rivers. More work and capacity building is needed among farmers in this issue, both for organic and Chemicals agriculture. (Nitrates directive).

- Organic farming is preferable for connectivity, because it permits the survival of a lot of invertebrates, which are not considered pests. This by itself is good, but those invertebrates are the base of feeding for other species (other invertebrates, amphibians, reptiles, fishes, mammals, birds), contributing in this way to maintain biodiversity and the permeability of the landscape for wild fauna.

5.1.3. Relevant EU Policy

EU Rural Development Policy 2007-2013

Rural development is a vitally important policy area in the European Union. The essential rules governing Rural Development Policy (RDP) for the period 2007 to 2013, as well as the policy measures available to Member States and regions, are set out in Council Regulation (EC) No. 1698/2005[18].

Under this Regulation, rural development policy for 2007 to 2013 is focused on three themes (known as "thematic axes"). These are:

- Axis 1: improving the competitiveness of the agricultural and forestry sectors;
- Axis 2: improving the environment and the countryside;
- Axis 3: improving the quality of life in rural areas and encouraging diversification of the rural economy.

Besides, the Leader initiative is considered as a methodological axis designed to help rural actors consider the long-term potential of their local region. It is integrated as an obligatory element into the rural development programs to be implemented by the Member States during 2007-2013.

Rural Development is financed by a single fund: the European Agricultural Fund for Rural Development (EAFRD). And to help ensure a balanced approach to policy, Member States and regions are obliged to spread their rural development funding between all three of the thematic axes.

The measures of Axis 1 serve the aim of further modernisation of production by encouraging farmers also to structural changes, primarily for quality improvement. Measures linked to more rational land use and protection of the environment are

[18] Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:277:0001:0040:EN:PDF

grouped around Axis 2, which aim at ensuring the delivery of environmental services by agri-environment measures in rural areas, and preserving land management. Such measures also help prevent the abandonment of agricultural land use through payments to compensate natural handicaps or handicaps resulting from environmental restrictions. The measures under Axis 3 are aimed at improving the income-producing possibilities and quality of life of residents of rural areas by encouraging a 'living countryside'.

EU Common Agricultural Policy

Environmental concerns play a vital role in the Common Agricultural Policy (CAP) which deals both with the integration of environmental considerations into CAP rules and with the development of agricultural practices preserving the environment and safeguarding the countryside.

The CAP has been reformed[19] so that farmers today get financial support only in return for respecting the European Union's stringent environmental requirements. The Common Agricultural Policy has two pillars: the market and income policy ('first pillar'), and the sustainable development of rural areas ('second pillar'). The 2003 CAP reform includes measures to promote the protection of the farmed environment in both pillars.

The CAP and other EU legislation

Article 3 of CAP regulation states that *óa farmer receiving direct payments shall respect the statutory management requirements referred to in Annex IIIô(paragraph 1).* Figure 1 below compiles the environmental statutory management requirements under CAP regulation.

Figure 5.1. Environmental statutory management requirements - CAP

ANNEX III

Statutory management requirements referred to in Articles 3 and 4

A. Applicable from 1.1.2005

Environment

1.	Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (OJ L 103, 25.4.1979, p. 1)	Articles 3, 4(1), (2), (4), 5, 7 and 8
2.	Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (OJ L 20, 26.1.1980, p. 43)	Articles 4 and 5
3.	Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (OJ L 181, 4.7.1986, p. 6)	Article 3
4.	Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375, 31.12.1991, p. 1)	Articles 4 and 5
5.	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna (OJ L 206, 22.7.1992, p. 7)	Articles 6, 13, 15, and 22(b)

[19] Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001.

Pillar I: Cross-compliance

The principle that farmers should comply with environmental protection requirements as a condition for benefiting from market support is incorporated into the CAP. Moreover, the cross-compliance has become compulsory.

Farmers must respect cross compliance standards in two ways: the GAEC and the SMR. These requirements are described next.

a. *Good agricultural and environmental conditions (GAEC)*

All farmers claiming direct payments, whether or not they actually produce from their land, must abide by standards to be established by the Member States. This new requirement is a consequence of the introduction of the Single Payment Scheme (SPS) and is intended to avoid the abandonment of agricultural land (and its environmental consequences)

For farmers to keep farms in good agricultural and environmental conditions requires a minimum level of maintenance through compulsory standards for:

- Retention of landscape features including where appropriate, hedges, ponds, ditches, trees (in line, in group or isolated) and field margins;
- Avoidance of encroachment of unwanted vegetation on agricultural land;
- Protection of permanent pasture;

Member States can also voluntarily set standards for:

- Minimum livestock stocking rates or/and appropriate regimes;
- Establishment and/or retention of habitats

b. *Statutory management requirements (SMR)*

Farmers must respect other cross compliance standards called Statutory Management Requirements set-up in accordance with 18 EU Directives and Regulations relating to the protection of environment; public, animal and plant health; animal welfare.

Two of these 18 SMR listed under Pillar I of the CAP concerns the respect of the following articles of the Nature Directives:

<u>Birds Directive</u>[20] → Articles 3, 4(1), (2), (4), 5, 7 and 8

- Article 3 requires Member States to take action to secure or re-establish habitats for all naturally occurring wild birds.
- Article 4 requires Member States to take special protection measures for certain species of bird, including the establishment of Special Protection Areas (SPAs). Appropriate steps have to be taken to avoid pollution or deterioration of habitats or disturbance of birds on these sites.
- Article 5 prohibits the deliberate killing and significant disturbance of wild birds, deliberate destruction of, or damage to, their nests and eggs, removal of their nests or taking of their eggs except under licensed conditions e.g. for protection of crops.
- Article 7 permits hunting of wild birds subject to conditions.
- Article 8 prohibits certain means of killing wild birds.

[20] Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds

Habitats Directive[21] → Articles 6, 13, 15 and 22(b).

- Article 6 requires (i) Special Areas of Conservation (SACs) to be designated for habitats (Annex I) and species (Annex II) to be protected from damage, deterioration of habitats or disturbance of species; and (ii) the effects of plans or projects that could cause adverse effects to be considered.
- Article 13 requires prohibition of destroying, cutting or uprooting of protected plant species listed in Annex IV(a) of the Directive.
- Article 15 requires prohibition of certain methods of killing or taking wild species.
- Article 22 requires regulation of introduction of non-native species where prejudicial to native wildlife.

Failure by farmers to respect these conditions can result in deductions from, or complete cancellation of, direct payments.

Pillar II: Expenditure under the Rural Development Regulation

Pillar II measures are aimed at supporting rural communities to develop and diversify. In budget terms this is much smaller than Pillar I support. The range of measures includes: agri environment, farm adaptation, forestry, processing and marketing of agricultural produce, training and development, and less favoured area support.

The following measures could be used to benefit nature conservation:

- Less Favoured Area payments (article 37): linked to existing farming practices where they support upkeep of traditional low-input farming systems.

- Natura 2000 payments (article 38): in order to compensate for costs incurred and income foregone resulting from legal or administrative restrictions on farming within Natura 2000 areas such as a mixed rotational farming system containing large mosaics of grasslands, arable crops (including winter crops) and fallow land.

- Agri-environmental (AE) schemes (article 39): linked to voluntary measures such as avoiding the use of herbicides, pesticides and fertilizers or armoured seeds, not ploughing fallow land in spring, not burning stubble in summer, delaying harvesting of crops until after chicks have hatched, leaving un-harvested crop islands around nest sites, suspending farming operations in leks during the mating season, avoiding night-time harvesting, leaving areas of unharvested crops and uncultivated field margins for foraging and cover, planting winter cereals and leguminous crops in great bustard wintering grounds to provide food and cover in winter, maintaining appropriate levels of grazing; providing wardening to avoid disturbance during breeding / nesting season.

- Reimbursement of non-productive investments (article 41): can cover a range of investments from on-farm investments linked AE schemes or to measures identified in management plans for an SPA such as promoting extensification programmes, restoring and reconnecting suitable habitats for the species, introducing active shepherding and wardening, planting of winter crops, marking powerlines, changing barbed wire fences to fences with a large mesh size.

[21] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna.

- Conservation of rural heritage (Article 57): for instance to cover the cost of drawing up management plans for Natura 2000 sites hosting particular species, undertaking habitat restoration measures in areas currently or potentially suitable for species, launching awareness campaigns on the conservation needs of species.

In addition the following measures could also be mentioned:

- Training and information (Article 21): e.g. could help make AE schemes more effective and train farmers and experts in the Farm Advistory Services on conservation and management requirements linked to wildlife;

- Farm Advisory Services (FAS) (article 24 and 25): to advise farmers on how to apply cross compliance rules.

- LEADER (Article 61): integration of species/habitats conservation into area-based local development strategies and enhancement of dialogue and collaboration between farmers, conservationists and other rural stakeholders in the area concerned.

Total Pillar 1 support was generally higher in more accessible regions, and lower in more peripheral regions, at all scales – European, national and regional. Higher levels of CAP expenditure per hectare of agricultural land were found to be strongly associated with more prosperous regions. Thus, because of the way that the market price support mechanism operates, Pillar 1 does not support territorial cohesion.

While Pillar 1 was never intended to be a cohesion measure, higher levels of Pillar 2 payments are made to peripheral EU regions. However, Pillar 2 remains focused on agricultural producers rather than territorial rural development, and will continue to be so during 2007-2013. This 'rural development' Pillar may aid cohesion within countries, but, as currently structured, it makes little contribution to EU-wide cohesion (ESPON 2006).

More detailed information on the CAP's contribution to environmental sustainability and the part played by other policy and regulatory measures in helping the EU to meet global environmental sustainability aims and targets can be found in the Fact-Sheet "Agriculture and the environment"[22].

Agri-environmental measures

The EU applies agri-environmental measures which support specifically designed farming practices, going beyond the baseline level of "good farming practice" (GFP), that help to protect the environment and maintain the countryside.

In the framework of the rural development policy, the Community offers a menu of measures to promote the protection of the farmed environment and its biodiversity. There are, among others, possibilities of support for less favoured areas and agri-environmental measures, which entail, respectively, applying or going beyond the usual Good Farming Practices.

Farmers who commit themselves, for a five-year minimum period, to adopt environmentally-friendly farming techniques that go beyond usual good farming practice, receive in return payments that compensate for additional costs and loss of income that arise as a result of altered farming practices.

[22] Available at: http://ec.europa.eu/agriculture/publi/fact/envir/2003_en.pdf

Examples of commitments covered by national/regional agri-environmental schemes are:

- Environmentally favourable extensification of farming;
- Management of low-intensity pasture systems;
- Integrated farm management and organic agriculture;
- Preservation of landscape and historical features such as hedgerows, ditches and woods;
- Conservation of high-value habitats and their associated biodiversity.

The Biodiversity Action Plan for Agriculture

The Biodiversity Action Plan for Agriculture[23], adopted in 2001, is an important integral part of the package of community measures in support of the Community strategy to predict, prevent and eradicate the causes of significant diminution or loss of biodiversity. The priorities of this Action Plan are:

- The promotion and support of environmentally-friendly farming practices and systems that benefit biodiversity directly or indirectly;
- The support of sustainable farming activities in biodiversity-rich areas;
- The maintenance and enhancement of good ecological infrastructures,
- The promotion of actions to conserve local or threatened livestock breeds or plant varieties.

All these priorities are supported by research, training and education actions. Biodiversity conservation greatly depends on the sufficient and targeted application of measures within the CAP, notably compensatory allowances for less favoured areas and agri-environmental measures.

Nitrates

The EU legislation on nitrates aims at reducing water pollution by nitrates from agricultural sources and at preventing further pollution.

The EU's nitrates directive (Council Directive 91/676/EEC of 12 December 1991) is managed by Member States and involves:

- Monitoring of water quality in relation to agriculture;
- Designation of nitrate vulnerable zones;
- Establishment of (voluntary) codes of good agricultural practice and of
- (Obligatory) measures to be implemented in action programmes for the nitrate vulnerable zones.

Codes of good agricultural practice cover such activities as application periods, fertiliser use near watercourses and on slopes, manure storage methods, spreading methods and crop rotation and other land management measures. Action programmes must include obligatory measures concerning periods of prohibition of the application of certain types of fertiliser, capacity of manure storage vessels, limitations to the application of fertilisers (on steep slopes; to water-saturated, flooded, frozen or snow-covered ground; near water courses), as well as other measures set out in codes of good agricultural practice.

[23] Available from: http://ec.europa.eu/agriculture/envir/biodiv/162_en.pdf

With the 2003 CAP reform, respect of statutory requirements arising from the implementation of the nitrates directive is included within the framework of the reinforced cross-compliance.

Pesticides

Pesticides used in agriculture are widely used in farming for their economic benefits. However, their use does involve risk because most have inherent properties that can make them dangerous to health and the environment if not used properly.

The EU thus seeks to ensure their correct use, it regulates in order to minimise their detrimental environmental impact and informs the public about their use and any residue issues. Current legislation such as Directive 91/414 on the placing on the market of plant protection products and Regulation 396/2005 on pesticide residues in food and feed aim at a high level of protection of human health and the environment.

Agri-environmental measures also offer support for commitments on keeping records of actual use of pesticides, lower use of pesticides to protect soil, water, air and biodiversity, the use of integrated pest management techniques and conversion to organic farming. Moreover, the EU's sixth environment action programme addresses the need to encourage farmers to change their use of pesticides.

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5.2. Forestry

Forests cover about one third of the EU territory and are considered one of the most important component of European nature, having a crucial role in dealing with the challenges of climate change, and in sustaining species and biodiversity conservation.

Contrary to what is happening in other parts of the world, forest cover in the EU is slowly but steadily increasing at a rate of approximately 0.3% per year. Nevertheless, although the absolute area of EU forests is expanding, the environmental quality of the forest ecosystems is generally in decline. The changes that forests have undergone over the last centuries have brought a great number of species to the verge of extinction.
Forests are for a big part of the public the most conspicuous representation of the Green Infrastructure and for most people saying forest, means nature. However this is not completely true, as it is explained in this chapter, forests in Europe have suffered deep changes in their structure and composition, and unless they continue being a very valuable part of the Green Infrastructure, a lot of them are far away from being the natural landscapes they used to be.

5.2.1. Current forest management

Forestry practices are in general a major factor affecting threatened wildlife species through loss and deterioration of habitats. In the boreal forest of northern Europe, numbers of species declined parallel to the onset of intensive clear-cutting. In central Europe for example, Capercaillie (*Tetrao urogallus*) abundance was highest at times when human land-use practices, e.g. collection of forest litter and cattle grazing, favoured open forest structures. During the past decades, however, increasing standing timber volumes throughout central Europe were paralleled by declining numbers of Capercaillie. At the Pan-European level, forestry practices are probably the major factor influencing numbers of the species.

Intensive forest management cause habitat degradation and significant biodiversity decrease in commercially managed forests, especially in North Europe. Particularly during the second half of the 20th century, industrialisation of the forestry sector has impaired conditions for wildlife, as the forest habitat has changed from mixed-age stands of modified natural forest with minor clearings to a large-scale mosaic of even-aged stands and clear-cuttings.

Plantation forests are of increasing importance worldwide for wood and fibre production, and in some areas they are the only forest cover. According to the European Forest Types: a proposal for a new MCPFE Forest Types classification, there are 14 forest classes reflecting variation in the main ecological and anthropogenic variables affecting forest condition, including biodiversity, across Europe. The last of these classes and the one with the lowest naturalness is "Plantations and self sown exotic forest", which comprises both plantation of site-native species (native conifers or broadleaves such as cherry, walnut, etc.) and plantations of not-site-native species and self-sown exotic forest (*Robinia pseudoacacia, Ailanthus altissima, Populus clones, Eucalyptus, Pseudotsuga menziesii, Pinus radiata*, etc.).

The main characteristics of these plantations are:

- simplification of forest structure (monospecific, regularly tree spacing)
- relevant modification in site species composition, when the native vegetation is replaced by forest stands predominantly consisting of non-native (or non-indigenous, exotic, introduced) trees.

For example, in central Europe and the lowlands of Alpine Europe much of the 'low quality' broadleaved forests were replaced by large coniferous reforestations during the

1700s and 1800s; on richer soils oak and beech were replaced by spruce, whereas on poor land Scots pine were planted (Ozenda, 1994). Uneven-aged forest structure became even-aged homogeneous and uniform. Other large afforestations were carried out in central Europe on areas that were devastated or that had been logged during or shortly after the First and Second World Wars; in the same period many national reforestation programmes were carried out in southern European countries to recover degraded lands and protect soil from erosion (EEA, 2006).

However, most of the recent afforestations in the European Union have been carried out, often with exotic species, on abandoned agricultural land as part of the set-aside strategy of the EU common agricultural policy (1 million hectares since 1991).

Deforestation is of course the ultimate threat to the habitat, but in almost all Member States forest area is now increasing. However, high forest cover per se does not necessarily correlate with the well-being of forest wildlife. Even if total forest area and the areas of primary and protected forest are now increasing, this may be of little value to some threatened species, if forestry practices do not suit the requirements of the species. The habitat requirements ï and hence the threats ï must be considered at two spatial scales: at the local scale, i.e. the scale of individual home ranges, habitat should be suitable and diversity sufficient to meet the requirements of the species throughout its yearly cycle. At the landscape scale, sufficiently large areas of suitable habitat should exist to support a viable population (or metapopulation).

5.2.2. Relevant EU Policy

The EU forestry strategy

Forest policy falls within the sphere of competence of the Member States, but the EU can contribute to the implementation of forest management through common policies based on subsidiarity and shared responsibility. This in turn can play a central role in enhancing the green infrastructure. Sustainable forest management is therefore based on coordinating the forest policies of the Member States and Community policies and initiatives.

To date, EU Member States are mainly responsible for forest protection policy. The European Commissionõs role is restricted to coordinating activities among Member States and to promoting concerted action through new and coherent approaches. Specific measures on forest protection can be found in different EU policies and directives such as the Common Agriculture Policy (CAP), the Water Framework Directive (WFD) and policies on nature conservation like Natura 2000.

EU competencies and policy developments

Forest policy is a competence of the member states but several EU laws influence national forest policies. Therefore, the Commission adopted in 1998 an EU Forestry Strategy which underlined the importance of the multifunctional role of forests and the need for sustainable forest management (SFM). In March 2005, the Commission evaluated the implementation of this strategy and proposed to develop an EU Action Plan for Sustainable Forest Management.

Definition of sustainable forest management (from Ministerial Conference for Protection of Forests in Europe, Helsinki 1993): "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems". In 2004, the EU adopted an EU Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT), which introduces a voluntary licensing scheme to ensure that only legal timber enters the EU.

Issues

One of the main challenges of forestry policy is to find the right balance between the different functions forests provide for society (the "multifunctionality" of forestry). The renewed interest in using biomass from forests could, for instance, endanger the material resource base for other uses of timber. Another aspect of forestry policy is that it touches on several other policy areas, such as agriculture and rural development policy, environment and energy policy, industrial and R&D policy or development and trade policy. There is a need to strengthen the coherence between these different policy objectives.

The EU's forestry industry is facing several challenges as a result of globalisation:

- competition with lower-cost producers in developing countries;
- illegal logging
- stronger demand for forest products and services
- climate change
- environmental degradation

The five-year (2007-2011) Action Plan tries to find answers to these complex challenges and has four main objectives:

- improve the long-term competitiveness of the forestry sector;
- protect the environment;
- contribute to the quality of life;
- and foster coordination and communication on these issues.

The Action Plan defines a framework of 18 key actions, which should be implemented at EU and Member State level. Most of these actions are rather general ("examine the effects of globalisation on the competitiveness of EU forestry" or "enhance protection of EU forests") or reformulate policy actions that had already been defined elsewhere ("promote the use of forest biomass for energy generation").

EU action plan for sustainable forest management

To develop an effective strategy for sustainable forest management, the Commission considers necessary:

- to reconcile socially and ecologically beneficial forest management with the fact that the income of European owners depends largely on the sale of timber. It is becoming increasingly difficult to achieve economic, social and environmental objectives simultaneously in an open and global marketplace;
- to strengthen coherence between the various EU policies that affect forests and forestry, and to improve coordination between the Commission and the Member States. Appropriate measures will be taken in this connection as part of the implementation of the strategy;

- to review and consolidate the forestry consultation structures in order to ensure transparency in decision-making and a structured dialogue with all stakeholders;
- to recognise the role of forests in sustainable development, e.g. in relation to climate change and biodiversity, and to support international commitments.

The development of an EU action plan for sustainable forest management will provide an appropriate framework for laying the foundations for a dynamic structure consistent with the current policy context and the Lisbon and Göteborg strategies. The plan would also provide a coherent framework for the implementation of forest-related action and serve as an instrument for coordination between Community action and Member States' forest policies. The action to be taken at Community level should cover several areas, ranging from socio-economic issues to environmental issues as well as the use of wood as an energy source. The action plan will also address issues relating to governance, cross-sectoral activities and coordination, communication and cooperation issues. The Commission proposes to present the action plan in 2006.

5.2.3. References

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5.3. Rivers and Water Management

Rivers are the support of a wide range of aquatic and non-aquatic habitats, vegetation and wildlife. As habitats, they are important components of the landscape, which they structure and influence at a broader scale than the river itself. Moreover, they act as links between other habitats. This and other characteristics of rivers and rivers components are presented in this chapter. Finally, a brief description of relevant EU legislation concerning water is included.

Rivers are fundamental part of freshwater habitats around which complex aquatic ecosystems are structured. In this way, rivers provide habitat to many plant and animal species. These habitats consist of benthic, aquatic, and terrestrial components. The river continuum concept, first proposed by Vannote et al. (1980), describes the structure and function of communities along a river system. Basically, the concept proposes that understanding of the biological strategies and dynamics of river systems requires consideration of the gradient of physical factors formed by the drainage network. This concept of dynamic equilibrium for biological communities is useful because it suggests that community structure and function adjust to river changes in certain geomorphic, physical, and biotic variables such as stream flow, channel morphology, detritus loading, size of particulate organic material, characteristics of autotrophic production, and thermal responses.

As linear ecosystems, rivers are particularly vulnerable to fragmentation. A number of human activities can disrupt the continuity of river. The most familiar human-caused barriers are dams. The structure and function of riverine ecosystems are based on five components: hydrology, biology, geomorphology, water quality, and connectivity. For instance, all hydrologic installation (such as dams for energy production or river regulation) should consider an instream flow adapted to the natural flow regime of the river (particularly downstream its location) in order to protect aquatic life functions dependent on this natural flow regime. Indeed, the alteration of natural flow conditions, in volume and timing, often occurs downstream from hydrological projects where large volumes of water are either stored or diverted. Consequently, a limit for the minimum flow and an occasional maximum or flushing flow may be required to maintain aquatic habitats downstream, whereas other type of solutions is needed for mitigation of upstream negative effects (for example, fish passes for migratory species). In the EU context, the maintenance of an ecological flow is a key issue for compliance with current environmental legislation such as the Water Framework Directive, which states that surface water bodies should achieve a good ecological status by 2015 (more details on this directive in the next section).

Despite the inclusion of all those concepts in river policies, there are not, up to date, enough practical solutions to recover the total continuity of the rivers and riparian ecosystems. In some countries most river systems are a rosary of dams linked by small stream stretches. River organisms adapted to running waters find lakes in their ways where they have to race with other organisms better adapted to lacustrine environment, or fly away from introduced predators, they also have to avoid hydroelectric turbines and finally riparian forests get interrupted. Dams are not going to be demolished because they have too much importance as water reservoirs for industry, irrigation and human consumption. Hence it is necessary to create, develop and implement imaginative ideas to recover this continuity and this is a matter of political will and financial investment taking in account the needs and natural characteristics of the river ecosystems.

Besides their function as ecosystems, the importance of rivers at a landscape scale is undisputable since, due to their continuous linear structure, they may also act as ecological networks. Indeed, well conserved rivers and their associated ecosystems (such as riparian galleries) are capital not only for typically aquatic species, but also for those which find food, shelter or refuge in these habitats or for other species using rivers in their movements. It is important to note that river networks function as a single ecosystem with numerous connections and interactions among the benthic, aquatic, and terrestrial components (Leccese et al. 2004).

Riparian galleries are important components of river ecosystems and have a fundamental role in preserving and maintaining biodiversity. The flora, structure and nature of these areas are determined by hydrological factors, the climate, the local topography and characteristics of the soil. The vegetation is usually structurally and floristically distinct from adjacent habitats with which it intergrades. Moreover, it is specifically adapted to the environmental conditions, through morphological, physiological and reproductive strategies (Fabiao and Fabiao 2006). . Riparian galleries are both affected by transversal and lateral dams. In the scope of this project, we would highlight the importance of riparian galleries as ecological networks for plant communities and wildlife, providing them with food, shelter, refuge or passage. The function of different nature elements as ecological networks is stressed by the "European Spatial Development Perspective[24]" which recognizes that biodiversity cannot be preserved with just a network of protected areas, and that the development of ecological links between them is just as important. In this context, the main ecological functions of riparian galleries are described next.

5.3.1. Ecological functions of riparian vegetation

Riparian vegetation has a multifunctional role in the Green infrastructure, as it is related to water quality with all the implications on wildlife, human health and recreation, sediment retention and flood and erosion prevention. It is a natural linear corridor for fauna and flora and it can also play a major role in climate change mitigation.

- **Habitat for wildlife**

  - Riparian galleries are important for species that require aquatic and terrestrial environments for their life-cycle; such as amphibians, aquatic insects, etc.
  - This zone can also favour wetland birds that forage in aquatic environments but shelter in terrestrial vegetation.
  - Some species can use specialized habitats along streams, for example the Large-footed Myotis, an insectivorous bat that forages above the surface of the water, is rarely found away from streams.
  - Although linear and limited in overall extent, riparian habitats can have a major effect on regional biological diversity.
  - Riparian vegetation may serve as a seasonal environment or refuge during extreme conditions for the fauna of adjacent habitats.
  - Streamside strips make a large and valuable contribution to maintaining indigenous species in modified landscapes, although habitat generalists are usually more likely to persist than habitat specialists or rare species.
  - Streamside vegetation and the resulting fallen trees and branches, root systems and overhanging vegetation contribute to the diversity of structural habitats and flow regimes (pools, riffles, waterfalls) in streams. In turn, these provide a wider range of microhabitats that support a greater diversity of fish and other aquatic organisms.
  - Streamside vegetation is also an important source of energy for aquatic ecosystems. Herbaceous vegetation is rapidly consumed after falling into streams, whereas trunks and logs are a long term source of nutrients for aquatic food webs.

- **Hydrologic regulation**

  - Vegetation slows runoff into streams and increases the rate at which water infiltrates soil. Litter and soil associated with riparian vegetation act as a sponge to hold water, which is later slowly released, adding stability to the water supply to the stream.

[24] European Spatial Development Perspective. Towards Balanced and Sustainable Development of the Territory of the European Union. Agreed at the Informal Council of Ministers responsible for Spatial Planning in Potsdam, May 1999. Available from:
http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/pdf/sum_en.pdf

- Vegetation in the riparian zone transpires water to the atmosphere. In arid environments transpiration may substantially influence the quantity and duration of stream flow.
- The scale of these hydrologic impacts is directly related to the amount of vegetation, and therefore the width of the riparian strip. Wide vegetated strips have a greater regulatory influence.

- **Filter for sediments and nutrients**

    - Streamside vegetation traps and filters sediments and nutrients from excessive fertilizer application to agricultural crops before they reach the stream, thus limiting their negative impacts. This type of vegetation also has a beneficial role in the retention of micro-pollutants such as those that result from pesticide application in the surrounding area.
    - Filtration efficiency of riparian vegetation is greatest for gentle slopes, wide streamside vegetation, and a high density of vegetation and litter cover at ground level.

- **Stabilisation of stream banks and beds**

    - Riparian vegetation plays a major role in stabilising stream channels. Root systems bind and hold soil along stream banks, while foliage, trunks and debris reduce the flow velocity and alter flow patterns.
    - Besides, the capacity of riparian galleries to retain sediments significantly reduces their introduction onto the aquatic environment, limiting sedimentation.
    - Regulation of water temperature
    - Riparian vegetation buffers water against changes in temperature by shading the stream surface. Shade prevents water temperature becoming too high, which positively influences dissolved oxygen levels important for aquatic organisms as well as for decomposition of organic matter.

5.3.2. Relevant EU Policy

Several types of policies (such as policies reducing emission levels to the water, defining standards of water quality, etc) are now integrated in the various phases of the implementation of the Water Framework Directive (WFD).

Figure 5.2. European legislation on water in chronological order.

1975 Quality required of surface water intended for drinking water (75/440/EEC)

1976 Quality of bathing water (76/160/EEC)
Discharging dangerous substances into aquatic environment (76/464/EEC)

1977 Common procedure for the exchange of information on the quality of surface water (77/795/EEC)

1978 Quality of fresh waters in order to support fish life (78/659/EEC)

1979 Conservation of wild birds (79/409/EEC)
Analysis of surface water intended for drinking water (79/869/EEC)
Quality of shellfish waters (79/923/EEC)

1980 Protection of groundwater from dangerous substances (80/68/EEC)
The Drinking water Directive (80/778/EEC)

1982 Limit values and quality objectives for mercury discharges (Chlor-alkali electrolysis industy) (82/176/EEC)

1984 Limit values and quality objectives for mercury discharges (other than in 82/176/EEC) (84/156/EEC)
Limit values and quality objectives for Discharges of hexachlorocyclohexane (84/491/EEC)

1985 Environmental impact assessment of certain public and private projects (EIA) (85/337/EC)

1986 Using of sewage sludge in agriculture (86/278/EEC)
Limit values and quality objectives for dangerous substances included into Directive 76/464/EEC (86/280/EEC)

1991 Urban waste water treatment (91/271/EEC)
Protection of waters against nitrates pollution (91/676/EEC)
Plan protection products (91/1414/EEC)

1992 Conservation of natural habitats (92/43/EEC)

1994 Protection of the Baltic Sea Area (Helsinki Convention) (94/156/EC & 94/157/EC))

1996 Integrated Pollution Prevention and Control (IPPC) (96/61/EC)
Control of major-accident hazards involving dangerous substances (96/82/EC)

1998 The Drinking water Directive (98/83/EC) (repealed the directive (80/778/EEC))

1999 European Spatial Development Perspective

2000 Water Framework Directive (WFD) (2000/60/EC)

2001 Environmental impact assessment of plans and programmes (EIA) (2001/42/EC)
Promotion of electricity from renewable energy sources (2001/77/EC)
Pricing and sustainable management of water resources (2001/C 123/15)
List of priority substances (amending WFD) (2455/2001/EC)

2002 Towards a strategy to protect and conserve the marine environment (COM(2002) 539)

2003 *Protection of groundwater against pollution (COM(2003) 550)*
Access to information, public participation and access to justice (Aarhus Convention) (COM/2003/0625)

2004 Flood risk management (COM(2004) 472)

Black: EU Directives. Pink: Communications of the Commission. Green: Decisions of the European Parliament and the Council. Brown: comments and recommendations. Italic font: proposals. Source: Frederiksen and Maenpaa 2007.

The Water Framework Directive

Water Policy at European level and, in particular the Water Framework Directive (WFD), aims at an integrated approach to water management at river basin level.

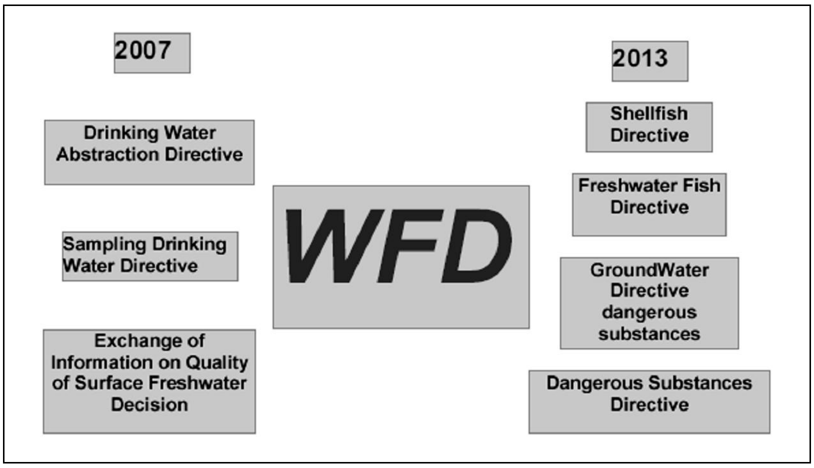
The EU Water Framework Directive[25], adopted in October 2000, is an important piece of EU environmental legislation which aims at improving the water environment. This Directive establishes a framework for the protection of all waters including rivers, lakes, estuaries, coastal waters and groundwater, and their dependent wildlife/habitats under one piece of environmental legislation.

Previous European water legislation set objectives aimed at protecting particular uses of the water environment from the effects of pollution and guarding the water environment from dangerous chemical substances. The WFD takes many of these objectives forward. More importantly, it also introduces additional, broader ecological objectives that are designed to defend, and where necessary restore the structure and function of aquatic ecosystems. In fact, one of the main environmental objectives of this Directive is to achieve good ecological status for all water bodies in the EU Member States by 2015.

The WFD and other EU legislation

The WFD will eventually repeal six other water quality directives and a Council Decision, and this seven and the next four thirteen years after the entry into force of the WFD (see Figure 5.3)

Figure 5.3. Directives and Council Decision to be repealed in the course of WFD implementation.



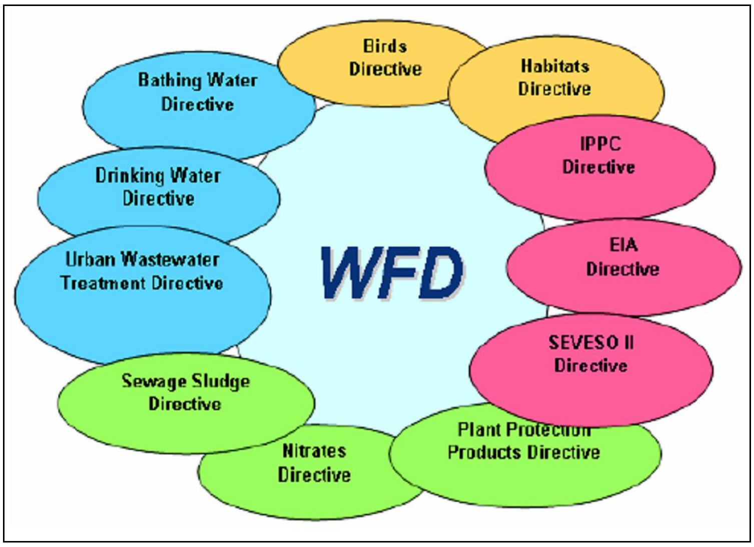
Source: Frederiksen and Maenpaa 2007.

Besides, there are eleven directives including measures and regulations that should be included into the "Programme of Measures" (see Figure 5.4), which all Member States must produce for each River Basin District. The Programme of Measures consists of

[25] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

policies and strategies that are intended to reduce the risk to water bodies and allow them to attain good ecological status.

Figure 5.4. Directives containing measures included in the Programme of Measures.



Blue: water related directives. Orange: protection of biodiversity in relation to water related measures. Green: other pressures related directives. Source: Frederiksen & Maenpaa 2007.

A central objective of the WFD is to improve integration between environmental, economic and social aspects of water management, striking a balance between the often competing claims. This requires more effective coordination between water management institutions and other institutions such as for spatial planning, nature protection and land use.

European Structural and Cohesion Funds

The Structural and Cohesion Funds are the European Union's main instruments for supporting social and economic restructuring across the EU. They account for over one third of the European Union budget and are used to tackle regional disparities and support regional development through actions including developing infrastructure and telecommunications, developing human resources and supporting research and development.

These funds target different types of projects and are used for regionally identified issues in different countries and regions in. The Structural Funds apply to the specific regions and areas which suffer from the greatest economic deprivation, while Cohesion Funds apply to whole countries. The European Council of December 2005 agreed a total Structural and Cohesion Funds budget of €308 billion for 2007-13. The Structural[26] and Cohesion Funds are divided into three separate funds, which are used to meet the three objectives of Cohesion and Regional policy (see table below):

[26] Structural Funds components: European Regional Development Fund (ERDF) and European Social Fund (ESF).

Table 5.1. Structural Funds and Cohesion fund used to meet objectives of Cohesion and Regional policy.

Cohesion/Regional Policy objectives	Funds used to meet the objective
Convergence	ERDF, ESF and Cohesion Fund
Regional Competitiveness and Employment	ERDF, ESF
European Territorial Co-operation	ERDF

Structural Funds investments in water sector

The measures supported under these funds are also supposed to tie in with Community water policies and can thus be made more "water positive".

For rural development areas, the European Agricultural Fund for Rural Development (EAFRD) is important for funding measures relevant to the environment. Implementation of the WFD is an explicit goal of the Fund and offers much scope for projects related to water, but to benefit from the scheme, the Member State or region must first prepare a special Rural Development Programme.

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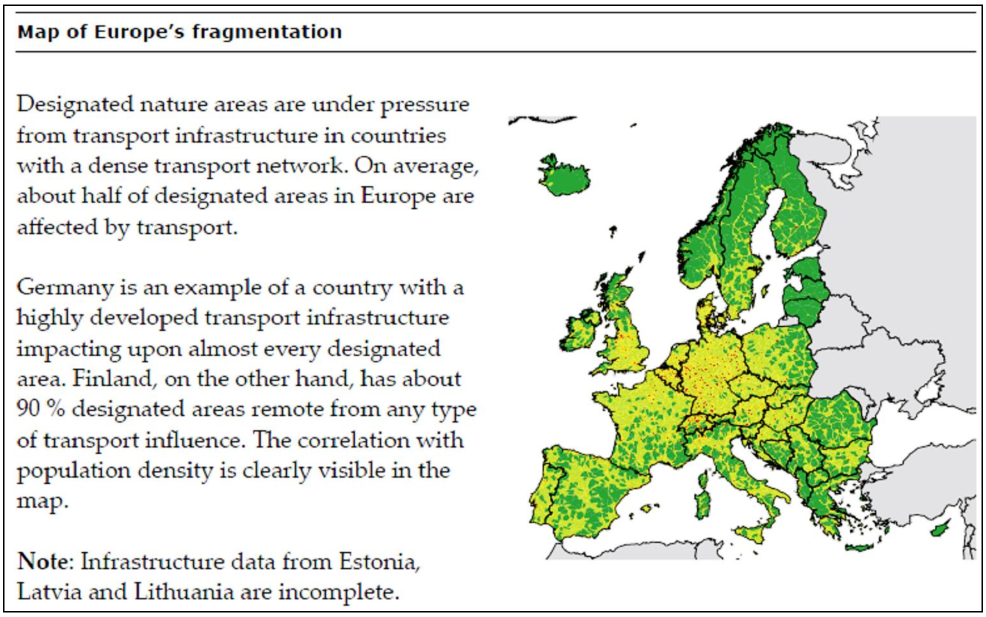
5.4. Linear infrastructures

The consequences for wildlife and for the Green Infrastructure, of constructing transport infrastructure include traffic mortality, habitat loss and degradation, pollution, altered microclimate and hydrological conditions and increased human activity in adjacent areas. All these cause considerable loss and disturbance of natural habitats. In addition, roads, railways and waterways impose movement barriers on many animals, barriers that can isolate populations and lead to long-term population decline (Trocmé et al. 2003).

Habitat fragmentation is recognised globally as one of the biggest threats to the conservation of biological diversity. Habitat fragmentation is mainly the result of different forms of land use change. The construction and use of transport infrastructure is one of the major agents causing this change as well as creating barriers between habitat fragments (Trocmé et al. 2003).

Figure 5.5. Map of Europeȍs fragmentation.



Source: EEA 2004.

5.4.1. Ecological effects of transport infrastructure

- **Loss of wildlife habitat**

The direct impact of road construction is the physical change in land cover along the route as natural habitats are replaced or altered by transport infrastructure.

- **Barrier effects**

  - <u>Physical barrier</u>: For most of the larger mammals, transport infrastructure becomes a complete barrier only if fenced or if traffic intensity is high. For smaller animals, especially invertebrates, the road surface itself and road verges impose a considerably stronger barrier, either because the substrate is inhospitable or disturbance is too great.

- Behavioural barrier: Many larger wildlife species are known to avoid areas near roads and railways related to the degree of human disturbance (traffic density, secondary development). Other animals, such as small mammals and some forest birds, exhibit behavioural avoidance patterns particularly associated with crossing large open spaces.

The only way to avoid the barrier effect is to make infrastructure more permeable to wildlife by means of fauna passages, adapting engineering works or by the management of traffic flows.

- **Fauna casualties**

For sensitive species (i.e. Iberian lynx), traffic can be a major cause of mortality and a significant factor in local population survival. Indeed, fauna casualties can be due to mortality from collision with vehicles, but also to mortality during road construction. Although many species are affected by road casualties, several amphibians and reptiles are particularly sensitive to traffic kill because their life histories often involve migration between wetland and upland habitats, which can lead to a substantial reduction of local populations of these species and, over several years, even to extinction. To counteract this fact, mitigation measures have been developed and employed in different locations, such as underpasses or temporal devices guiding the individuals away of the road but all these need to be adapted to the species present in the site to be effective.

- **Disturbance and pollution**

  - Hydrological changes: Cuttings may increase soil erosion and drain aquifers. Embankments may change the water regime producing either drier or wetter conditions.
  - Chemical pollution: A wide range of pollutants are derived from road traffic and the road surface. The chemicals pollute surface and groundwater, soil and vegetation along roads.
  - Noise and vibration: The disturbance from noise is mainly influenced by the type of traffic, traffic intensity, road surface properties, topography, rail type and the structure and type of the adjacent vegetation. Some species are sensitive to noise-disturbed areas.
  - Lighting and visual disturbances: Artificial lighting can affect growth regulation in plants, disturb breeding and foraging behaviour in birds or influence the behaviour of nocturnal amphibians. Lights can also attract insects and, in turn, increase the local densities of bats along roads resulting in increased bat mortality.

- **Infrastructure verges**

They can be important habitats for some species of wildlife, but they can also lead animals to places where mortality is increased or aid the spread of alien species. More detailed information on this issue is given next.

- **Secondary ecological effects**

  - Increased degree of human access and disturbance. Networks of small forest roads may provide hunters and tourists access to otherwise undisturbed wildlife habitats. Even if little attention has been paid to small roads mortality, in some regions – touristic areas in particular, these infrastructures are intensively demanded by tourists at particular seasons (such as the some mountainous and coastal areas). A study carried out in central Portugal, evaluated the vertebrate mortality due to road traffic in two forest roads. They found that road mortality presents a clear seasonal and spatial pattern, most casualties occurring between November and March (coinciding with amphibians reproduction period), and the amphibians were the most affected group (Petronilho and Dias 2005).

5.4.2. Transport infrastructures and ecological networks

The Pan-European Biological and Landscape Diversity Strategy (PEBLDS) promotes the concept of 'ecological networks' (i.e. connections between habitats via ecological corridors). This has been specifically identified as an effective strategy for addressing habitat fragmentation as it promotes the integration of biodiversity conservation into land use planning procedures. Consideration of these 'ecological networks' in the planning of roads, railways and waterways may help to avoid critical bottlenecks in habitat connectivity and identify where mitigation measures are required (Damarad and Bekker 2003).

More recently, the increasing demand for renewable energy production has been raising the issue of their impacts on nature. Wind farms, solar power plants and dams, depending on their location, may affect habitats and species in different ways. For example, the establishment of a wind farm and related infrastructures, including access roads, power-lines for grid connection, turbine bases, etc. involve direct land take as well as fragmentation of habitats, and impact linked to associated infrastructures is often equally or more important than from the turbines. Therefore in nature sensitive areas, the location of this kind of project is a crucial issue for reducing the environmental impacts and habitat fragmentation.

5.4.3. Minimising the negative effects of transport infrastructure on wildlife

To some extent fragmentation of landscapes due to transport infrastructure can be avoided or mitigated by environmentally sensitive planning, at national, regional and local scales and by implementing specific measures that reduce the barrier effects of roads, railways, etc. In the former case, Member States can introduce legal or policy measures that specifically guide the development of transport networks away from areas that are important for biodiversity and nature conservation, e.g. Natura 2000 sites. In particular, transport regulations or guidelines can be used to avoid fragmentation by preventing the development of roads and railways within large areas of contiguous ecologically valuable habitat (Kettunen et al. 2007). The Strategic Environmental Assessment (SEA) and the Environmental Impact Assessment (EIA) are good tools for addressing these issues at a planning stage.

As regards the <u>specific measures</u>, artificial pathways (e.g. wildlife bridges and tunnels) and other measures to reduce collision risks can be used to improve 'the permeability' of transport networks. Such measures can reduce mortality rates and enable some species to cross roads and railways that would not otherwise be able to. However, artificial passages need to be well-designed, located in appropriate positions (according to scientific studies of connectivity needs) and appropriately managed and monitored if they are to effectively support the movement of species within fragmented landscapes (Kettunen et al. 2007). It also, has to be taken in account that artificial passages are not always used by amphibians, reptiles and small mammals (as the hedgehogs) unless they find them in their way, they rather tend to cross roads through the closest places in their ways and often get killed, so sealing roads to drive those species to artificial passages could be a solution to this problem. It can be highlighted here that the COST action 341-project has elaborated a handbook (Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions, 2003) with detailed ecological solutions to minimise or mitigate wildlife and traffic conflicts.

In relation to infrastructure verges and as indicated earlier in this section, they can serve to reduce collisions, thus increasing the landscape permeability. For example, hedges along fences can lead animals towards fauna passages; tall tree hedges force birds to fly high making them cross the road at a height where they don't collide with cars. But on the other hand, hedges may attract birds to the vicinity of the road increasing the risk of collisions (Iuell et al. 2003). Therefore, caution is needed when selecting the species to be planted along roads. In the United States, the concern over the impact of roads on ecosystems has led to an emerging academic field: road ecology. Road ecologists are concerned with the adverse impacts of roads on natural systems at many spatial scales. At regional scales, it is important to understand how highways can affect the distribution of individual animals between populations. At smaller, local scales, it is important to be able to identify specific places where animals are likely to cross highways in order to manage for landscape permeability, provide crossing opportunities for animals, and minimize risks to motorists from animal-vehicle collisions (PNW Science Findings 2006).

In the EU several initiatives are being implemented. For example, in the Netherlands three different ministries (Ministry of transportation and water management, Ministry of agriculture and nature, Ministry of planning and environment) worked together to design a national defragmentation programme. The resulting document provides a long term programme of actions with a clear time frame and a healthy budget (the budget for 2005-2018 is 410 million ú). According to the timetable, problem areas for grey/green infrastructure conflicts must be resolved by 2018. The coordination of the project is with the provincial governments (GI workshop proceedings 2009).

5.4.4. Relevant EU initiatives

The EU has not developed any specific legislation to counteract habitat fragmentation due to infrastructure, but has incorporated the issue in several Directives and decisions, such as the Nature related Directives (Trocmé et al. 2003).

Trans-European Transport Network ï TEN-T

In July 1996, the European Parliament and Council adopted a decision to develop guidelines for the development of the Trans-European Transport Network (TEN-T) (1692/96/EC). The main objective of the TEN-T is to ódevelop a better integrated transport system in the EU and as a result contribute towards growth, competitiveness and employment in Europe, with the additional aim of improving economic and social cohesion through the linking of peripheral regions to EU networksô The TEN-T plans cover major road, rail (both conventional and High Speed Rail), and inland waterways, whether existing, new or to be adapted. It also includes maritime ports, airports and combined networks.

The TEN-T regulations[27] stipulate that granting funding is conditional upon compliance with the principles of the common transport policy, which includes promotion of the least polluting modes of transport, and guidelines on public procurement and interoperability. Applications for funding must also demonstrate that the project respects all other EU legislation, including health protection and sustainable development. The most relevant environmental legislation includes the Birds and Habitats Directives, Water Framework Directive and impact assessment directives (EIA - Environmental Impact Assessment and SEA - Strategic Environmental Assessment). Applications must include documentation from environmental impact assessments. The EIA and SEA directives require public consultation and identification of potential alternatives to the project or programme.

Table 5.2. Estimated length (in km) of Trans-European Transport Network.

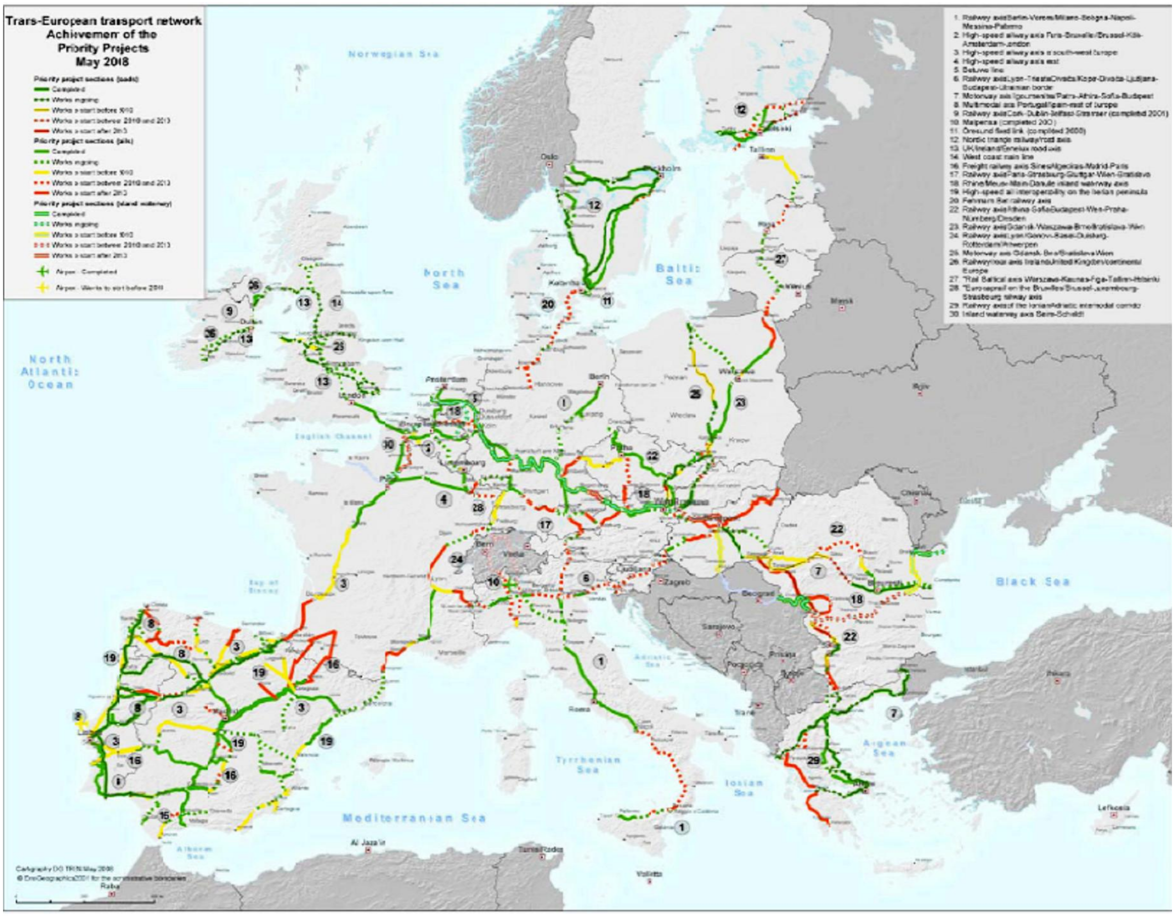
Network		Existing TEN-T (1996)	Planned TEN-T (2010)		European Transportation Infrastructure (1995)
			new	upgraded	
Road		49,598	¤12,363	¤14,512	*49,024
Rail	Conventional	48,477	1,372	-	155,836
	HSR	4,901	10,088	14,408	2,406
Inland waterways		12,239	1,412	n.a.	30,191

* motorways only

Source: Trocmé *et al*. 2003.

Figure 5.6. Trans-European Transport Network: Achievement of the Priority Projects, May 2008.

[27] Decision 1692/96/EC as amended by Decision 884/2004/EC.



Source: EC 2008

In relation to these priority projects, a joint report by BirdLife International, RSPB and other environmental groups highlights the threat to Natura 2000 from transport development, with over a thousand protected nature areas in Europe under serious threat. In numbers, a total of 379 Special Protection Areas (SPAs) and 935 Sites of Community Importance (SCIs/pSCIs), designated under the EU's Natura 2000 programme, are likely to be affected by the 21 TEN-T Priority Projects analysed for the study (Byron and Arnold 2008).

European transport policy for 2010: time to decide or White Paper

The Commission's White Paper on the Common Transport Policy ("European transport policy for 2010: Time to decide"), adopted in September 2001, is the guiding plan for European transport. It proposes some 60 specific measures to be taken at Community level under the transport policy. It includes an action programme extending until 2010, with milestones along the way, notably the monitoring exercises and the mid-term review in 2005 to check whether the precise targets are being attained or whether adjustments need making (EC 2001).

The White Paper highlights the importance of sustainable development principles within the transport sector and strives to make the transport more environmentally friendly. It gives priority to air quality, climate change and noise pollution problems; however, it is useful to mention biodiversity or habitat fragmentation as issues of concern (Damarad and Bekker 2003). Yet the neither the White Paper nor the midterm review mentioned the question of habitat fragmentation or impacts on biodiversity.

The European Structural and Cohesion Funds

The Structural and Cohesion Funds are the European Union's main instruments for supporting social and economic restructuring across the EU. They account for over one third of the European Union budget and are used to tackle regional disparities and support regional development through actions including developing infrastructure and telecommunications, developing human resources and supporting research and development.

The European Council of December 2005 agreed a total Structural and Cohesion Funds budget of €308 billion for 2007-13.

The Structural and Cohesion Funds are divided into three separate funds:

- European Regional Development Fund (ERDF);
- European Social Fund (ESF);
- Cohesion Fund.

These funds are used to meet the following three objectives of Cohesion and Regional policy, of which the Structural Funds are an instrument:

- Convergence → ERDF; ESF and Cohesion Fund,
- Regional Competitiveness and Employment → ERDF; ESF
- European Territorial Co-operation → ERDF

In this context, the development of the trans-European transport networks is among the priorities for the assistance of the Cohesion Policy. To support the development of sustainable transport infrastructure, Cohesion Policy will dedicate some € 38 billion to Trans-European Transport Networks (TEN-T) projects on the road, rail and inland waterways over the period 2007-2013 and will provide financing for secondary connections to improve access to the TEN-Ts. Moreover, some € 6.2 billion will be dedicated to Ports, Airports and Intelligent Transport Services, most of them being TEN-T projects and totalling approximately € 44.2 billion to TEN-T development (EC 2009).

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5.5. Extractive industry

Extractive industry has a very strong impact on the natural environment. Mines and quarries make strong transformations in the territory where they are located and frequently impact on other ecosystems close to those activities through transformation of the dynamics of water, noise and pollution. This is a direct impact on the Green Infrastructure.

According to the EC, "extractive industry" is defined as "all establishments and undertakings engaged in surface or underground extraction of mineral resources for commercial purposes, including extraction by drilling boreholes, or treatment of the extracted material"[28]. In the scope of this section, the extractive industry will be referred to the non-energy extractive industry, including the construction, industrial and metallic minerals sector; as well as to salt, peat and coal extraction.

Despite their diversity, all extractive activities have in common that they can only operate where the geological resources are present in sufficient quantity and quality, and under conditions that can be worked economically and safely with the available technology. Therefore, to remain in operation, the industry has to continuously identify

28 EC Directive 2006/21/EC, Article 3 (5) and (6).

and develop new resources to replace those that are becoming, or have become, exhausted or depleted to uneconomic levels.

As the resource in a particular site is often finite in an economical sense, the industry occupies an area of land for a limited time ð this period may span from just a few years to many decades. Many new resources are found close to existing operations, as exploration activities tend to concentrate around the same areas. New operations include, therefore, extensions of existing sites (ôbrownfieldô sites) and new 'greenfield' sites (EEA 2008).

5.5.1. Impacts on biodiversity

Mining and quarrying have the potential to affect biodiversity throughout the life cycle of a project, both directly and indirectly. Environmental impacts of extractive activities can vary considerably depending on the type of extraction and on the location of the activities. The extent of the impacts is influenced by the size of the operation, the sensitivity of local environment, the geographical and climatic conditions, the characteristics of the extracted mineral, the extraction methods and the technology employed. Impacts of extractive activities have thus to be considered on a case by case basis. Nevertheless, some general issues are described next.

- <u>Fragmentation</u>: an extractive activity taking place within or in the surroundings a natural site may cause the destruction and fragmentation of habitats and the disappearance or displacement of species.
- <u>Loss or deterioration of habitats and species</u>: concerns the physical destruction or deterioration of species habitats in and around the extraction areas including associated works (eg. access roads).
- <u>Alteration of hydrology/hydrogeology conditions</u>: When de-watering of the ore-body is required, extractive activities have the potential to modify hydrological conditions in the extraction areas and its surroundings, with consequent changes in the drainage network caused by a temporary imbalance in surface runoff, infiltration etc. In such cases, this could lead to impacts on nearby or distant springs and wetlands, both in terms of quantity and quality.
- <u>Effects on water quality</u>: Mineral extraction and production processes could directly affect the aquatic habitats and species existing in the site and indirectly other sites that can be reached by those effects.
- <u>Noise and vibrations</u>: Different kinds and intensities of noise may occur in extractive activities. It is important to distinguish between permanent noise (e.g. produced by crushing, screening, trucks, conveyor belts for transportation of materials, etc.) and intermittent but violent noise (e.g. from blasting). The sensitivity to different types of noise and vibrations depends on each species and it is difficult to assess given the lack of studies on the subject.
- <u>Movement related disturbances</u>: The movement of equipment and vehicles and the presence of people on the site may affect some species. For example, large raptors are quite sensitive to human presence, especially in the vicinity of their nesting sites, and may even abandon their eggs or clutches if disturbances are too numerous or too close.
- <u>Dust emissions</u>: The potential for dust emission depends on the operation methods and activities (blasting, loading, transport, crushing, etc.). The dynamics of dust generation is a complex issue and the assessment of its effect on the species and habitats should include a qualitative evaluation of dust emissions and dispersion considering prevailing winds.

- Landslides and collapses: Currently, these impacts are very limited and may concern mostly underground quarries of cut stone, chalk, gypsum, clay or ochre. Risks for animal and plant species are also very limited, but they could be significant if they occur.

Invasive species colonisation

Additionally to the potential impacts described above, it may be highlighted that the ecological changes caused by mines and quarries can favour colonisation by pioneer species, some of which can be invasive ones (Melki 2007). Colonization by invasive species may have three origins:

- Natural colonization from areas where the species is present and by different dispersal means (through animals, wind, water). In little disturbed environment, invasive species may not express their invasive potential due to the competition with local species. The creation of a new environment may allow invasive species to grow rapidly, creating a risk of subsequent invasions of other areas.
- Species introduction due to site rehabilitation. This can be intentional introduction, for instance when fishes are introduced in ponds, or unintentional introduction, in the case of exotic seedlings contained in imported soils used for land fill in. The latter may be prevented through the preservation and reuse of the original soil from the site.
- Uncontrolled introduction by third parties (residents, fishermen, etc.). Once operations have ceased and depending on the rehabilitation of the site, species may be introduced by others on the site.

Prevention of impacts throughout the life of a mine is to a significant degree determined by decisions reached in the feasibility and design phase of a project. Different mining methods present different risks and possibilities for mitigation. Underground mines typically have a small footprint associated with ore extraction and processing. Open pit mines progressively deepen and widen, increasing the areas disturbed each year and offering few opportunities for early rehabilitation. Open cast mines usually offer opportunities for progressive rehabilitation, as the mined areas may be re-contoured behind the active mining areas (ICMM 2006).

5.5.2. Positive Impacts

New environmental conditions created by the extractive activity, especially when properly managed and adapted, may offer suitable habitats for particular species. This is the case, for instance, for new wetland areas that are suitable for different amphibians or new cliffs that provide good nesting opportunities for some birds. Some species that are protected under the Birds and Habitats Directive can be found in extraction areas. However, the creation of new habitats must be carefully assessed as it might lead to the introduction of foreign species and upset fine ecological balances in the site.

Quarry and mine rehabilitation projects are now a common practice across Europe, and these are increasingly used to improve wildlife habitats and biodiversity during the project and at the end of the project life cycle.

5.5.3. Relevant EU Policy

Relevant legislation affecting the extractive industry and nature conservation in Europe is briefly described next.

Mining Waste Directive

The Directive 2006/21/EC on the management of waste from extractive industries provides for measures, procedures and guidance to prevent or reduce as far as possible any adverse effects on the environment, in particular water, air, soil, fauna and flora and landscape, and any resultant risks to human health, brought about as a result of the management of waste from the extractive industries. An associated best available techniques reference document has been developed to assist in its implementation[29].

The Nature Directives

The key pieces of EU legislation for nature conservation are the Birds and Habitats directives. The Birds Directive (79/409/EEC, Directive on the Conservation of Wild Birds), provides a framework for the conservation of all wild bird species naturally occurring in the EU territory of the Member States. The Habitats Directive (92/43/EEC, Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna), approved in 1992, aims to conserve species and habitat types of EU conservation interest and to establish an EU-wide network of nature protection areas, Natura 2000.

The European ecological network Natura 2000 is the centrepiece of EU nature & biodiversity policy, in addition to a strict system of species protection. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats.

Natura 2000 is not a system of strict nature reserves where all human activities are excluded. The two nature directives provide an EU level environmental legislative framework aiming at ensuring that human activities – inter alia extractive activities – occur without adversely affecting the integrity of Natura 2000 sites. The overall framework for the management of Natura 2000 areas is laid down in Article 6 of the Habitats Directive. In relation to this article in particular (and the Natura 2000 network in general), the EC is preparing a guidance document on the appropriate assessment under this directive that should be soon available.

EU Strategy on Sustainable Use of Natural Resources

The EU Strategy on Sustainable Use of Natural Resources was launched in December 2005[30]. The objective of the strategy is to reduce the environmental impacts associated with resource use and to do so in a growing economy. The strategy emphasises the importance of the integration of environmental concerns into other policies that affect environmental impacts of natural resources use but it does not attempt to implement specific initiatives in areas that are already covered by other policies. It aims to introduce an analytical framework with allowing the environment impact of resource use to be taken into account into public policymaking.

Strategic Environmental Assessment

29 http://ec.europa.eu/environment/waste/mining/index.htm

30 COM(2005) 670 final. http://ec.europa.eu/environment/natres/index.htm

The purpose of the SEA Directive[31] is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. A SEA is mandatory for land-use plans and programmes.

In the context of extractive industry, the SEA Directive is most likely to be applicable where a national, regional or local authority is preparing a land-use plan which is either specifically designed to deal with mineral extraction (e.g. a "minerals plan"), or where mineral extraction is one of the land uses considered in the plan (EC 2007a). The scale of SEA should be determined by consideration of the likely scale of environmental impacts, the framework required to facilitate EIA of individual projects that may result from implementation of the plan as well as the geographical scope of the plan or programme.

Environmental Impact Assessment

The "EIA Directive" 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, amended in 1997 (97/11/EC) and 2003 (2003/35/EC)[32], states that development consent for projects which are likely to have significant effects on the environment should be granted only after prior assessment of the likely significant environmental effects of these projects has been carried out.

The EIA Directive defines project as the execution of construction works or of other installations or schemes, other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources (Article 1.2). Mining operations are listed in both Annex I and II of the EIA Directive and therefore often require an environmental impact assessment under this Directive.

Environmental Liability Directive

The Environmental Liability Directive[33] establishes a framework for environmental liability based on the "polluter pays" principle, with a view to preventing and remedying environmental damage. Under the terms of this Directive, environmental damage includes direct or indirect damage to species and natural habitats protected at Community level by the Birds Directive or by the Habitats Directive. The liability scheme applies to certain specified activities where it is possible to establish a causal link between the damage and the activity in question. The public authorities are responsible for ensuring that the operators responsible take or finance the necessary preventive or remedial measures themselves.

Water Framework Directive

Extractive Industries may have a strong impact on water courses and ground water so preventive and corrective environmental measures of those activities are frequently related with water management and hence with the Green Infrastructure. The Water Framework Directive (2000/60/EC)[34] establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems.

31 Recommendations for further consultation: http://ec.europa.eu/environment/eia/sea-legalcontext.htm, http://ec.europa.eu/environment/eia/sea-support.htm

32 Details about these directives can be found at http://ec.europa.eu/environment/eia/eia-support.htm

33 http://europa.eu/scadplus/leg/en/lvb/l28120.htm

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5.6. Nature tourism and recreation

Nature tourism has the particularity of being developed in the most delicate and precious elements of the Green Infrastructure, such are the natural protected and unprotected sites, which, by themselves, are the core areas of this Green Infrastructure. Hence, it is compulsory to have a very close approach to this activity to avoid impacts on the natural values but keeping the benefits for the society and even for nature conservation. It has been a repeated story along many European areas (especially coastal) that natural values and landscapes have attracted tourism development which finally has spoiled most of the natural values that promoted that tourism.

Demographic changes, consumer behaviour and the increasingly mobile and connected lifestyles of European citizens have produced trends for outdoor recreation preferences and for broadening travel horizons. In this context, recreation and nature tourism have become increasingly important activities with many implications both economic and environmental (Bell et al. 2007).

In the scope of this section, outdoor recreation refers to activities that people undertake out of doors in places where they can access nature or green areas, mainly as part of their daily or weekend routines. The places associated with outdoor recreation include forests, the coast, lakes and rivers, mountains and other spectacular scenery that are nowadays frequently designated as national park or similarly protected (Bell et al. 2007).

Nature tourism is a term that covers activities that people enjoy while on holiday and which focus on engagement with nature and usually includes an overnight stay. Typically this means travelling to and staying overnight in locations close to or in national parks, forests, lakes, the sea or the countryside and participating in activities using these settings and compatible with their natural qualities (Bell et al. 2007). Another related term of common use is Ecotourism which, according to The

International Ecotourism Society (TIES), concerns travelling ñto natural areas that conserves the environment and improves the well-being of local people (TIES 2009).

5.6.1. Ecological impacts

According to Newsome et al. (2002), the potential environmental impacts of nature tourism can be divided into three categories: (i) transport and travel, (ii) accommodation and shelter, and (iii) recreation and tourism activities in the natural environment. Moreover, in cases where the three categories occur together, this may lead to a cumulative impact situation. These authors also highlight that the degree of biophysical impact depends on the location, diversity, intensity and duration of the activities themselves. A detailed-illustrated by case studies-description of nature tourism issues can be found in Newsome et al. work (2002, see References at the end of the section). Some main aspects of this work concerning the environmental impacts of tourism on nature are described next.

- **Trampling**
    - Trampling damages both soils and vegetation as a result of visitors leaving established trails and pathways.
    - Vegetation. The following common tourism/recreational activities are sources of trampling damage to vegetation: camping and firewood collection, use of bush/informal toilets, horse riding, off-road vehicles, walking and hiking, wildlife viewing and photography, off-road bikes, trail/motorcycling, access to riverbanks and viewing points and boat launching activities.
    - The <u>type and distribution of visitor activity</u>, amount and type of use, density and relative fragility of vegetation influence the degree of impact. For example, a sub-tropical grassland can tolerate 1412 passes before the vegetation in reduced by 50%, while a eucalypt woodland can only tolerate 12 passes before the same percentage of vegetation cover is lost.
    - Vegetated surfaces can be altered through the development of flattened vegetation or narrow trails, at one end of the scale, through to a situation where extensive areas are denuded of plant cover and dominant plants, such as trees, are lost.

- **Soils**
    - <u>Microbiota</u>: Decrease in microbial activity is likely to be due to the corresponding loss of vegetation. The loss of microbiota can translate into less favourable soil conditions for plants and impact on nutrient cycling at the local scale.
    - <u>Microphytic crusts</u>: their loss in arid landscapes could lead to increased soil erosion. For example, according to Newsome et al. (2002), experimental work showed that after only 15 passes human trampling had reduced the microphytic crust cover by 50%, and it was subsequently reduced to zero after 250 passes.
    - Disturbance and erosion result in the loss of organic matter and prevent the accumulation of weathered soil and the development of a deeper soil profile.

- **Roads, trails and built facilities**
    - <u>Roads and traffic</u>. As described on the ôLinear infrastructures sectionö, the major negative impacts frequently associated with roads and traffic include clearing and road construction, sediment and pollutant runoff, weed invasion, disturbance to wildlife due to noise and traffic and roads kills. For more information on this issues, refer to the section on linear infrastructures.

Here we would only highlight the use of off-road vehicles, since this type of vehicles has the potential to cause damage in most environments.

- Trails. Degradation of trail resources may occur through track widening, root exposure and soil erosion, among other.
- Hiking trails: in some areas, such as mountain regions, accelerated erosion from trails can be an important biophysical impact of visitors, especially in zones with steep slopes and harsh environmental conditions.
- Horse riding: it can cause important damages to existing trails, producing a great risk of erosion. Besides, horseshoes can also be a source for introducing exotic weed species into non-altered environments.
- Built facilities. When the accommodation is situated in natural areas, it can be a source of disturbance and can also have the following impacts:

- **Water availability, waste and sewage**

  - Intensive use of groundwater supplies when located in remote areas and particularly important in arid environments since it has been estimated that the average tourist uses twice the amount of water that local people.
  - Waste disposal: depending on the volumes produced and recycling applied, may constitute a source of pollution but also an attraction to some species (i.e. gulls, rats).
  - Sewage pollution of freshwater may affect rivers, lakes and small water bodies, among others.

5.6.2. Focus on sensitive areas

- **Use of water edges.** Since visitors tend to concentrate at water edges, the following ecological impacts may occur:
  - Recreation activities taking place along river banks and amongst riparian vegetation such as viewpoints, fishing, camping, etc., may cause the destruction of riparian vegetation, bank erosion and pollution.
  - Boating activities on freshwater bodies may cause erosion of river banks by wave action, turbidity, pollution, noise among the main types of impact.

- **Coastal areas**. The access and use of beaches may cause:
  - Destabilisation and degradation of coastal dunes systems and beach erosion.
  - Litter and human waste accumulation can cause pollution and water contamination.
  - Boating activities can cause disturbance to wildlife (by noise, fumes or direct contact) and water pollution.

- **Mountainous areas**. Depending on the season and the site's specific characteristics and fragility, recreation activities in these areas may cause:
  - Disturbances in region with steep slopes and thin soils.
  - Degradation of slow growing and fragile plant species which can be rare, of restricted distributions or endemic ones.
  - Many of the issues previously described can also occur in mountainous areas (e.g. trampling, access roads, ski lifts and tracks. parachuting etc.) causing a cumulative impact situation.
  - Rock climbing: rock ledges are important elements for cliff-nesting birds such as the Buzzard (*Buteo buteo*), Peregrine Falcon (*Falco peregrinus*) or the Golden Eagle (*Aquila chrysaetos*) in Europe. Disturbance by climbers

may cause birds to desert their nests and the resultant exposure of eggs and your can lead to mortality.

- **Caves**. The unique features, archaeological remains and particular wildlife of caves have resulted in many cave systems becoming the target of tourist activity. Besides, cave fauna or troglobites are very sensitive to disturbance due their narrow ecological niche. In relation to this, some sources of impact include:
  - Touching of cave features (stalactites, stalagmites) which can result in breakage and discoloration.
  - Habitats of caves can be damaged by constant trampling.
  - Respired carbon dioxide and heat derived from visitors and artificial lighting can change the microclimatic conditions in a cave.
  - Disturbance from visitors may cause young bats to fall and frequent disturbance may increase mortality.

- **Observation of wildlife**. The increasing interest in seeing animals in the wild may result in negative effects and cause disturbance to wildlife.

- **Camping and campsites** can result in significant localised effects which include: soil compaction, damage to vegetation in and around campsites, disturbance to wildlife, litter can constitute a source of pollution for the surroundings, firewood collection in the surrounding area may cause a loss of coarse woody debris, which is an important component of ecosystems and habitat of many species.

5.6.3. Positive impacts

Even it is not the scope of the section, it can be highlighted that nature tourism also has positive impacts on conservation as well as on social and economic aspects. For example, in some regions nature tourism may be directly responsible for keeping protected areas and reserves operational. This, in turn, translates into protection of numerous threatened and endangered plant and animal species in a variety of habitat types (Langholz 1996).

5.6.4. Relevant EU Policy

Although the Community has no direct tourism competence, European policies in a number of areas have a considerable and even growing impact on tourism. This section contains a non-exhausting list of information on various EU programmes, schemes, funds, initiatives and actions of interest to the tourism sector.

European Structural and Cohesion Funds

The Structural and Cohesion Funds are the European Union's main instruments for supporting social and economic restructuring across the EU. They account for over one third of the European Union budget and are used to tackle regional disparities and support regional development through actions including developing infrastructure and telecommunications, developing human resources and supporting research and development.

These funds target different types of projects and are used for regionally identified issues in different countries and regions in. The Structural Funds apply to the specific regions and areas which suffer from the greatest economic deprivation, while Cohesion Funds apply to whole countries. The European Council of December 2005 agreed a total Structural and Cohesion Funds budget of ú308 billion for the period 2007-2013. The Structural[35] and Cohesion Funds are divided into three separate funds, which are used to meet the three objectives of Cohesion and Regional policy (see table 1 below):

Table 5.3. Structural Funds and Cohesion fund used to meet objectives of Cohesion and Regional policy.

Cohesion/Regional Policy objectives	Funds used to meet the objective
Convergence	ERDF, ESF and Cohesion Fund
Regional Competitiveness and Employment	ERDF, ESF
European Territorial Co-operation	ERDF

The Commission has foreseen the possibility of funding sustainable tourism-related projects through the European Regional Development Fund (ERDF) in support of socio-economic development. Under the three objectives, ERDF shall support more sustainable patterns of tourism to enhance cultural and natural heritage, develop accessibility and mobility related infrastructure and to promote ICT, innovative SMEs, business networks and clusters, higher value added services, joint cross-border tourism strategies and inter-regional exchange of experience. As an example, Table 2 below shows the planned investments in the 'tourism' category for the EU cross-border cooperation

Table 5.4. Structural Funds - Community amount for the period 2007-2013. Tourism category.

EU cross-border cooperation

Code	Description	Community amount	%
55	Promotion of natural assets	131,153,207	22.62 %
56	Protection and development of natural heritage	141,248,147	24.36 %
57	Other assistance to improve tourist services	307,347,250	53.01 %
	Sum:	**579,748,604**	**100 %**

Source: EC-DG Enterprise and Industry website, 2009.

Besides, tourism development, given its employment creation potential, is an important domain of the European Social Fund's (ESF) intervention. Amongst others, the ESF co-finances projects targeting educational programmes and training in order to enhance productivity and the quality of employment and services in the tourism sector. The ESF provides also targeted training combined with small start-up premiums to tourism micro-enterprises. These actions tend to be very effective in creating economic activity and employment. It also co-finances actions that support professional mobility.

European Charter for Sustainable Tourism in Protected Areas

In 1995 EUROPARC took the initiative to set up the European Charter for Sustainable Tourism in Protected Areas, with a project funded by the EUÕs LIFE programme and led by the Fédération des Parcs Naturels Régionaux de France.
At heart, the European Charter for Sustainable Tourism in Protected Areas is a partnership between a protected area and all those with a stake in how tourism in that parkÕs region is run. It also contains elements of a quality label as the park also commits itself to producing a comprehensive strategy and implementing an action plan

[35] Structural Funds components: European Regional Development Fund (ERDF) and European Social Fund (ESF).

for managing tourism. As such the Charter is a valuable management tool for ensuring that tourism development in Europe's protected areas is sustainable.

COST E33 Action: Forests for Recreation and Nature Tourism

This COST Action aimed to provide a European focus to forest recreation and tourism research to bring together existing knowledge on these activities and in particular the benefits they can deliver, but also how those benefits might be provided in a way which reduces the economic, social and environmental costs of delivery. One of the main outputs of the project is a handbook called European Forest Recreation and Tourism, published in 2008.

5.6.5. References

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5.7. Urban environment

Urban dynamics related to socioeconomic factors are described in chapter 3 and impact of urban development on the integration of natural protected areas is described in chapter 4. This section is about a different issue. It is about urban nature and urban green infrastructure.

Currently, half of the world's population lives in towns and cities (UNFPA 2007). In Europe, approximately 75 % of the population lives in urban areas with more than a quarter of the European Union's territory directly affected by urban land use (EEA 2006).

Urban areas are hot spots that drive environmental change at multiple scales. Material demands of production and human consumption alter land use and cover, biodiversity, and hydrosystems locally to regionally, and urban waste discharge affects local to global biogeochemical cycles and climate (Grimm et al. 2008). Moreover, the environmental impact of cities extends beyond their borders. For example, cities produce greenhouse gases whose impact is global. More subtly, urban residents stimulate resource extraction and manufacturingð with all the attendant environmental pressuresð beyond the city boundaries. Therefore, the increased rate of urban expansion, and where and how additional land is incorporated into the urban make-up, has significant social and environmental implications for future populations (UNFPA 2007).

The territorial expansion of cities also affects environmental outcomes. For example, when cities are situated at the heart of agricultural areas or other lands rich in biodiversity, the extension of the urban perimeter evidently cuts further into available productive land and encroaches upon important ecosystems (UNFPA 2007). The EEA (2006) has described urban sprawl as an unplanned incremental urban development, characterised by a low density mix of land uses on the urban fringe.

Urban sprawl has accompanied the growth of urban areas across Europe over the past 50 years. But it is no longer a phenomenon tied to population growth. Instead, a variety of other powerful factors drive the development of the modern city, including individual housing preferences, increased mobility, commercial investment decisions, and the coherence and effectiveness of land use policies at all levels. The areas with the most visible impacts of urban sprawl are in countries or regions with high population density and economic activity (like the Netherlands, Belgium, the Paris region, etc) and/or rapid economic growth (Ireland, Portugal, the Madrid region). Also, urban sprawl is particularly evident where countries or regions have benefited from EU regional policies. Moreover, hot spots of urban sprawl are also common along already highly populated coastal strips, such as in the case of Spain where the artificial areas may cover up to 50 % of the total land area. This is worrying given the known vulnerability of coastal ecosystems (EEA 2006).

However, there is increasing realization that urban settlements can be an opportunity for sustainability. The size of the land area appropriated for urban use is less important than the way cities expand: global urban expansion takes up much less land than activities that produce resources for consumption such as food, building materials or mining. Worldwide, it is also less than the yearly loss of natural lands to agricultural activities, forestry and grazing, or to erosion or salinization (UNFPA 2007).

5.7.1. Urban nature

Urban habitats and species are often considered somehow less natural than, or not as important as, their rural counterparts. However, recent studies argue that there is now plenty of evidence to suggest that urban biodiversity can be higher in cities than surrounding rural areas and those unique assemblages of species and habitats can produce as much scientific and social interest as non-urban landscapes. In the UK for example, The Royal Society for the Protection of Birds (RSPB) supports these findings and suggests that gardens, parks and churchyards all support a wealth of wildlife (RCEP 2007).

In this context, research suggests that more and more wildlife is adapting to urban environment. Birds living in cities constitute a common example of this, with pigeons and sparrows now having the town as their predominate habitat. Pigeons scrounge most of their food from man and nest in tall buildings which act as rock faces with ledges for roosting. Other study argues that the ómost adaptableô of all garden birds is the common blackbird. They are twice as common in urban areas than in the countryside, they nest in holes in the walls or in the bends of rainwater pipes and have also become almost totally omnivorous. An increasing number of birds of prey are also being seen in towns and cities. For example, peregrine can be seen nesting on buildings and artificial man-made structures (RCEP 2007).

Concerning urban vegetation, the composition of urban forests differs from that of wild and rural stands in several ways. Species richness has increased in urban forests but this is because of the increased presence of exotic species. Urban areas show a preponderance of trees of wetland or floodplain provenance. Even when the tree composition remains similar between urban and rural forests, the herbaceous flora of urban forests is likely to differ between the two types of forest. Such compositional trends reflect the context and configuration of the forest stands in urban areas. For example, vascular plant diversity increases with the area of the park/garden, etc. Furthermore, studies suggest that the percentage of the flora represented by native species decreased from urban fringes to centre city (Pickett et al. 2001).

On the other hand, urban parks and gardens as well as private gardens can be a source for invasive alien species which may spread to the surrounding countryside and water bodies. Indeed, a study suggests that human made habitats such as farmland and urban landscapes facilitate the spread of alien plants. In the Czech Republic for example, the study found a high proportion of alien plants on urban walls (EC 2008).

5.7.2. Urban green infrastructure

Urban green structures are fundamental to link town and countryside. In a spatial perspective, urban green structure is more than the sum of green spaces of a city. Speaking of urban green structure implies drawing attention to the spatial network that links open spaces, public and private gardens, public parks, sports fields, allotment gardens and recreation grounds within the city to the networks of woodlands and river floodplains in the surrounding countryside (Werquin et al. 2005).

Due to their structure and multi-functionality, urban green areas accomplish several functions in cities at different levels, such as the environmental, ecological, social, economical, cultural and aesthetic levels, promoting the image and character of an urban area. Therefore, it is important to highlight the role that these green areas fulfil in the city, in order to understand and potentiate their value in an articulated, holistic and planned way, together with the remaining urban elements (Quintas and Curado 2009). Some of the main environmental and ecological functions and interests of urban green infrastructures are summarized in the box below:

Box 5.1. Main environmental and ecological functions of urban green infrastructures

- Improvement of air, soil and water quality
- Noise reduction
- Reduction of thermal amplitude variations
- Protection against wind
- Reduction of erosion processes
- Waste management, sewage treatment
- Improvement of rainwater infiltration and drainage
- Reduction of flood risks
- Enriched habitat and biodiversity
- Maintenance of natural landscape processes
- Link between urban as well as peri-urban and adjacent countryside habitats

Example: 40% of CO_2 emissions from traffic is assimilated by the green areas in Stockholm County, Sweden (Elmqvist 2008).

Based on: Quintas and Curado 2009, Benedict and MacMahon 2002.

Finally, at the European level, the COST C11 Action has produced a document focusing on the role played by planning, design and management in dealing with interactions between ógreenô and built-up areas (Werquin et al 2005).

5.7.3. Relevant EU legislation and initiatives

The European Commission has adopted and developed strategies, programmes and guidance to óimprove the quality of the urban environment, making cities more attractive and healthier places to live, work and invest in, and reducing the adverse impact of cities on the wider environmentô (EC 2006). Some of these main programmes, strategies and initiatives are briefly described next.

6th Environment Action Programme EAP

The 6th EAP[36] is a decision of the European Parliament and the Council adopted on 22nd July 2002. It sets out the framework for environmental policy-making in the European Union for the period 2002-2012 and outlines actions that need to be taken to achieve them.

The 6th EAP identifies four priority areas:
- Climate change
- Nature and biodiversity
- Environment and health
- Natural resources and waste

Among the instruments developed for this programme, the 6th EAP calls for the development of seven Thematic Strategies in several fields including the urban environment (in the priority area of environment, health and quality of life). This strategy is briefly presented next.

Thematic Strategy on the Urban Environment

[36] Decision No 1600/2002/EC. Available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0001:0015:EN:PDF

The European Commission adopted the Thematic Strategy on the Urban Environment on 11 January 2006. The Strategy builds on existing European policy initiatives for improving the quality of the urban environment. It sets out new measures to support and facilitate the adoption of integrated approaches to the management of the urban environment by national, regional and local authorities.

Concerning urban nature and biodiversity, the Strategy states that ósustainable urban design (appropriate land-use planning) will help reduce urban sprawl and the loss of natural habitats and biodiversity. Integrated management of the urban environment should foster sustainable land-use policies which avoid urban sprawl and reduce soil-sealing, include promotion of urban biodiversity and raise awareness for urban citizensô (EC 2006).

URBAN Community Initiative

The URBAN Community Initiative is an instrument within EU Cohesion Policy, dedicated to the sustainable development in the troubled urban districts of the European Union.

The second round of URBAN (URBAN II[37]) consisted of 70 programmes across the EU, covering some 2.2 million inhabitants, to be implemented during the 2000-2006 period. These areas often face quite severe deprivation and specific challenges. Concerning green spaces for example, the proportion of green spaces - an indicator of environment and amenity - is only half the EU urban average.

Between 2001 and 2006, the European Union will invest more than ú728 million of European Regional Development Fund (ERDF) money in these urban areas. Funding concentrates on physical and environmental regeneration, social inclusion, training, entrepreneurship and employment. In relation to urban natural spaces, the initiative will finance projects aimed to improve living conditions, for example by renovating buildings and creating green areas.

An interesting feature of this initiative is that there will be a network of the URBAN II programmes ("URBACT") to exchange information and experience on sustainable urban development across the European Union.

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5.8. Invasive alien species

The Convention on Biological Diversity (CBD) describes invasive alien species (IAS) as õspecies whose introduction and/or spread outside their natural past or present distribution threatens biological diversityö (CBD 2009). The European Commission goes further in the definition and includes in as IAS all species that may represent a õreal threat, causing serious damage not only to ecosystems but also to crops and livestock, disrupting the local ecology, impacting on human health and producing serious economic effectsö(EC 2008b).

Invasive alien species occur in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. For a species to become invasive, it must successfully out-compete native organisms, spread through its new environment, increase in population density and harm ecosystems in its introduced range. Common characteristics of IAS include rapid reproduction and growth, high dispersal ability, phenotypic plasticity (ability to adapt physiologically to new conditions), and ability to survive on various food types and in a wide range of environmental conditions. Ecosystems that have been invaded by alien species may not have the natural predators and competitors present in its native environment that would normally control their populations. Native ecosystems that have undergone human-induced disturbance are often more prone to alien invasions because there is less competition from native species (CBD 2009).

Globalization facilitates and intensifies the spread of IAS through intentional or accidental introductions as modern trade, travel and technology have increased the process of species introduction (Meyerson and Mooney 2007).

The main concern about IAS is that they represent a serious threat to biodiversity and are a major cause of extinction globally. Moreover, IAS may soon surpass habitat loss as the main cause of environmental degradation globally and are now likely the main cause of extinctions in island ecosystems (Reaser et al. 2007). In Europe several IAS dominate their new environments, threatening native species with extinction. For example, European red squirrel populations are on the brink of extinction in Italy and the UK, following the introduction of the larger American grey squirrel (EC 2008).

In fact, the number of invasive species in Europe is growing. An EU-funded project has compiled a list of 10 822 non-native species in Europe. While not all of them are invasive, it is estimated that about 10-15% are potentially dangerous to European biodiversity. Also, the European Environment Agency has drawn up a list of the 163 worst invasive alien species threatening ecosystems in Europe (EC 2009).

5.8.1. Ecological impacts

The ecological impacts of IAS on ecosystems vary significantly depending upon the invading species, the extent of the invasion, and the vulnerability of the ecosystem being invaded Loss and degradation of biodiversity due to IAS can occur throughout all levels of biological organization from the genetic and population levels to the species, community, and ecosystem levels, and may involve major alterations to physical habitat, water availability, essential resources and ecological processes. These impacts can vary in terms of the lapse of time between the initial introduction and subsequent spread of an IAS, its severity of impact, the likelihood of synergistic interactions with other threatening processes, and the potential for initiation of a cascade of effects ramifying throughout an entire ecosystem (Ciruna et al. 2004).

In this context, IAS generally reduce the abundance of native water species through predation, hybridization, parasitism, or competition for resources, and may alter community structure and ecosystem processes, such as nutrient cycling or energy flow, for example (Ciruna et al. 2004).

The Convention on the Conservation of Migratory Species of Wild Animals has summarized these main threats posed by invasive alien species as follows (UNEP-CMS 2008):

- Competition with native species
- Detrimental impacts on habitat
- Direct predation on adults, young and/or eggs
- Hybridisation with the native species
- Diseases by pathogens and parasites

Moreover, IAS can also have significant socioeconomic impacts directly (for example human health) and indirectly through their effects on ecosystem goods and services (Reaser et al. 2007). For example, the European Union today spends at least ú12 billion a year on control and on damage caused by invasive species (EC 2009).

5.8.2. Invasive alien species and landscape permeability

Some authors have questioned the role of ecological corridors for many reasons including that these types of networks may provide an entry route for weedy or exotic species, favouring their introduction in natural un-disturbed habitats (McKenzie 1995). On the other hand, a recent study by Brudvig et al. (2009) found no evidence for this effect. According to their research, corridors did not influence the diversity of exotic plant species in connected target habitats (protected areas), resulting in no spillover of exotic species into surrounding non-target habitat. The authors suggest that this is due to the sufficient movement capabilities of invasive exotic species, making corridors unnecessary for their spread.

5.8.3. Relevant EU proposals and initiatives

Since invasive species pose a major and fast growing threat to native biodiversity in Europe, the EU has recently put forward proposals for a Europe-wide strategy to combat invasive species. Some of the main European initiatives are briefly described next.

EU Biodiversity Action Plan

The EU's Biodiversity Action Plan[38], published in 2006, addresses the challenge of integrating biodiversity concerns into other policy sectors in a unified way. It specifies a comprehensive plan of priority actions and outlines the responsibility of community institutions and Member States in relation to each. It also contains indicators to monitor progress and a timetable for evaluations.

To face the problem of invasive species, this action plan set as objective nº 5: "to substantially reduce the impact on EU biodiversity of IAS and alien genotypes." The mid-term review of progress[39] published in 2008 points out that the number of invasive species in Europe continues to increase rapidly and even if several Member States have included objectives addressing IAS in their national biodiversity strategy, fourteen currently do not have strategies or plans in relation to invasive species. Therefore, the review urges for an EU-wide strategy.

Towards an EU Strategy on Invasive Species

In 2008 the European Commission issued a Communication Towards an EU Strategy on Invasive Species[40]. This Communication describes the nature of the threat posed by IS as well as the possible approaches for addressing the problem. It represents a first step towards an EU Strategy which is due to be ready in 2010. The aim of this strategy will be substantially reducing the impact of IS on European biodiversity.

This Communication also stresses the importance of an Early Warning and Information System based on a regularly updated inventory combined with effective response mechanisms. In this context, the following EU-funded research initiatives play an important role.

Delivering Alien Invasive Species Inventories for Europe – DAISIE

[38] COM(2006) 216
[39] COM(2008) 864
[40] COM(2008) 789

This a project supported by EU research funds that brings together data about biological invasions across Europe. The general objectives of DAISIE are:

- To create an inventory of invasive species threatening European terrestrial, fresh-water and marine environments.
- To structure the inventory to provide the basis for prevention and control of biological invasions through the understanding of the environmental, social, economic and other factors involved.
- To assess and summarise the ecological, economic and health risks and impacts of the most widespread and/or noxious invasive species.
- To use distribution data and the experiences of the individual Member States as a framework for considering indicators for early warning.

The project's website provides information on biological invasions in Europe, delivered via an international team of leading experts in the field of biological invasions, latest technological developments in database design and display, and an extensive network of European collaborators and stakeholders. In figures, it gives details of 10 822 alien species currently invading European countryside, waterways and marine environments. An international team of 1657 experts updates the database continually.

Assessing Large Scale Environmental Risks for Biodiversity with Tested Methods – ALARM

This EU funded project focuses on assessment and forecast of changes in biodiversity and in structure, function, and dynamics of ecosystems. This relates to ecosystem services and includes the relationship between society, economy and biodiversity. In particular, risks arising from climate change, environmental chemicals, biological invasions and pollinator loss in the context of current and future European land-use patterns will be assessed.

In relation to IAS, research carried out within the project framework has analysed how habitats succumb to invasion, helping to predict which areas might be under threat in the future. Another study has identified the six main 'pathways' incoming species take: deliberate release; escape; unintentional contamination; stowaway; corridor (along roads, canals etc.); and unaided (natural spread).

North European and Baltic Network on Invasive Alien Species – NOBANIS

NOBANIS is a network for cooperation between competent authorities of the region and contributes to implementing recommendations from CBD's COP6. One of the goals of NOBANIS is to provide administrative tools for making the precautionary approach operational in preventing the unintentional dispersal of invasive alien species. Furthermore, it establishes a regional cooperation to aid countries in eradication, control and mitigation of ecological effects of invasive alien species.

NOBANIS is a regional portal supplying information on alien species in northern and central Europe. It involves 18 partner countries within and beyond the EU, and connects with regional and global networks and projects on invasive aliens species. NOBANIS has developed a network of common databases on alien and invasive species of the region. It covers marine, freshwater and terrestrial environments and provides:

- a distributed but integrated database on introduced species in the region
- fact sheets on many of the most invasive aliens written by regional experts
- a catalogue of the regulation relevant to invasive species in participating countries
- a literature database

The database of alien species in NOBANIS will be used to identify species that are invasive at present and species that may in the future become invasive. NOBANIS thus provides the foundation for the future development of an early warning system for invasive alien species.

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5.9. Climatic change

Climatic Change is one of the greatest environmental, social and economic challenges facing the European Union. Most efforts up to now are addressed to control climate change through reducing emissions, promoting alternative energy sources,

Climatic Change is an accepted fact, but the effects on nature and biodiversity are still not well defined. It is expected to have an average increase on temperatures across all Europe but changes in rainfall will be very different depending on the countries. Most scenarios record an increase of rainfall in central and northern Europe as in Ireland and Britain, including more flood episodes in these areas. In southern Europe rainfall is expected to be reduced, and the amount of this reduction varies according to the different scenarios, but it is expected an increase in droughts episodes mainly in the Iberian Peninsula, Greece, Italy, Bulgaria and Romania.

This of course will affect biodiversity in very different ways. For mountain ecosystems and species this will make species to migrate upper in altitude but for those who live at their ecological limits in the upper habitats this will mean the extinction.

Intuitively it should be expected that species and habitats would migrate to north or upper in the mountains, but this has not been proved. It is not known how would living systems react to those changes and it is reasonable to think that depending on the species or habitats affected the reaction will be very different. Some of them will migrate, will others would adapt or disappear. Some habitats will change to degraded forms while they will loose some of the species and some others species will appear changing the general conditions of the habitat.

In the discussion paper: "Towards a Strategy on Climate Change, Ecosystem Services and Biodiversity" prepared by the EU Ad Hoc Expert Working Group on Biodiversity and Climate Change, a very important issue is taken in account:

"Climate change does not act in isolation. It interacts with and often exacerbates other existing pressures such as pollution, over-exploitation, invasive species, habitat fragmentation by changes in land use, and habitat degradation and loss. Reducing these impacts will also help species adapt to climate change. Furthermore, land use change driven by human responses to climate change such as changing agricultural patterns and the demand for biofuels or building of hard flood defences will also affect biodiversity. It is important that climate change driven land use change is sustainable."

In fact, one of the issues that should be taken in account is that, for the time being, major threats to biodiversity come from human activities and land uses, then the climatic change will impact on a natural environment previously mistreated and weakened by human pressure.

Invasive alien species will probably find new opportunities to spread. The Group of Experts on Climate Change recognise that climate change could alter the structure and composition of native communities and, as a consequence, the way an ecosystem functions, increasing the risk of biological invasion in the future and that under climate change criteria, invasions can be produced by alien species introduced ex novo, spread of already established invasive alien species and finally already established alien species, non invasive at present but becoming invasive under new ecological conditions. However they also recognise that it is very difficult to predict how climate change will affect invasive processes per se as well as in combination with other factors of global change (biotic changes, land use changes, etc.).

5.9.1. The Green Infrastructure and climatic change

In this situation, the Green Infrastructure becomes a very important actor for several reasons:

1. The natural habitats, notably forests of the Green Infrastructure are considered Carbon sinks, so they have a primary role in mitigating the green house emissions.

2. Natural flooding areas are seen as a good tool to control expected flooding episodes, as it has been implemented in the lower Danube basin where WWF with National authorities and local stakeholders have restored several thousands of floodplain helping to the implementation of the Lower Danube Green Corridor (LDGC) Agreement, for areas that suffered big damages during flooding episodes.

3. A well developed Green Infrastructure, with proper ecological functions, should allow connectivity among natural protected and unprotected areas, so wild species and habitats would have an opportunity to migrate from their present location to areas where climatic an ecological conditions are more suitable for their living.

4. Green infrastructure can also be an opportunity for species to develop an adaptation strategy to habitat fragmentation and local extinction caused by climate change. Besides, a well established Green Infrastructure may serve as spatial refuges for the most endangered species and habitats by linking valuable natural and semi-natural spaces in the most affected zones.

5.9.2. Relevant EU Policy

The EU has been taking serious steps to address its own greenhouse gas emissions since the early 1990s. This section compiles some of its main programs and initiatives.

White Paper: Adapting to climate change

In April 2009 the European Commission presented a policy paper known as a White Paper which presents the framework for adaptation measures and policies to reduce the European Union's vulnerability to the impacts of climate change.

The White Paper outlines the need to create a Clearing House Mechanism by 2011 where information on climate change risks, impacts and best practices would be exchanged between governments, agencies, and organisations working on adaptation policies. This should help decision-makers to adopt the best measures to counteract the negative effects of global warming.

Since the impacts of climate change will vary by region - with coastal and mountain areas and flood plains particularly vulnerable ï many of the adaptation measures will need to be carried out nationally or regionally. The role of the European Union will be to support and complement these efforts through an integrated and coordinated approach, particularly in cross-border issues and policies which are highly integrated at EU level.

Adapting to climate change will be integrated into all EU policies and will feature prominently in the Union's external policies to assist those countries most affected.

European Climate Change Programme

The European Commission has taken many climate-related initiatives since 1991, when it issued the first Community strategy to limit carbon dioxide (CO 2) emissions and improve energy efficiency. These include: a directive to promote electricity from renewable energy, voluntary commitments by car makers to reduce CO 2 emissions by 25% and proposals on the taxation of energy products.

The Commission responded in June 2000 by launching the European Climate Change Programme (ECCP). The goal of the ECCP is to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. The development of the first ECCP involved all the relevant groups of stakeholders working together, including representatives from the Commission's different departments (DGs), the Member States, industry and environmental groups. The second European Climate Change Programme (ECCP II) was launched in October 2005.

Integration of climate change into the EU's Rural Development Policy

Part of the EU's Common Agricultural Policy is rural development with a budget of around €7 billion per year for 2000-2006. It aims to strengthen the agriculture and forestry sectors, to improve the competitive position of rural areas and to help safeguard the environment. Co-financing is available for over 20 measures that include environment-friendly farming and investments in forests to improve their ecological value.
The Commission has proposed a similar budget for 2007-2013, but aims to strengthen the environmental aspect by declaring improvement of the environment and the countryside through land management one of the main objectives and requiring Member States to spend at least 25% of the rural development funds on this priority.

Carbon sequestration potential of afforestation & reforestation measures, forest management and natural forest expansion in the EU-15 Member States by 2010: 33 Mt CO2 eq.

Integration of climate change into the EU's Structural and Cohesion Funds

The Structural and Cohesion Funds are the EU's main instruments for supporting regional development in the EU in order to eliminate economic and social disparities. The budget is around €235 billion for 2000-2006. Member States submit proposal for projects, which the EU co-finances.

Many of the priority areas that the EU supports benefit the climate system: sustainable transport (€12 billion), forest and nature protection (€4.7 billion), sustainable urban centres (€2 billion), environmental technologies in industry (€1.2 billion), renewable energies (€800,000), sustainable waste management (€2 billion).

Under the Commission's proposal for the 2007-2013 EU budget, the Structural and Cohesion Funds will increase by around 30% (to take account of EU enlargement), and actions against climate change, in particular in the transport and energy sectors, will receive increased funding.

LIFE funding programme (Regulations No. 1655/2000/EC and 1682/2004/EC)

This environmental funding scheme had a budget of ú957 million for 2000-2006. LIFE Environment, the component of LIFE most relevant to climate change, co-finances innovative environmental demonstration projects. Beneficiaries include enterprises, national and local authorities, NGOs, research institutions and inter-governmental bodies.

Since 2000, more than 100 projects that directly or indirectly deal with climate change have received an estimated ú50 million. The Commission has proposed to extend the scope and budget of LIFE in the next 2007-2013 budgetary period.

Climate-change related R&D (Decision 1513/2002/EC and 2002/668/Euratom)

The EUõs sixth R&D framework programme (2002-2006) allocates roughly ú2 billion to research that directly or indirectly deals with climate change. Another ú1.2 billion are being spent on nuclear research. The aims are to understand, observe and predict climate change and its impacts; to provide tools to analyse the effectiveness and costs & benefits of different policy options; and to improve existing climate-friendly technologies and develop the technologies of the future.

The Commissionõs proposal for the seventh R&D framework programme (2007-2013) envisages more than ú11 billion for research relevant to climate change (energy, transport and environment). Another ú4.2 billion is proposed for nuclear research.

Reduction of N2O in soils (Nitrates Directive 91/676/EEC)

The main goal of the 1991 Nitrates Directive is to prevent water pollution caused by nitrous oxide (N2O), which stems from the excessive use of agricultural fertilisers and from agricultural waste. The reduction of N2O in soils benefits the climate system since N2O is a powerful greenhouse gas.

The upcoming ôthematicô long-term strategy on soil will put an emphasis on preventing soil contamination by nitrates, while the ôthematicô strategy on pesticides will promote low-input farming, both of which will benefit the climate system.
Emission reduction potential in the EU-15 Member States by 2010: 10 Mt CO2 eq.

Climate change in relation to the Natura 2000 network

In 2008, the óBiodiversity and climate change in relation to the Natura 2000 networkò project was launched. This project will provide the EC with an overview of the likely impacts of climate change on biodiversity in the European Union, particularly within the Natura 2000 network of protected areas. It will also include indications of how the design and implementation of current policy might need to be adapted to ensure that the EU delivers its commitment to halt biodiversity loss by 2010 and beyond. Besides, the study will identify those species and associated habitats that are likely to be most vulnerable to climate change and the steps required to protect the integrity of the network from negative effects. The work was completed in June 2009.

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Chapter 6. The Role of the European Commission in building the Green Infrastructure

Content

Chapter 6. The Role of the European Commission in building the Green Infrastructure

Healthy ecosystems not only contribute to halting the loss of biodiversity and to conserving species and habitats. They also provide us with valuable ecosystem services important for our well being. In this context, the EC dedicates great efforts to counteract the loss of nature and fragmentation. This section points out the main measures to build an ecologically coherent green infrastructure for Europe for the benefit of all, people and nature.

6.1. Conclusions

The Green Infrastructure is a physical phenomenon that encompasses all natural and semi natural areas in Europe. The main component of this Infrastructure is the protected natural sites namely the Natura 2000 Network and the links which communicates the sites among them. Those links are built in the landscape matrix which surrounds the protected sites, and this matrix is subject to changes through human use of the land.

The review of the present status of the knowledge and application of connectivity studies and ecological networks shows that the concern for this issue is not new and in most EU countries there are initiatives at regional or national level to solve the problem of the connectivity between protected sites. The main conclusion is that while the preoccupation about the problem exists, there is an evident lack of common approach to the problem. Each country/region understands the problem on his way and gives the best solutions to it as they are able, but there is not a common approach, neither common solution for it.

This work is an attempt to collect the different initiatives and views of the problem around a table, as starting point to enhance the present status of Natura 2000 Network, so that it can operate as a fully functional and ecological coherent network which may comprise the back bone of a European Green Infrastructure.

Human land use is strongly connected to socioeconomic situation and evolution: on average in Europe, the tendency has been to abandon the countryside for the cities, while this tendency has been different for each country and region, and has been counteracted by the occupation of traditionally empty spaces for instance in the countryside around the cities and in some coastal and mountain regions.

The changes in land use have been studied using Corine Land Cover (LUMOCAP) and this has permitted to build two alternative hypothetic scenarios (extreme scenarios to emphasize the differences). First is a scenario which continues and deepens the present tendency to urban environment, with a migration of the people from the countryside to the cities, this scenario has been called Urban scenario. In contrast a Rural scenario has been built taking into account a return of the people to the countryside.

Analysisôof the integration of the Natura 2000 network into a wider countryside has been developed for the data contained in Corine Land Cover in 1990 2000. Applying those analyses to the above mentioned scenarios, Rural and Urban, for 2015 and 2030 has permitted to make an analysis of vulnerability to those changes.

The results show that, in average, for the integration of Natura 2000 into a wider countryside, it is better in the urban scenario than in the rural one, because the countryside becomes depopulated and hence the rural landscape tends to get closer to the natural and semi natural protected landscape, while in the rural scenario there is an increase of the population and an intensification of land uses in rural areas promoting a progressive differentiation between the protected an unprotected landscapes.

The areas which appear less vulnerable to changes are, on average, those that show the worst level of integration of Natura 2000 network, this is because the changes occur in very populated areas which have been already transformed, and they are not affected in the same level by changes like they are the rural areas where the permeability of the landscape is affected directly by any change in land uses.

Another conclusion for this analysis is that, on average, intensification of the uses in the rural landscape is contrary to the integration of Natura 2000 into a wider countryside. In areas where land uses have already changed towards non-natural areas, there are fewer possibilities for land use changes. If most of the natural environment has been destroyed, the region will have less vulnerability to new changes in natural environment. If you have no money nobody can steal you.

Revision of the present policies and instruments of the European Union to tackle with environmental measures towards nature conservation shows that there are enough instruments available to address the challenge of ensure the integration of Natura 2000 Network into a wider countryside. The basic problem, common to most cases is the lack or insufficient inclusion of the permeability of the landscape and connectivity among protected areas into the policies.

6.2. Objectives and goals for the implementation of a functional Green Infrastructure

Building on the project results and the findings of the workshop, the following objectives have been identified:

6.2.1. Set up a Task Force within the European Commission

Given the scale of the challenge, which involves and touches several socio-economic sectors, the establishment of a task force between DGs concerned with the issue would help explore best ways to integrate the GI concept further into their different policies.

6.2.2. Contact the Committee of the Regions

For spatial and development strategies, the regional level is the key delivery level for this kind of action. Therefore, the regional level seems to be the best scale for GI initiatives. This was also a main conclusion of the workshop held in the framework of this project. That is the reason why an early contact with the Committee of the Regions (CoR) is crucial to facilitate the implementation of GI at regional and local levels and to ensure its functionality in combination with other compatible land uses. Collaboration with the *CoR* may also help integrate connectivity into the regional governmentsô spatial planning policies which would legally reinforce its need.

6.2.3. Evaluate and maintain ecological functionality between Natura 2000 sites

Connectivity analyses constitute a sound scientific tool to evaluate the spatial ecological functionality between Natura 2000 sites. Given that the Natura 2000 network (due to its biological diversity and value) is the core of the Green Infrastructure, it is necessary, to guarantee the future, to develop the links among the sites. This is an essential step to build a functional and coherent Green infrastructure and it can be carried out in three phases:

a. Connectivity study between Natura 2000 sites: This first phase to assess the ecological coherence between Natura 2000 sites is to carry out connectivity studies. This should be done first at a regional level and then at country level and finally at supranational level. Importance should be given to the selection of species and/or habitats to be used in the modelling since a connectivity analysis for all the species present in the study are seems technically difficult.

   It would be useful to find common or equivalent methodologies to do those analyses in order to obtain results which could be fitted among different regions and countries studied.

b. Definition of a network of ecological corridors and high permeability areas: Once the connectivity studies are finished, its results must be included into a broader landscape analysis in order to define ecological corridors and high permeability areas between protected sites. At this stage, it is also important to identify the conflict areas for connectivity which can be acting as obstacles or barriers for species and habitats (e.g. a highway without ecoducts can be an obstacle for many animals), as well as other land uses.

c. Implementation on the field of the network of ecological corridors and high permeability areas: Once there is well defined spatial projection for the connectivity of Natura 2000 sites and species, this should be taken to the stakeholders at the appropriate levels (from peasants to land planners always trying to follow a bottom up approach) to find the way to implement this network of ecological corridors and high permeability areas. In this process may constrictions, problems and financial needs should be identified and solved. When all those problems are solved and the network of protected areas is correctly interconnected then it can be said that the backbone of the Green Infrastructure has been implemented.

6.2.4. Development and implementation of a communications strategy

A Communication Plan is a key tool that helps keep stakeholders and the public informed of the initiatives, decisions, actions, etc. carried out within the projectõs framework. Besides itõs a key to integration into other sectors and can help promoting the benefits of GI multi-functionality (e.g. nature conservation but also climate change adaptation, water retention and other ecosystems services). But before launching a communication strategy the definition of the green infrastructure should be clear and the same for all, otherwise it will lead to confusion and misunderstandings.

6.2.5. Integration of sectors

To successfully accomplish a functional GI, the implication and support of key sectors such as Agriculture, Water management and Transportation amongst others, is crucial, and this as early as from the development process. In the workshop it was concluded that there is no need for new EU legislation on GI but it is necessary to improve the implementation of existing legislation and, chiefly, it is necessary to do more effort in terms of integration with the key policy sectors. In this context, it seems urgent to include connectivity issues into SEA, EIA and Appropriate Assessment evaluations to correctly address biodiversity issues. Whether or not new legislation is needed, it will be known from the results of the contacts with other sectors and from the close application of present legislation.

A good way to achieve integration is to collaborate with sectors causing the greatest impacts on biodiversity in order to identify common goals, as well as the measures needed to attain them and the drives for changes. Involved sectors should recognise the benefits GI provide and offer to them through ecosystem services. This will help increase public acceptance and political will.

The main points and priorities for integration of GI into some specific sectors are summarised below.

- **Agriculture**

Agriculture is the most important sector for correct GI implementation and functioning. In this context, the objectives to reach are:

- To integrate ecological connectivity and coherence into the CAP and other RD policies, guaranteeing that funding effectively targets environmental needs.
- To limit intensive agricultural practices within the limits of the GI components, including use of pesticides and fertilizers.
- To increasingly support and promote organic nature friendly farming and old tradition agro-systems within GI, as well as a label guaranteeing their quality products.
- To compensate farmers for set-aside land and diminished production originated by nature friendly practices. This means to pay environmental services to farmers.
- To apply agro environmental measures in areas important for permeability and connectivity among protected natural sites.
- Better control and follow up of the application of agro environmental measures.

- **Forestry**

- As with intensive agricultural practices, to limit intensive forestry practices within the limits of GI.
- To set forestry practices in line with species requirements.

- **Water management**

- To limit alteration of natural water bodies.
- To restore degraded water bodies, including removing of old dams and other infrastructures out of use.

- When modified, to define and maintain an ecological minimum flow adapted to the water body stretch.

- **Linear infrastructures**

  - To adapt, minimise and mitigate the negative effects of linear infrastructures on GI components.
  - To adapt already constructed linear infrastructures to overcome their negative effects on nature.

- **Urban environment**

  - To promote the benefits of urban nature as links with the countryside.
  - To implement measures to limit pollution susceptible to reach the countryside GI.

- **Extractive activities.**

  - When the activities ends, to restore the sites integrating them into an ecologic functional strategy for the areas where they are located.
  - When working, to apply the existing regulations to minimize environmental impacts of the activity on adjacent ecosystems.

- **Tourism**

  - To promote and support sustainable and responsible nature tourism practices.

- **Research and monitoring**

  - To increase and support research and monitoring on ecological connectivity for species and habitats.
  - To improve data available and knowledge sharing on connectivity, ecological coherence and GI implementation.
  - To promote and support research and monitoring of species and habitats Favourable Conservation Status (FCS) and the contribution of GI to contribute to reach FCS.
  - To continue working in research and measures addressed to the adaptation and prevention of the effects of Climatic Change on biodiversity.

GLOSARY OF TERMS

Adaptation: Process of making one thing fit another. In this document we have considered that in a given the Natura 2000 Network is well adapted when the index of dissimilarity (Orloci Index) maintains or reduces its value along time.

Agricultural Pollution: Farming wastes, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; improper disposal of animal manure and carcasses; crop residues, and debris.

Agricultural Waste: Poultry and livestock manure, and residual materials in liquid or solid form generated from the production and marketing of poultry, livestock or fur-bearing animals; also include grain, vegetable, and fruit harvest residue.

Alternative solutions: Different ways of achieving the objectives of a plan or project. The Commission services suggest that 'they could involve alternative locations, different scales or designs of development, or alternative processes (EC guidance on art. 6 (3) and (4), 2001).

Appropriate Assessment (AA): The process under Article 6(3) of the Habitats Directive by which the potential effects of a plan or project upon a Natura 2000 site are assessed in view of the site's conservation objectives in order to ascertain whether the plan or project will adversely affect the integrity of the site.

Biodiversity Variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems Convention on Biological Diversity (CBD) (Article 2)

Boundary conditions: Are the ensemble of external agents or factors, which have a defined effect (positive or negative) on dispersion of habitats and species. They include physical properties of the environment as climate, lithology, topography and the properties derived from human land use.

Biological diversity: means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biological resources: includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

Biotechnology: means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

Connectivity: Structural and functional Structural connectivity is equal to habitat continuity and is measured by analysing landscape structure, independent of any attributes of organisms. This definition is often used in the context of metapopulation ecology.

Functional connectivity: within landscapes is a result of a species use of the landscape. For functional connectivity to exist, landscape elements allowing the species' use of the landscape, including movement of species within the landscape, need to be in place.

The nature and scale of these elements can differ significantly between species and consequently species-specific requirements need to be carefully considered, for example, when developing suitable management/conservation strategies for species at a broader landscape level.

Clumpiness index for landscape patterns: Is an index used to measure the level of aggregation of the elements present in a given area.

Conservation status of a natural habitat: Means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2.

Compensatory measures: A requirement set out in Article 6(4) where damage to a European site has been justified in the absence of alternatives and for imperative reasons of overriding public interest (IROPI). Compensatory measures must be designed to protect the overall coherence of the Natura 2000 network. This normally entails the creation of appropriate habitat as close as possible to where the damage will occur and fully functioning before the damage occurs.

Cumulative impacts: Impacts that accumulate over space and time from multiple plans/projects.

Deterioration: physical degradation affecting a habitat, or a breeding site or resting place of a species. In contrast to destruction, such degradation may occur slowly and gradually reduce the functionality of the site in terms of quality or quantity and might over a certain period of time lead to its complete loss.

Disturbance: A temporary change in environmental conditions that may have a negative effect on a natural habitat or a species. Disturbance may be detrimental for a protected species e.g. by reducing survival chances, breeding success or reproductive ability and may give rise to

Habitat: means the place or type of site where an organism or population naturally occurs.

Ecological coherence: Is often used to describe the ecological status of a network and is of particular importance to these guidelines because several references are made to ecological coherence in the EU Habitats directive (see Section 1.2.2). No commonly agreed generic definition for this term exists. However, the following definition was developed by the expert workshop in 2005 in Vilm for the specific case of the ecological coherence of the Natura 2000 network: ó*A sufficient representation (patchquality, total patch area, patch configuration, landscape permeability) of habitats /species to ensure favourable conservation status of habitats and species across their whole natural range*ô

Ecological corridors: A strip of territory used by wildlife and potentially allowing movement of biotic factors between two areas

Ecological stability: Ability of a community or ecosystem to withstand or recover from changes or stress imposed from outside. (See resilience).

Ecology: the study of the relationship of living things to one another and their environment relationships.

Ecosystem Structure: Attributes related to the instantaneous physical state of an ecosystem; examples include species population density, species richness or evenness, and standing crop biomass.

Ecosystem: Is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. The elements of an ecosystem interact with each other in some way, and so depend on each other either directly or indirectly.

Ecosystem process: An intrinsic ecosystem characteristic whereby an ecosystem maintains its integrity. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

Ecosystem resilience: The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks (Walker at al. 2004). Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.

Ecosystem services: are the benefits people obtain from ecosystems, namely *provisioning services* such as food, water, timber, and fibre; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling.

The term “environmental services” was first used in 1970 to describe well-functioning ecosystems and the benefits people receive from them, such as food, pest control, flood control, climate regulation, and recreation (SCEP 1970). These benefits are central to human well-being, yet it is unclear whether they are sustainable at current or projected use levels.

Ecotone: A habitat created by the juxtaposition of distinctly different habitats; an edge habitat; or an ecological zone or boundary where two or more ecosystems meet.

Environment: The place in which an organism lives and the circumstances under which it lives. Environment includes measures like moisture and temperature, as much as it refers to the actual physical place where an organism is found.

Eutrophication: The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Evapotranspiration: The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.

Exotic Species: A species that is not indigenous to a region.

Favourable Conservation Status: The conservation status of a natural habitat will be taken as "favourable" when: its natural range and areas it covers within that range are stable or increasing; the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and the conservation status of its typical species is favourable (Article 1.e of the Habitats Directive).

The conservation status of a species will be taken as "favourable" when: viable population is maintained on a long-term basis; the natural range of the species is neither being reduced nor is likely to be reduced in the future; and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Fragmentation: Normally encompasses two components, the loss (or change) of habitat and the breaking up of the remaining habitat into smaller units (although the term is commonly used to describe only the latter process).

Habitat fragmentation: The breaking up of extensive landscape features into disjunct, isolated, or semi-isolated patches as a result of land-use changes. Fragmentation has two negative components for biota: loss of total habitat area and the creation of smaller, more isolated, remaining habitat patches (Meffe and Carroll 1997).

Habitat of Community Interest: a natural habitat type in Annex I of the Habitats Directive. "Genetic material" means any material of plant, animal, microbial or other origin containing functional units of heredity.

Habitat: Means the place or type of site where an organism or population naturally occurs or the place, and conditions, in which an organism lives.

High permeability areas: Areas which allow the flow of wild species.

Integration: In this work we have interpreted the concept as the capacity of the landscape matrix surrounding the protected area to allow the flow of wild species and habitats. Then we may say that a protected area is well integrated into a wider countryside if the connectivity of the surrounding unprotected landscape is adequate for the species and habitats sheltered in the protected area.

Mitigation: Measures aimed at minimising or even cancelling the negative impact of a plan or project, during or after its completion.

Monitoring: Collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective.

Natura 2000 site: sites designated to form the Natura 2000 network, which include Special Protection Areas (SPA) and Sites of Community Importance (SCI) approved by the European Commission and declared as Special Areas of Conservation (SAC) by the Member States.

NUTS: Nomenclature of Territorial Units for Statistics (*in French*, Nomenclature d'Unités Territoriales Statistiques) is a geocode standard for referencing the administrative divisions of EU countries for statistical purposes. The NUTS classification is hierarchical in that it subdivides each Member State into three levels: NUTS levels 1, 2 and 3. For example, NUTS 3 level corresponds to: "arrondissements" in Belgium; "amtskommuner" in Denmark; "Kreise/kreisfreie Städte" in Germany; "nomoi" in Greece; "provincias" in Spain; "départements" in France; "regional authority regions" in Ireland; "provincie" in Italy; "län" in Sweden; "maakunnat/landskapen" in Finland.

Offset: Biodiversity offsets are conservation actions intended to compensate for the residual, unavoidable harm to biodiversity caused by development projects, so as to aspire to no net loss of biodiversity.

Precautionary principle: where scientific evidence is insufficient, inconclusive or uncertain and there are indications through preliminary objective scientific evaluation that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection, lack of scientific knowledge shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (Rio Declaration, 1992 & EC, 2000).

Protected area: means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

Qualifying Interest: a natural habitat type listed in Annex I or a species listed in Annex II of the Habitats Directive, a species listed in Annex I of the Birds Directive or regularly occurring migratory species not listed in Annex I, for which a Natura 2000 is designated.

Recharge: The process by which water is added to a zone of saturation, usually by percolation from the soil surface; e.g., the recharge of an aquifer

Rehabilitation: The process of converting derelict land to usable land and may include engineering as well as ecological solutions. The restoration of natural habitats is often included as part of the site closure and rehabilitation process. In this guidance document the term is used to imply a process guided by ecological principles that promotes the recovery of ecosystem integrity in all its structural and functional aspects.

Restoration: action taken at a site following anthropogenic degradation or deterioration, to restore or enhance its ecological value. In this guidance document is often used for rehabilitation that is guided by ecological principles and promotes the recovery of ecological integrity; reinstatement of the original (pre-mining) ecosystem in all its structural and functional aspects.

Resilience: Capacity of a system to recover its primary properties and functions after a disturbance.

Riparian Habitat: Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands

Run-Off: That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waters

Site of Community Importance (SCI): it is defined in the Habitats Directive (92/43/EEC) as a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type in Annex I or of a species in Annex II and may also contribute significantly to the coherence of Natura 2000, and/or to the maintenance of biological diversity within the biogeographic region or regions concerned. SCIs are proposed to the Commission by the Member States and once approved; they must be designated as Special Areas of Conservation (SACs) by the Member States.

Special Area of Conservation (SAC): site of Community importance designated by the Member States through a statutory, administrative and/or contractual act where the necessary conservation measures are applied for the maintenance or restoration, at a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated.

Special Protection Area (SPA): Protected area designated in accordance with the Birds Directive for species listed on Annex I of the Directive and/or regularly occurring migratory species, and included in the Natura 2000 network.

Species of Community Interest: a species listed in in Annex II and/or Annex IV or V of the Habitats Directive.

Stakeholders: People or organisations that will be affected by, or will influence a programme, project or action.

Surveillance: An extended programme of surveys systematically undertaken to provide a series of observations to ascertain the variability that might be encountered over time.

Sustainable use: means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Vulnerability: The vulnerability indicates de sensitivity of a system to changes. In this document it has been used to indicate when a region natural areas network is sensitive to socioeconomic changes. This region will be vulnerable if changes affect negatively the integration.

FOR MORE INFORMATION:

http://www.green-infrastructure-europe.org