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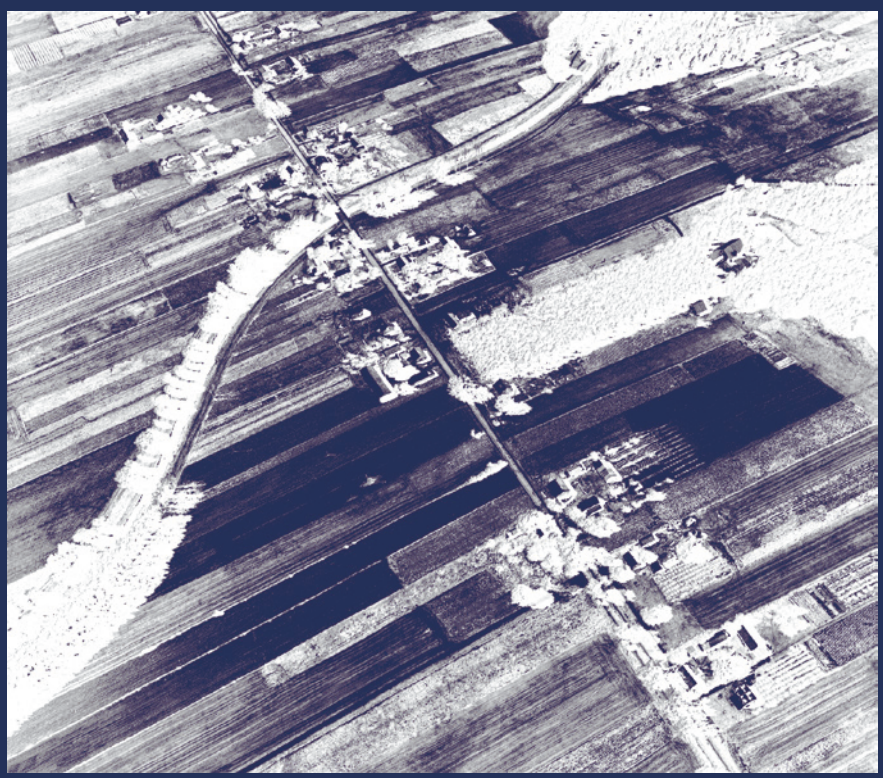
European Land Use Patterns

Editors:
Jerzy BAŃSKI and Gemma GARCÍA-BLANCO



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Preface

Land use in Europe has changed drastically during the last fifty years, primarily in relation to the betterment of human well-being and economic development, while unfortunately causing serious environmental problems. Policy change plays a role in the performance of territories. Understanding the impacts of these land use changes on sustainability is currently a major challenge for the policy and scientific community.

The following research paper documents the results of a three-year-long applied research project entitled European Land Use Patterns, (EU-LUPA), which was carried out under the auspices of the European Observation Network for Territorial Development and Cohesion (ESPON) 2013 Programme, and financed by the same programme. The mission of the ESPON 2013 Programme is to "support policy development in relation to the aim of territorial cohesion and a harmonious development of the European territory by (1) providing comparable information, evidence, analyses and scenarios on territorial dynamics and (2) revealing territorial capital and potentials for development of regions and larger territories contributing to European competitiveness, territorial cooperation and a sustainable and balanced development".

The EU-LUPA Project had a number of overarching goals. The first of these was the creation of a cohesive methodology for the analysis of land use in different regions of the European Union, based on data from a variety of sources and utilizing a variety of spatial scales. The second was the production of knowledge and valuable information integrating the physical dimension with the socio-economic as well as with environmental protection – knowledge that would allow us to comprehend changing modern-day trends in land use, their dynamics and underlying conditions. The third goal was to identify the main problems and challenges in terms of land use in different territories and regions as well as to identify remediating steps and offer recommendations that would help us resolve these problems.

The EU-LUPA Project was headed by Tecnalia[1] (Spain) and developed by the Autonomous University of Barcelona[2] (Spain), Alterra[3] (The Netherlands), Nordregio[4] (Sweden) and the IGSO-Institute of Geography and Spatial Organization[5] (Poland) and constitutes a first attempt within the ESPON framework to assess land use changes in Europe at a regional level.

Jerzy Bański and Gemma Garcia-Blanco
Editors of the volume

[1] http://www.tecnalia.info
[2] http://www.uab.es
[3] http://www.alterra.wur.nl
[4] http://www.nordregio.se
[5] http://www.igipz.pan.pl

1.

Introduction

Gemma García-Blanco, Efren Feliu-Torres

1.1. The project rationale

Current European land use patterns are both the visual expression and the culmination of centuries of human intervention on its environment. Land use has changed drastically during the last fifty years (EEA, 2010a; EEA, 2011b) sometimes with important negative effects such as urban sprawl, soil sealing and loss of biodiversity (EC, 2010a), soil erosion, soil degradation, flooding or desertification. These land use changes vary among different types of regions.

The geographical context and the availability of resources, alongside the push of demographic evolution and the economic development have played an important role in driving land use changes and shaping Europe's landscapes.

Moreover, the legacy of past decisions constitutes a crucial element to understand this changing process, where leadership, policies, planning systems have also had a major influence. Those differences in land use decision processes due to different pattern of legal, constitutional and administrative framework represent an aspect, which macro-regionally shape Europe.

During the last decades land use and land use change in Europe have been mainly addressed from a thematic perspective (e.g. environment, agriculture, urban areas). The need to integrate all these different sector views was more than evident, to provide a better understanding on key questions even more relevant in a context of general economic crisis, and at the same time realizing that land use characteristics are becoming increasingly multi-functional, crossing not only sectors but also administrative boundaries, and thereby becoming more demanding in relation to background information and institutional and administrative structures.

The tangibility, dependence and interconnectedness we share with the land itself (particulary the bio-physical perspective of what covers the land) puts emphasis on the importance of accounting for land patterns and attributing these patterns to the general conditions of socio-economic development.

Accordingly, based on data from different sources and at different scales, EULUPA project provides a consistent methodology for analyzing comparable information and supplies regionalized characterization of land use and land use change, integrating the physical dimension of land use (land cover) with socio-economic and environmental dimensions, with a European coverage.

This will help decision makers in:

a) Understanding current land use dynamics and land use change patterns in the European territory, using CORINE Land Cover 1990-2000-2006 data.
   - What does the current European land use look like, what are the current land use patterns on the European territory, where are certain patterns dominant and in what particular types of regions or countries?
   - What are the changes of land use, the main dynamics and trends? Where are the main changes in typical land use patterns? And what are the main driving forces behind these land use and land use pattern changes?
   - To what extent are existing land use patterns throughout Europe in line with the general spatial development principles as formulated in most territorial policy documents (e.g. ESDP)? How will this picture look like if no extra policy action is taken and new territorial dynamics come into play?

b) Identifying main challenges and opportunities for development in different types of territories, regions and cities.
   - What are the relations between land use patterns (and more specifically urban land use patterns) and drivers of development such as geographical, demographic and cultural influences, climate change, transport, employment, Gross Domestic Product and other economic structures?
   - Are there typical land use developments and patterns in particular types of regions such as border regions? How can these developments, e.g. through cooperation initiatives, be coordinated and create a development potential?

c) Creating policy decisions to cope with the challenges and enhance the opportunities.

It is important to highlight that the analysis done in EU-LUPA project is for the period 1990-2006, and therefore just before the economic and financial crisis which hit Europe in the year 2008. However, the outcomes of the analysis provide powerful information about the situation in which the regions entered the crisis; and this is considered very useful since it offers lessons that should help policy makers at the regional level to identify their context and in term chances to exit the crisis.

1.2. EU-LUPA policy framework

Although European policy does not have competence for spatial planning *per se*, it sets the framing conditions of planning through different strategies and instruments.

Land use implications on the compliance of the key EU policy objectives and targets are crucial due to its cross-cutting nature touching upon many different territorial challenges: urbanization and rural-urban relationships, climate change

mitigation and adaptation, natural resource management, energy, transport, regional competitiveness and cohesion.

Within the EU policy framework we could find many specific responses to land use and land take.

While the first decades of planning in the EU were related to the economic development and the economic, social and cultural integration of the member states, other issues, such as the harmonious territorial development towards sustainability have appeared on the agenda during the last three decades. This resulted in the evolution of planning from land use development by means of economic incentives, towards a more equal concern with economic development, environmental justice, and social and economic equity (UNECE, 1998).

Back in 1999 the European Spatial Development Perspective (ESDP) (EC, 1999), a non-binding framework aiming at coordinating various European regional policy impacts, already advocated the development of a sustainable, polycentric urban system and balanced territorial development in Europe. The ESDP resulted in European policy orientations for territorial balance and cohesion, improved competitiveness, urban system with compact cities and strengthened partnerships between urban and rural areas, parity of access to markets and knowledge, as well as wiser management of natural and cultural resources.

From the ESDP the territorial dimension began to be addressed in the EU political agenda and EU policies, also at regional level, increasingly focused on harmonious territorial development towards sustainability (Rivolín and Faludi, 2005).

In 2007 the enlarged EU adopted a Territorial Agenda for the European Union (IMM, 2007a), which modernized the policy orientations of the ESDP and added stronger emphasis on: a) competitiveness of regions and cities including creation of innovative clusters, b) climate change concerns, c)territorial cooperation and d) multilevel governance.

The Territorial Agenda has been followed up by an ambitious Action Plan 1 (IMM, 2007b). The Territorial Agenda was reviewed in the first half of 2011. Some of the actions are related to the themes of ESPON applied research, others are being supported by ESPON targeted analyses. Besides the, shifting of EU presidencies are keeping up the momentum of the Territorial Agenda and the development of territorial thinking and approaches.

The Leipzig Charter (IMM, 2007c) built on a process of cooperation aimed at strengthening urban development in the European context. With the Leipzig Charter the Ministers agreed on common principles and the need for proposals and strategies for sustainable EU cities calling for a European polycentric urban structure.

The Lisbon Strategy (European Council, 2007b) also includes the new aim of "territorial cohesion". This dynamic strategy (climate change, energy, financial and social sustainability) making sustainable development a key objective for the EU and, in 2010, the EU reneweda number of Environmental Directives to ensure they comply with it.

Besides, the Gothenburg Strategy (European Council, 2001), Development Strategy Sustainable reviewed in 2009 also defines a number of key environmental objectives and target dates, both political and legislative. Major priorities include climate change, sustainable transport, public health and natural resources management. This strategy has had an important impact on the EU political agenda as revealed by the EU's climate change and energy policies.

The Commission published a Green Paper on Territorial Cohesion (EC, 2008) in order to launch a debate that could support a better understanding of this policy aim. This document puts a territorial perspective on economic and social cohesion setting the objective of a more balanced and harmonious development of the European territory, a debate that during the next years will nourish the concept of future EU Cohesion Policy.

The Commission also published in November 2010 the 5th Cohesion Report (EC, 2010d) with further policy orientations, stressing the importance of providing more support for the less developed EU regions in line with the Union's strong commitment to solidarity and its Treaty aim of reducing regional disparities in levels of development, to foster territorial cooperation in its three dimensions (cross-border, transnational, and inter-regional) and concentration of social exclusion in urban areas.

At the same time, the main challenges with territorial impacts (accelerating globalization and market integration, ageing and migration, climate change, changing energy paradigm) as well as the need for ex-ante territorial impact assessment of EU Policies are all increasingly taken seriously by policy makers.

On 17 June 2010, the European Commission adopted the Europe 2020 Strategy (EC, 2010c) as the EU' s growth strategy for the coming decade. This policy document sets out a vision of Europe's economy for the 21st century. It shows how the EU can come out stronger from the crisis and how it can be turned into a smart, sustainable and inclusive economy, thus delivering high levels of employment, productivity and social cohesion for the EU and its member States. The strategy has five ambitious objectives on – employment, innovation, education, social inclusion and climate/energy. As highlighted by the ESPON SIESTA (ESPON, 2012) report on Spatial Indicators for a Europe 2020 Strategy Territorial Analysis, the spatial dimension of the strategy is not obvious. Indeed, the report reiterated how scholars such as Böhme et al. (2011) have recently stated that the spatial derivative of the EU2020S is territorially blind.

The 'Rural Development Policy' (towards 2020) – where priorities include restoring, preserving, and enhancing ecosystems (e.g. Natura 2000, landscapes, soil management, etc.); and the 'Common Transport Policy'– where development of transport services must take account of their possible effects on the environment. Even further still, the White Paper on transport, the energy efficiency plan and the communication of the Commission' A Roadmap for moving to a competitive low carbon economy by 2050' constitutes the key deliverables under the Resource Efficiency flagship. (COM (2011)112 final), while 'The European Landscape Convention' (Council of Europe, 2000) deals with the protection, management and planning of all landscapes in Europe.

But perhaps most notably, the 'Roadmap on Resource Efficient Europe' includes the bold milestone of no net land-take by 2050. Yet EU-LUPA perceives that implementing this mandate would mostly likely work against the goals of a number of regions; particularly those seeking to ascend the socio-economic ranks towards the most established European nations. The magnitude of land change has been more or less maintained throughout the period from 1990 to 2006, conversely new members of EU appear ready to make use of land change and land consumption as a vehicle for economic progress. It seems that measures of compensating any limitations in this respect would be needed. Therefore, it is both an unlikely and unrealistic goal for a number of European regions.

Existing European policy regarding land use lacks a comprehensive and integrated approach that takes the inherently broad number of trade-offs between many sector, social and environmental issues. In particular, this includes activities relating to: industry, transport, energy, mining, forestry, agriculture (EEA, 2010b), as well as recreation and environmental protection/conservation. Accordding, to the EEA, "these trade-offs can be tackled through integrated planning for land use and territorial planning, sector policies, as well as targeted policy instruments, such as protected area networks." (EEA, 2010a, p. 5). Similarly it is expected that the integration of the European Landscape Convention as a tool in territorial planning would become an important contribution to the planning process. Along these lines, institutional arrangements dictating land use policy in Europe include the EU objective for Territorial Cohesion – with which this project is closely connected to – the Water Framework Directive, Common Agricultural Policy (CAP), Natura 2000, and with an increasing importance, Energy 2020. Important tools for informing, monitoring and evaluating these policies and programmes are Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), and most importantly, the advent of the Corine Land Cover inventory (EEA, 2010a).

All these processes stress the need for better and deeper knowledge, more scientific evidence, development of territorial indicators as well as assessment methods for territorial impacts. The applied research themes of the ESPON 2013 Programme are chosen by the policymakers involved to respond the best possible to this policy demand.

Within this context, it is increasingly understood that a more integrated, comprehensive and up-to-date policy approach is needed; one that can bolster sustainability through increased efficiency and a multi-functional approach.

Two European initiatives have been developed in order to gain an understanding on these process and also to provide evidence/warning on more unsustainable process. Each one has its advantages and constrains:

Corine Land Cover. The information is derived from satellite images and available for three time shots in most of the European countries: 1990-2000-2006. In fact the nomenclature reflects a mixture of land cover (biophysical component of the land – e.g. water) and land use (e.g. built-up areas are differentiated by its use). The main limitation is on the resolution of the data, both in terms

of stock (percentage of certain type of land cover) and changes. Limitations are also clear on linear features (e.g. roads and rails) and also on plots below the CLC resolution. Additionally, each portion of land has one single attribute or class, not allowing assessing the degree of multifunctionality.

The development of the Corine Land Cover project has been a milestone in relation to the discussions regarding the characteristics and changes in Land Use in Europe. Originally designed to be aiming at providing consistent localized geographical information on the land cover of the 12 Member States of the European Community, the project was considered necessary in order to provide information – together with information on environmental features such as relief, drainage systems etc. – essential for the management of the environment and natural resources. The data on land cover therefore should provide a reference source for various purposes such as determining and implementing joint environment policies, and together with other data on climate, inclines, soil, etc. enable more complex assessments, e.g. mapping erosion risks, development capabilities, etc., and thereby providing the benefits of using a single joint project to meet both Community and national as well as regional needs for planning of land use development issues.

LUCAS. This is an initiative of Eurostat (started in 2001), which is based on *in situ* monitoring and focussed on pure land use. In fact this approach recognises all land uses in a certain place. In parallel, a soil monitoring has been developed. The downside of LUCAS is that its statistical significance is only relevant at NUTS 2 level (Kleeschulte et al., 2011).

These two initiatives illustrate to a certain extent the interchangebility of "land cover" and "land use" as terms describing overlapping or even identical perspectives to the way land exists or is consumed in time and space. Nevertheless, the distinction between the two can be made very simply. "Land cover" is a term that reflects the bio-physical nature of the land surface. To determine the land cover is simply to ask one's self what they see when they look to the ground. Therefore, in its absolute sense it is void of human perception and be placed in zero-sum terms. Examples of land cover could be given in relational terms (i.e. natural or non-natural) or in absolute terms (i.e. grassland or bare rock).

In contrast, "land use" is an adjective that is used to describe the manner in which the land is perceived or consumed by humans. For example, recreational, preserved or waste land uses are often legal entities but also speak to the describing the nature of human activities that use, exploit and consume land. For example, agriculture, industrial land, transport areas, pastures, agro-forestry, plantations and irrigated land all relate directly to the use of land in space. Here, human intervention does not operate in zero-sum terms and allows for the inclusion of multiple functions on a given piece of land. For instance, we often hear the term mixed land use within planning policy as a way of describing the conditions and benefits of over-lapping land uses.

With the focus on current European land use patterns and land use changes as well as the dynamics and trends over the last 16 years (1990-2000-2006) and

the driving forces behind them, the question of defining land use is a critical issue in the EU-LUPA project.

The EU-LUPA project has a pan-European approach to land use. Land use changes and dynamics in Europe are addressed as policy driven processes in the context of European Spatial Development, although the evaluation of policy impacts is definitely out of its scope.

1.3. Hypothesis for investigation

The objective of EU-LUPA is to find an innovative way of accounting for land use patterns and dynamics through the use of land cover data. As such, this project seeks to provide evidence to support sustainable land use management by means of a new and insightful way of characterizing land use patterns and their dynamic relationship with socio-economic growth. As discussion will show, while land cover and land use are two terms that often get misused in place of each other, we have approached a means of investigating land use through Corine Land Cover data by means of the "intensity" concept.

Although the legacy of the past is an important component, we will test the hypothesis that certain processes tend to homogenize and converge into similar typology pattern. In that sense land use change becomes a function of economic growth and spatial localization.

In the EU-LUPA project land use patterns and dynamics are integrated in a certain typologies as a means to synthesize the information and highlight similar regions in Europe. It could be considered that each group in the typology also reflects certain pathways which will be relevant for the identification of potentialities and territorial challenges. Consequently, the regional typologies do not directly integrate data reflecting regional socio-economic conditions in Europe, but the intensity concept shows a clear correlation between the presence of land cover types and the characteristics of socio-economic development that takes place as a result.

An important issue to bear in mind is that land use patterns have a scale dimension. Thus certain processes will only be detected in the case studies; while at European scale will be identified as emerging patterns. Land use patterns have also a time dimension. The impact of intensive process tends to be immediate while extensive process takes longer (decades or even a century). An intensive process could be described by the amount of energy involved in the process of change (either input or output – e.g. building a new infrastructure or the impact of a forest fire). This is also relevant for the interpretation of the impact of different policies on the land cover and land use.

Land Use Functions provide a conceptual framework to assess how changes in land use (partly driven by policies) impact on the multiple functions attached to land use, which in turn affect sustainability and stock and quality of natural resources. Therefore the approach of Land Use Function reflects the performance and efficiency of different regions. It is expected that the groups identified in the ty-

pology will not be homogenous in terms of land use functions and efficiency. However, this approach will help to identify hidden process and fine tune the potentialities of the regions.

The project also seeks to answer the question: Is Europe's preliminary Resource Efficient Strategy promoting legitimate goals? In particular – A Resource Efficient Europe 2011: Flagship initiative under the Europe 2020 Strategy, sets the goal of no net land-take by 2050. Yet this mandate, as already argued in the previous section, will mostly likely work against the goals of a number of regions; particularly those seeking to ascend the socio-economic ranks toward the most established European nations. Even more, globalization and new communication tools open the space for new geographies sometimes disconnected from the physical source.

It is strikingly clear that we have double-sided relationship between land and growth. The land use paradox is that we are dependent on land to provide the resources we need to grow (particularly in the short term), yet our ability to grow (particularly in the long term, which is often referred to as development) is inseparable from our need to conserve and protect land. It emphasizes that we need land to grow, but our growth puts pressure on the social, economic and environmental services we can obtain from it. But it also shows that the drivers, the enablers and the ingredients of what we require for development are the very things pressuring the over-consumption of land. This pressure cannot continue to escalate as we continue to develop and it means that a growth model that is blind to the host of thresholds related to land and its resources cannot continue sustainably.

It is expected that the diversity between the regional realities within the European territory could be also reflected in their land use dynamics, which in principle would obligate the analysis of each reality independently in order to be able to define meaningful policy recommendations. However, considering the complexity of the subject it is out of the EU-LUPA project scope to provide recommendations directly transferible to all European regions, other than for the case studies.

1.4. Methodology

EU-LUPA uses a multi-sector perspective based on a stepwise process. This builds on the following main components:

Land use characterization. Based on data provided by Corine Land Cover (hereinafter CLC) 1990, 2000 and 2006, regional typologies are defined as the classification of European NUTS 2/3 regions into types based on shared or common characteristics. The role of the typologies has been to serve as an analytical tool to support the development of land use policy recommendations for the ESPON territory. In looking to develop typologies based on the available data of land cover status and changes, the answers to three central questions are sought:

1. What are the stable elements of land cover in Europe?
2. What characterizes the observed land changes?
3. How are both of these connected to the socio-economic development?

The EU-LUPA typologies provide an optimal characterization of land cover status and changes that can be analysed *vis-à-vis* with socio-economic dimensions. This in turn reveals additional insight into the nature of land use patterns and their relationships with socio-economic development:

- *Prevailing characteristics of land use:* based on the distribution to CLC data 1990-2000-2006 this typology answers the question, what characterizes the land use in Europe?
- *Amount of land use change*: as a percentage of the total area of NUTS 2/3 regions. To simple answer the question, how much land is changing, and where?
- *Intensity of land use change*: in NUTS 2/3 regions, to answer the question, what is the degree of human intervention on the land in order to meet the needs of our socio-economic activities? In relation to the intensity of land use change it is understood as the degree of human intervention on the land caused by socio-economic activities by means of the consideration of GDP and population density. It is included in the analysis based on an inferred intensity hierarchy that is inherent in the CLC classification.
- *Hotspots of land use change*: in relation to the two previous outputs, Hotspots generalize regions based on a matrix of absolute change (by area) and intensity of change. This provides a picture of which regions stick out in terms of high levels of physical land change, in terms of the degree of human intervention on the land, or both.
- *Land Use Change typology:* this is the cornerstone of the EU-LUPA land use characterization and it answers the question, what characterizes land use changes for NUTS 2/3 regions in Europe? based on the regional clustering of all Corine Land Cover Flows and changes in land use intensity. The results are typologies of Land Use Change provided at a regionalized NUTS 2/3 level.

Land Use Functions approach. How and to what extent are changes in land use patterns interacting with socio-economic developments? To answer this question a Land Use Functions approach was used. Land Use Functions express the goods and services that the use of the land provides to human society. It is used to assess how changes in land use (partly driven by policies) impact on the multiple functions attached to land use, which in turn affects sustainability and stock and quality of natural resources.

Case studies are used to better understand hidden land use processes not captured through analysis at the European scale, and to validate and better understand the main project outcomes. Four areas in EU have been selected: Øresund – a cross-border region with highly differentiated and multifunctional land use

structure (from urban core, semi-urban to arable); Eurocity Basque Bayonne-San Sebastián – a cross-border region, with high share of urban areas in a multifunctional rural setting which is still dominated by agricultural activities, Chełmsko-Zamojski, which is located on periphery (EU border) and characterized as a monofunctional agricultural region; and Jeleniogórski – located on the Poland-Germany-Czech Republic borderland with multifunctional land uses reflecting the economic transition taking place there.

Policy recommendations. Based on scientific evidences and key findings, EU-LUPA outlines some general responses and key messages for policy development towards more sustainable land use management, and hence a more resource efficient territorial development. This is in line with the EU development principles and objectives mainly under the EU Cohesion Policy, EU2020 Strategy and the Territorial Agenda.

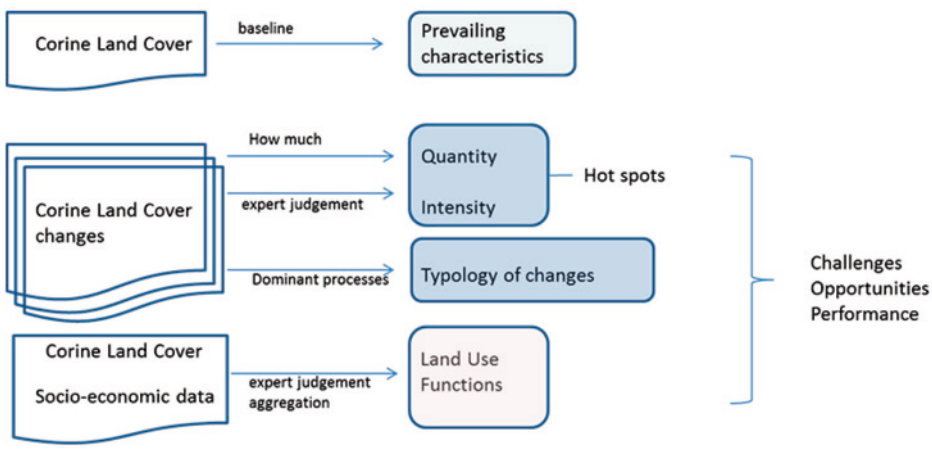


Figure 1.1. Overview of the methodological approach to the land use patterns taken by EU-LUPA. The first pillar on the left represents the needed data as inputs. The second pillar can be analysed from the top to the bottom, starting with a simple characterization of the baseline, then identification of hot spots and typologies of changes, and finally the characterization of land use functions. All these elements together assist in the identification of challenges, opportunities and performance.

2.

Characterizing land use and changes at the regional level

Rasmus Ole Rasmussen and Ryan Weber

2.1. The role of land and land use within the perspective of Sustainable Development

Right alongside energy inputs, minerals, biotopes, water and climate, land is one of many environmental resources that we need to use within a sustainable level in order not to endanger our continued development. However, in relation to environmental sustainability, land is unique in the sense that it is simultaneously the most tangible and intangible of these resources. It is tangible in the sense that, in its variety of terrestrial forms, it is the universal physical property of where we situate ourselves, interact with one another and move about in space. But as the interface between society and economy, and the environment, it is also the most intangible of resources. On one hand this considers the array of often discrete interactions (both compliments and trade-offs) between socio-economic development and the environment, but it also considers the aspect of land as embedded within societal, cultural and individual values and perceptions. As emphasized by Kostrowicki (1992) land use is a historical concept encompassing types of varying orders, and a dynamic concept, with types changing in an evolutionary or revolutionary way. It should therefore not be considered as a simple sum of its components but as a set of highly interconnected and interrelated phenomena and processes, and can be treated as a complex or a system in terms of a system approach (Kostrowicki, 1982).

These perspectives highlight that while we are dependent on what land provides us, we also have an ability to manipulate it away from its natural state in order to meet our needs. It can be deforested through logging or by environmental pressures, it can be cleared and prepared for agricultural production and, most importantly, it can be covered with buildings and infrastructure in urban areas. Perhaps most concerning, negative environmental consequences take place under complex and often discrete feedbacks, which due to a range of place related factors, are difficult to predict. As such, the onset of negative impacts from land change and over use can develop very quickly and dramatically.

The recently concluded EU FP-6 project PLUREL (Peri-urban Land Use Relationships) specifically emphasizes the EC document 'Towards a strategy for the ur-

ban environment'(CEC, 2006), where it is said that urban sprawl is the most urgent of planning and design issues. In so doing, the results of PLUREL identify the most important negative consequences of inefficient land take (urban sprawl). These are:

- Consumption of land, loss of high-productive agricultural land
- Destruction of biotopes and fragmentation of landscape structure and ecosystems
- Less open space, longer distance to attractive recreational areas, unhealthy lifestyles
- Increase in the dependency of private car, traffic congestion, longer commuting times and distances, climate change emissions and air pollution
- Decay of downtown areas; social segregation and larger gaps between rich and poor areas. (Piorr et al., 2011)

The above list runs across a range of social, economic and environmental impacts of urbanization. As such, it emphasizes some of the main relationships between land take and sustainable development; especially reflecting the permanency of urbanization where we, under normal conditions, are limited in the extent that we can improve biodiversity and engage ecological preservation on land that becomes urbanized. Given this crucial importance of land take, the urban dimension is specifically highlighted in the following chapter (EC, 2010c)

Put together, it is strikingly clear that we have double-sided relationship between land and socio-economic growth. We are dependent on land as a provider of the resources we need to grow, yet our ability to grow within a framework of diversity is inseparable from our need to conserve and protect land. With this in mind, EU-LUPA is partially a response to a realization that current rates of land take cannot continue indefinitely without significant and diverse negative impacts on the environment – impacts that will be felt both at a range of scales, from the local to the global. The rationale behind EU-LUPA also conveys that improved land use management can create synergies for improving resource efficiency across a number of sectors at the same time. One example is how compact urban development principles simultaneously promote energy efficiency in the building and transport sectors, biodiversity, and protection of agricultural areas for food production.

These realizations show that regional evidence on land use patterns in Europe are needed; and with a special eye on a) how land use dynamics relate to socio-economic development, and b) how such evidence can inform European regional policy for Economic, Social, and especially, Territorial Cohesion. Accordingly, the focus of the forthcoming discussions are on the relationship between land use and land use change, and the drivers, effects and challenges of regional development in Europe.

2.2. Existing knowledge base – short overview of available sources and typologies (or classifications) of land use in Europe

2.2.1. How the concept of land management is approached by European policy and analysis

Establishing a general rationale for the utility of land use planning within a territorial planning perspective allows us to not only investigate the actual extent it is taken up in EU policy, but also what potential it has to be a strengthened dimension in future EU policy making. Again with reference to Kostrowicki (1976, 1982), research on land use systems is of considerable importance, both for better knowledge of resulting processes as well as for more rational land management. To start such research a typology and classification of land use systems is necessary, taking off by the discussion of possible criteria, methods and techniques of land use systems identification.

With this in mind, land management is based on a few key spatial justifications that must be considered in parallel:

- To promote the widest range of functions that can be achieved by an asset (land), thereby unlocking the greatest benefits (cf. EEA, 2011a, p. 8).
- To consider land use functions in relation to their environmental, social and economic costs and benefits, treating each with an equal importance.
- To acknowledge that the way we use land shapes environment, both in terms of how it is appreciated (i.e. in terms of landscape) and how it limits (or promotes) climate change and health.

These justifications, while concretizing the discussion above on the link between land use planning and sustainability, shows the importance of using land as efficiently as possible for social and economic purposes, while explicitly seeking to promote environment. As a result, to answer the question of the extent that land use is taken up by EU policy we must first answer the question 'how does land use management promote the environment'? Answers to such a question will ultimately boil down to the following guiding principles:

- That social and economic demands are balanced by a goal to minimize or eliminate land take, depending on regional preconditions.
- That existing agricultural areas are maintained.
- That forest resources are used in a multifunctional and sustainable way (i.e. a sustainable forest sector committed to harvest and renewal).

– The principles of green infrastructure, nature protection and landscape preservation are placed at the centre of spatial planning efforts.

These principles quite clearly relate to the overall objective of Territorial Cohesion, which the EEA states is, "the spatial representation of sustainability, and which would mean that assessing policies in terms of the environmental dimensions of territorial cohesion can constitute an important step towards the better integration of environment and sustainability" (EEA, 2011a, p. 16).

The troubling aspect, however, is that environmental dimensions of territorial cohesion are generally poorly understood. As the EEA states, "Most discussions focus on the economic and social issues of territorial cohesion, and there is often a tendency to consider environment and territorial cohesion as antipodes" (EEA, 2011a, p. 22).

Simply put, there is no explicit, comprehensive and integrated approach to land use management within European policy. In defence, there are two key reasons why this is the case: First, policy decisions that influence land use and land use management are complex, involving trade-offs between many sector interests, including industry, transport, energy, mining, forestry, agriculture (the latter two of which represent the largest share of land use by economic sectors) (EEA, 2010a, p. 4-5), as well as recreation and environmental protection/conservation.

Second, policy decisions regarding land use also involve a number of trade-offs between multiple scales of government; where land use development in terms of buildings and the built environment is typically a competency undertaken by local planning authorities, most often at the municipal level; while other issues that affect land use, such as interregional transport development or nature protection (i.e. highway and rail connections or formation of national parks), are typically governed at the national and European scale. As one key example, the lack of regional coordination on issues of land use planning has been emphasized by numerous sources a key driver of urban sprawl (Piorr et al., 2011; Galera-Lindblom et al., 2011). Likewise, one of the key findings of the PLUREL project was that more balanced and sustainable land use planning requires more policy attention on the regional level, which includes an implication that if any EU intervention appears likely to produce additional urban sprawl it should not proceed (Piorr et al., 2011).

Instead, the land use perspective underlies a number of policies and policy concepts concerning the evolution of EU policy discourse, in particular relating to economic development, environmental management and territorial planning, which are the focus of discussion in the next section. Skipping forward to present day**,** these include the aforementioned EU objective for Territorial Cohesion – with which the EU-LUPA project and the entire ESPON network is closely connected to – the Water Framework Directive, Common Agricultural Policy (CAP), Natura 2000, and with an increasing importance, Energy 2020. Similarly, it is expected that the integration of the European Landscape Convention as a tool in territorial planning would become an important contribution to the planning process**.** Important tools for informing, monitoring and evaluating these po-

licies and programmes are Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), especially, the advent of the Corine Land Cover inventory (EEA, 2010a).

The manner in which the land use dimension can be strengthened in EU policy is very much an open question; not least exemplified by the rationale for attempting to integrate socio-economic and land use dimensions in characterizing EU regions within the EU-LUPA project. Nevertheless, it is increasingly understood that a more integrated, comprehensive and up-to-date policy approach is needed; one that can bolster sustainability through increased efficiency and a modern, multi-functional approach to land use. As such, the manner in which land dynamics are analysed in the next chapter seek to provide evidence to support such a policy initiative, by providing a new and insightful ways of characterizing land use patterns and their dynamic relationship with socio-economic growth.

But first, it is important to go back and trace the development of the land management concept through the development of the EU policy, and the research and analysis supporting such policy. This will show that its current lack of explicit discourse is closely connected to the way it has been taken up by research and policy of the past 30 years.

Pre-Territorial Cohesion

The above discussion reflects that there is no explicit "land use policy" for the EU. This implies that analyzing how it is taken up at the EU level requires a certain measure of interpretation and an investigation across a variety of sectors and themes. Perhaps, this can most easily be done by taking a step back and tracing how land use concepts (i.e. land use, land cover, landscape, etc.) have evolved alongside the EU development. While these concepts are not the same, they are considered to be reflecting different perspectives of overlapping phenomenon, which will be seen through the progressing analysis where important distinctions between the three become clearer.

The development of the EU is characterized by a process of coordination and integration of historically developed governing and planning systems. However, during most of its existence – from the starting point with the six members of the European Coal and Steel Community to the present situation with 27 EU Member States and additional 6 candidate countries – an overarching focus of the EU has been on economic development. In this context, the issue of land use has largely been a competency left for individual Member States.

It has only been during the last decades, and especially within the last 5-10 years, that issues such as a harmonious territorial development towards sustainability have appeared on the policy agenda of the EU. This includes the traction gained through the parallel development of social, economic and territorial cohesion - thus emphasising more equal concern with economic development, environmental justice, and social and economic equity.

At the same time, this has brought forward a continued focus on sector specific development as the determining issue, and as such, a relative lack of land management as a bridging and spatial concept of sustainability. The rationale for this has mainly been the belief that Europe as a whole only would be able to compete successfully on a global scale by turning the focus on the strongest candidates in its largest regions, and with relatively less recognition of the potential landscape and environmental impacts of such a strategy.

An important milestone for the consideration of land use issues was increased attention paid to sustainable development and environmental protection during the late 1980s and early 1990s. In particular, an expanding governing bodyof the EU led to the formation of The European Environment Agency (EEA) in 1993. Since its inception, the EEA's task has been "to provide sound, independent information on the environment", ensuring evidence based information "for those involved in developing, adopting, implementing and evaluating environmental policy, as well as the general public". This in order to help planners and policy makers to advance informed decisions about how to improve the environment, and not the least to work towards the integration of environmental considerations into economic policies which eventually should lead EU towards sustainability (Caspersen, 1999).

However, it is relevant to point out that the EEA's current (2009-2013) Strategy document considers that land is something which is impacted by development activities rather than being an integral part of the development process: "Over the past decade the Agency has analysed conflicts over the use of space and land-based resources in Europe and observed that they will be exacerbated by urbanization, transport growth, shifts in agricultural priorities, new forms of tourism, evolving societal aspirations around mobility and housing, demography and the continuous changes to the territorial landscape from climate change putting at risk ecological and social resilience."(EEA, 2009, p. 29).

Likewise, in the Agriculture and forestry section of the document alludes to land use as being something being impacted by development, rather than vice versa: "Our main objective [is]: To provide integrated analyses of land use trends in agriculture and forestry through assessments of their current and future impact on water, soils, air quality, biodiversity and landscapes. This will help to assess the impact of new societal demands, demographic and technological trends on the natural environment and form a basis for policy evaluation and feedback into related sectorial and environmental policies"(EEA, 2009, p. 30).

At the same time, it is notable that these statements are, to some extent, contradicted by the EEA's comments in 2007: "Most of the available longterm studies focus only on one sector or one dimension of a problem. This comes at the expense of analyzing inter-linkages of the many socio-economic driving forces that contribute to problems in our increasingly complex and fast changing world" (McGlade, 2006).

Yet from another angle the Pan-European Biological and Landscape Diversity Strategy (COE, 1996), which served as a preamble for the European Land-

scape Convention in 2000, opened up for "recognising the uniqueness of landscapes, ecosystems and species, which include, inter alia, economic, cultural and inherent values… [in a] Pan-European approach to the conservation and sustainable use of shared natural resources" (COE, 1996, p. 6). The proposed strategy was a response to the Convention on Biological Diversity and included 10 strategic principles for its implementation:

- Threats to Europe's biological and landscape diversity are reduced substantially.
- Resilience of Europe's biological and landscape diversity is increased.
- Ecological coherence of Europe as a whole is strengthened.
- Full public involvement in conservation of biological and landscape diversity is assured.
- Conservation, enhancement and restoration of key ecosystems, habitats, species and features of the landscape through the creation and effective management of the Pan-European Ecological Network.
- Sustainable management and use of the positive potential of Europe's biological and landscape diversity through making optimum use of the social and economic opportunities on a national and regional level.
- Integration of biological and landscape diversity conservation and sustainable use objectives into all sectors managing or affecting such diversity.
- Improved information on and awareness of biological and landscape diversity issues, and increased public participation in actions to conserve and enhance such diversity.
- Improved understanding of the state of Europe's biological and landscape diversity and the processes that render them sustainable.
- Assurance of adequate financial means to implement the Strategy.

Especially principle 4 on public involvement in conservation measures, objective 6 on optimum use of the social and economic opportunities, and objective 8 on increased public participation in actions to conserve and enhance diversity indicate not only an opening towards the inclusion of the landscape concept, but at the same time also an indication of the need of public involvement.

A next step towards the recognition of the land an concept as more than just a bystander environmental-cultural aspect was by the adoption of the ESDP – European Spatial Development Perspective – Towards Balanced and Sustainable Development of the Territory of the European Union, prepared by the Committee on Spatial Development and agreed at the Informal Council of Ministers responsible for Spatial Planning in Potsdam (EC, 1999). In this document the concept of landscape planning is recognized: „Natural and cultural heritage in the EU is endangered by economic and social change processes. European cultural landscapes, cities and towns, as well as a variety of natural and historic monuments are part of the European heritage. Its fostering should be an important task for

modern architecture, urban and landscape planning in all regions of the EU "(EC, 1999, p. 10).

The next breakthrough in the recognition was clearly the European Landscape Convention (ELC), adopted on 20 October 2000 by members of the Council of Europe. It became binding in 2007, where 27 countries obliged to acknowledge the importance of landscape protection, management and planning in their legislation, as well as to raise the public awareness of landscape issues and promote international cooperation. Importantly, the convention stressed that it should cover natural, rural, urban as well as peri-urban areas. Yet it also emphasized that, in addition to "outstanding" landscapes, other landscapes which might be thought of as being "ordinary" or even "degraded" should also be included as they are the outcome of human on landscapes.

As stressed in D'ejeant-Pons (2006) and Pedroli (2000) the ELC was the first international convention to focus specifically on the protection, management and planning of all landscapes in Europe. D'ejeant-Pons also stresses how the convention highlights the need to recognise landscape in law, to develop landscape policies, and to establish procedures for the participation of the general public and other stakeholders in the creation and implementation of landscape policies. And in this connection it is important to recognize the importance of including the landscape concept in promoting the consolidation of the European identity.

The advent of territory within Cohesion Policy

The introduction of the concept of Territorial Cohesion indicates another important milestone in the EUs understanding on the importance of land, environment and spatial planning. As summarized by Böhme and Gløersen (2011) "Territorial cohesion is about achieving balanced development, focusing on European solidarity, and stressing inclusive growth, fair access to infrastructure and services, and reduction of economic disparities". As further emphasized a key element is the strengthening the use of development potential outside what used to be the previously targeted territorial entities, namely the main growth poles. This should be done in order to ensure a minimum of welfare provision in all regions as the previous assumption of growth poles automatically being the "locomotives" that would pull other regions ahead.

The reasoning behind this shift in focus is the perception that all territories are endowed with their own unique set of potentials for further development – defined as the specific "territorial capital or comparative advantages. It emphasizes how every region and local area is endowed with territorial capital, but it is mainly a question of making "other types of resources available to territories to activate their potentials and respond to deficiencies". In this context the question of equal and fair regional development opportunities needs to be supported by fair access to common goods such as infrastructure and services. A development prerogative is therefore a situation where all parts of a territory should be provided with access to certain standards of services depending on territorial context.

In this regard, and backtracking slightly, UNCSD Rio 1992-Agenda 21 emphasized the importance of understanding (and embracing) the diversity and complexity of land use functions: "By examining all uses of land in an integrated manner, it makes it possible to minimize conflicts, to make the most efficient trade-offs and to link social and economic development with environmental protection and enhancement, thus helping to achieve the objectives of sustainable development".

As such, the focus on territorial development – and thereby on inclusiveness of land management in territorial cohesion – represents the core interest of the action emphasized by UNCSD, in addition to drawing the attention to the role of valuable natural ecosystems, environmentally sensitive areas, cultural landscapes, monuments and historical sites are endangered by pollution, floods, droughts, erosion, fires, earthquakes and landslides, but also where economic development is excluding – or neglecting – the role of territory and landscapes. In follow-up discussions such as O'Rourke (2008) it is emphasized how land use planning is synergistic in that it informs the policy-making and legal structure of comprehensive land use planning (O'Rourke, 2008)

The future of land use planning and smart growth in the above described context is recognized as being "tied to comprehensive landscape planning in concert with economic development and socio-economic equity planning" (O'Rourke, 2008). This force to some extend planning of communities to include landscape planners in order to provide a scientific rationale for smart growth that encompasses the environmental as well as cultural quality goals, and to recognize that cultural landscapes are the visible result of history on the territory interacting with present activities, and therefore an utmost important topic. Not the least in Europe.

Europe 2020 Strategy and beyond – stalled progression of land management in EU policy?

In the midst of the economic crisis, the Europe 2020 Strategy (EU2020S) (EC, 2010c) set important goals for European development, which have been suggested and translated into national targets in order to let each Member State check its own progress towards these goals. The following list includes the three overall priorities and five headline targets of the goals:

Priorities

- Smart growth: developing an economy based on knowledge and innovation
- Sustainable growth: promoting a more resource efficient, greener and more competitive economy
- Inclusive growth: fostering a high-employment economy delivering social and territorial cohesion

Targets

- Employment: 75% of the 20-64 year-olds to be employed

- R&D: 3% of the EU's GDP to be invested in Research and Development
- Climate change / energy greenhouse gas emissions: 20% (or even 30%, if the conditions are right) lower than 1990, 20% of energy from renewables, 20% increase in energy efficiency
- Education: Reducing school drop-out rates below 10% at least 40% of 30-34 year-olds completing third level education
- Poverty / social exclusion: at least 20 million fewer people in or at risk of poverty and social exclusion

Within the above priorities and targets it is clear that the land management perspective fits into two aspects: the notion of sustainable, resource efficient growth and achieving the 20/20/20 targets. However, when digging into the supporting thematic strategies and roadmaps, the elaboration of land management is still kept in a sector based perspective. For instance, the document 'A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy' makes reference to land use, but only in terms of how improved energy efficiency will ease pressure on land resources, and that land used to produce food will compete with land for producing energy and for acting as a carbon sink.

In the document, 'A Roadmap for moving to a competitive low carbon economy in 2050' an entire section is dedicated to the theme of 'Raising land use productivity sustainably', yet the converzation is almost exclusively about the relationship between land use and agricultural (and to a lesser extent forestry) productivity. For example, one excerpt from the report reads: "The dual challenges of global food security and action on climate change need to be pursued together. In order to cope with these increased land use requirements in the EU and on a global scale sustainable increases in the productivity delivered by diverse agricultural and forestry systems (both intensive and extensive) will need to continue at rapid pace. (…) Any negative impacts on other resources (e.g. water, soil and biodiversity) will need careful management."(EC, 2011b, p. 10) Interestingly, the report then says that all land uses need to be considered "…in a holistic manner and address Land Use, Land Use Change and Forestry (LULUCF) in EU climate policy" (p.10). The use of the term "holistic is as close as the document comes to discussing an integration of land use issues with European policy, and entirely absent from the discussion is the most crucial (and integrated) land use aspect – that of land take and urban sprawl and its combined effect on a variety of environmentally related issues (i.e. diverse effects of landscape fragmentation, energy efficiency in the building and transport sectors, loss of arable land, etc.)

Regarding the intersection between land management and agriculture, certain advances are proposed in relation to the most recent outline of CAP reform. According to the proposal the aim of the future CAP will be to guarantee European citizens healthy and quality food production, whilst preserving the environment. As such, three broad objectives of the future CAP are: "Viable food production, Sustainable management of natural resources and Balanced territorial development", which responds directly to the economic, environmental and

territorial balance challenges identified and which will guide the proposed changes to the CAP instruments. One of these instruments is the EC's proposition requiring that 30% of direct payments are spent specifically for the improved use of natural resources. Consequently, farmers would be obliged to fulfil certain criteria such as crop diversification, maintenance of permanent pasture, the preservation of environmental reservoirs and landscapes (EC, 2011b). Furthermore, issues such as the development of local infrastructure and local basic services in rural areas, not the least leisure and culture related activities, would be included.

Towards integration – the concept of land use multifunctionality

What is clearly evident is that even if a more integrated land use policy perspective has yet to materialize at the EU level, there is at least an understanding that land use planning must incorporate multiple functionalities to maximize efficiency and performance in a sustainable way. This is in contrast to the trend over the past 50 to 60 years, where development of urban, rural and peri-urban regions alike has led to spatial and functional segregations.

As such, land use strategies can emphasize multi-functionality as reflecting the land use in the future will have to serve, simultaneously and in integrated ways, a number of different functions either overlapping each other or in close proximity. It means that such functions should be employed in relation to analysis and policy proposals:

- Ecological (as an area for living organisms and natural environments)
- Economic (as an area for production and reproduction)
- Socio-cultural (as an area for cultural actions and identification)
- Historical (as an area for settlement, memory and identity) and
- Aesthetic (as an area for shaping and experiencing) (Haber, 1977)

The concept of territorial cohesion has to do with recognising the territorial diversity in Europe and the interaction of a complex system of functions as outlined above. And its implementation through policy measures involves endogenous development potentials and fragilities (the impact of developments in other territories, and the effects of different sector policies at various levels of decision making), as well as exogenous factors which importance needs to be recognized in the territorial context in its multifaceted dynamics.

The expression "multifunctional land use" refers to land which serves different functions by combining its variety of qualities, i.e. that different material, mental, and social processes in nature and society take place simultaneously in any given area and interact accordingly. It therefore means the co-existence of ecological, economic, cultural, historical, and aesthetic functions. Furthermore, even a single land use can involve numerous functions. Paracchini et al. (2011) therefore emphasizes that the concept of multifunctional land use provides a favourable approach based on the recognition of that in order to maximize the benefits ob-

tained from a given parcel of land, a more equitable balance of the competing economic, environmental and social demands on land is more sustainable in the long-term than an unbalanced system based on individual sector based rationale. In such a context there is, however, also a need for evaluation tools which allow a more sensible approach to the assessment of whether competing demands in a multifunctional land use system are sustainable or not. In particular, there is a need to integrate information and data from a wide variety of sources into a single evaluation framework, recognizing that different land uses can result in different functions, but not all functions can be expressed as land uses.

The problem in this connection is that the concept "land use" often is only related to the physical characteristics of the land cover and the main economic activities related to its use. This may have been correct when for instance agricultural used land was considered the main activity while for example, aesthetic, and recreational functions were secondary. Today, however, which was previous considered secondary activities have become dominant, for instance when aesthetic or recreational functions are defining what kind of land cover would be acceptable. Another example showing change in valuing without any land-use change is taking place could be the change in image and importance due to social re-interpretation when for instance a stretch of farm land is declared "green infrastructure", or part of a "Regional Park", even without any material land-use changes occurring.

The approach to "land use" should therefore not only be seen from the land cover perspective but also from the perspective of "functionality", which provides linkage with other transversal issues. "Functionality" could be a motivating approach in the integration of landscape, land cover, land use management, socio-economics, transportation, energy conservation, water management and climate change. While the concept of "land use" traditionally has been considered (to some extend) to be binary, i.e. one land use activity would exclude other activities, the situation in Europe is that the functionality of land areas has been increasingly diversified: on one hand towards exclusiveness with mono-functional large scale production, and on the other hand towards inclusiveness, which stresses the fact that different activities co-exists. In regards to the latter, policy and planning should develop methods where the question of harmonious and disharmonious functionalities could be a way of improving the planning process.

2.2.2. The concept of land management as approached by European level research and analyses

The European Spatial Planning Observation Network (ESPON) was launched as a programme jointly managed by the Member States and the European Commission in accordance with the work programme adopted at the meeting of spatial planning Ministers in Tampere, Finland, in 1999. The aim has from the start been to increase knowledge about territorial structures, trends and policy impacts in the enlarged European Union. As emphasized by Johannes Hahn,

EU Commissioner for Regional Policy commenting on the ESPON`s benefits to the EU: "ESPON provides the European Commission with a lot of information and studies dealing with territorial cooperation. This is exactly the benefit we have out of ESPON. The advantage of ESPON is that there are lot of member states participating not only from the European Union but also outside like Switzerland, Norway, Iceland and others. That's why we have a lot of data available for the European Union, for the European Commission. For instance the Fifth Cohesion Report is based on a lot of data given by ESPON" (Hanh, 2011).

Throughout the 1990s progress was achieved in advancing the role of spatial planning in Europe, culminated with the adoption of the European Spatial Development Perspective (ESDP) in Potsdam in 1999. Further details on this can be found in chapter 3.1.

The momentum unleashed the Study Programme for European Spatial Planning 2000-2001 (SPESP) providing the basis for ESPON. The programme served as a pilot phase in the preparation for a European network of institutes of spatial research aiming at analyzing current issues related to the ESDP. Inspired by this, the ESPON programme started in 2002 and was originally planned to continue until 2006.

As stressed in the first ESPON (2004) synthesis report, the ESPON programme was designed to improve European knowledge on trends and policy impacts affecting the enlarged European territory and through networking support a further development of a European research community in the field of territorial development and spatial planning. Much in line with the EU policy emphasis the ESPON studies were intended to address:

Factors relevant to securing a more polycentric Europe:

- Territorial indicators and typologies, capable of identifying and measuring development trends as well as monitoring the political aim of a better balanced and polycentric Europe
- Tools supporting diagnosis of principal structural difficulties, as well as potential
- Territorial impacts of European sectorial and structural policies, such as the Structural Funds
- Integrated methods to support balanced and polycentric spatial development, including spatial scenarios for 2015 and 2030

The integration of different concepts has been an important trademark for ESPON projects, and at the same time an indication of which concepts have been considered important in understanding territorial dynamics. In the ESPON 2006 Programme the typologies were mainly a tool for communicating different aspects of policies.

Emphasizing a transition from typologies as only descriptive, and towards them being an analytical tool, the ESPON typology compilation (Böhme et al. 2009) identified typologies is not an end in itself but rather a *tool* enabling meaningful analysis and comparison. As such it is stressed that typologies – at least

in the beginning – had to be of limited complexity in order to be used by other projects to assist the analysis of their own data and typologies. What is important, however, is that "complexity of the typologies will stepwise increase as the typologies are applied by various ESPON projects".

This evolution of typologies from descriptive to analytical, and from complex towards less complexity and eventually to higher level of complexity through application, is extremely important in this context. It illustrates the evolution of ESPON from being a provider of evidence base for policy development in conjunction with expansion of EU, to becoming a test bed for policy ideas, as well as the relevance and implications of new concepts. Especially in the latter case where the demands placed on policies are moving from "exclusive" and descriptive to be more "inclusive" and analytical. In this context exclusiveness relates to the extent the typologies try to focus on simple characteristics in order to prevent the risk of mixing different types of dynamics (natural, social, economic, cultural etc...) or actually include different dynamics. Here, the work of the EU-LUPA typologies clearly reflects an inclusive integration of multiple dynamics, thus in part attempting to reflect the importance of not just the land use multifunctionality concept, but more broadly, the important of combining concrete data on land cover/land use with measures of socio-economic performance.

The homogenous ESPON Typologies

The best way to assess the manner in which the European research community has taken up the concept of land use is through an analysis of the ESPON Typology Compilation, which started in March 2009. The compilation was tasked with compiling the existing territorial typologies and then to propose a set of eight territorial typologies to be used throughout the ESPON 2013 Programme. Following the Terms of Reference the fields to be addressed were:

- Urban / metropolitan regions – analysis of 8 typologies
- Rural regions – analysis of 18 typologies
- Sparsely populated regions – analysis of 4 typologies
- Regions in industrial transition – analysis of 1 typology
- Cross-border regions – analysis of 12 typologies
- Mountainous regions – analysis of 6 typologies
- Islands – analysis of 3 typologies, and
- Coastal regions – analysis of 4 typologies

A total of 56 existing typologies were identified and used as basis for a proposal for eight envisaged typologies. The project report concluded that it did not find any typology that could be proposed as ESPON typology for one of the eight thematic fields. And as a consequence, the authors had developed a proposal for the typologies, which were supposed to bring together elements from the 56 ty-

pologies, eventually leading to the composition of a coherent set of eight homogenous ESPON typologies.

After analyzing the 56 typologies, it was determined that typologies within six of the eight groups acknowledged the concepts of land use, land cover or landscape in one way or another. Highlights include:

Urban / metropolitan regions where the proposed typology is grounded in three different approaches to urban areas: functional, structural and morphologic. The only use of the concept of land use is in determining whether or not a selected "city" does display any urban land use characteristics, a situation which is of course being unlikely by the authors.

Rural areas which at 17 constitute the largest field of typologies addressed in the study. The authors of the compilation found that most of them did not catch the complexity of rural-urban settings, and while population density, accessibility / peripherality and land use are the most common features taken up, often only one or two of the factors are taken into account by any given typology.

For the authors' proposed "Rural regions" typology the defining typology should only include those regions not covered by the urban typology. And for further differentiation of these regions two dimensions should be used:

- Proximity to larger urban centres (e.g. areas within 45 minutes reach from urban centres).
- Importance of primary production to the overall regional economy (GVA branches A-B as a share of total GVA) and employment (employment in branches A-B as a share of total employment).

Four sub-categories in the typology are suggested: (a) rural areas close to urban centre without agrarian profile (b) rural areas close to urban centres with agrarian profile (c) remote rural area without agrarian profile (d) remote rural area with agrarian profile. It is clearly seen that these delineations have very limited reflection on rural characteristics beyond the economic categorizations registered through the industrial classifications. More importantly, they have absolutely no direct reference to the concept of land use.

Among the available typologies included in the analysis the Urban-rural typology by CURS/ESPON 1.1.2 was based on two dimensions (a) the degree of urban influence, which is defined on the basis of population density and the functional ranking of urban centres, and (b) the degree of human footprint, which is defined on the bases of land cover (the share of artificial surfaces and of agricultural land). However, besides the urban land cover category there was no other reference to land use / cover / scape.

The Draft Typology of Rural Development Environments, ESPON EDORA, is clearly the most elaborated typology. The following data sources are included in the decision tree:

- The Dijkstra and Poelman (2008) urban-rural codes
- The population trend typology (produced by Mats Johansson in the ESPON Programme 2008)

- Gross value added by sector – (the Eurostat REGIO Database)
- European size units data from the European Farm Structures Survey – (the Eurostat REGIO database)
- Farm holders with Other Gainful Activities (OGA) from the European Farm Structures Survey – (the Eurostat REGIO database).

The generated types were characterized as:

- Urban
- Depleting rural
- Primary sector dominated rural economy
  - with semi-subsistence agriculture
  - with pre-productivist agriculture
  - with para-productivist agriculture
- Fordist mixed rural economy with strong manufacturing sector
- New rural economy

However, even different types of rural activities are included there are still no elements of a consistent land-use and landscape approach available. Likewise, all other 14 analysed typologies in this category were – more or less similar to the above mentioned – basically determined by the two components: population density and distance to urban centres.

Sparsely populated regions where the defining indicator again relates to number of inhabitants per km^2 and with sub-categories (a) very sparsely populated, (b) sparsely populated, and (c) non-sparsely populated. In the typologies used for generation of the overarching type there are only references to population density and distance to urban centres: thus nothing explicitly considering Land use/cover/scape.

Mountainous regions with the defining indicator being the population share of mountainous LAU 2 regions (according to DG Regio Mountain Study) within a NUTS 3 region. In includes sub-categories of (a) Mountainous regions / population, (b) Predominately mountainous population, (c) Partly mountainous population, and (d) Non-mountainous regions / population. Similarly to the two previous typologies this has also no reflection of the land-use and landscape characteristics of these regions.

Coastal regions with the defining type being the share of the population living in coastal municipalities (LAU 2) within each coastal NUTS 3 region. It includes the subdivision of (a) Island regions, (b) Regions with a high share of coastal population, (c) Regions with a low share of coastal population, (d) Regions with a medium share of coastal population, and (e) Regions without any coastline. In the typologies used for generation of the overarching type there are only references to distances to the coastline.

Islands characterized by the share of islands population (in municipalities at least 1 km from the mainland) within a NUTS 3 region plus NUTS 2 and

3 regions which are islands, and with subtypes a) Island regions, (b) Regions with a high share of islands population, (c) Regions with a low share of islands population, and (d) Non-island regions. This typology is the only one where the typologies used for generation of the overarching type show direct reference to the landscape concept. In the ESPON Project EUROISLANDS (2003) the typology was aiming at determining differences and similarities among the 286 European islands (following the EUROSTAT definition of islands) based on variables considering: size, natural conditions and distance to mainland.

In the analysis the overarching framework worked with three themes: Economic efficiency, Social justice/equity, and Environmental conservation in the latter included a series of element encompassing:

- Availability and quality of drinking water
- Quality of sea water
- Air quality / Climate change
- Land quality
- Biodiversity
- Landscape quality
- Preservation of cultural capital
- Quality of urban space

In this context the land issues are directly taken up in terms of land quality and landscape quality, the latter of which is explained by the variables Construction beyond the designated urban areas and Artificialization of coastal zone (to specified use), while the former considers questions such as Desertification, Erosion, and first and foremost the question of Cultivation practices. Additionally, analysis of Biodiversity includes issues such as Change of land use, parcelling, cultivation practices and management plans of protected areas are included.

A general conclusion of the activities summarized in the study on ESPON Typology Compilation in 2009 reveal that out of the 56 projects generated within the ESPON community and selected for analysis only one made explicit reference to land concepts. Almost all others were related primarily towards urban development and population characteristics. Only very broad categories in relation to land and land use characteristics – rural, urban, islands, sparsely populated areas, mountains and coastal areas – were taken into consideration. The reality is that the key concepts included in the various typology compilations reflected the dominant discourse of EU development policy from the last 10-20 years which is described further in the ESPON LIVELAND project (2012).

2.2.3. Evolution into explicitly analyzing land use via typologies

Land surveys date back as far as 1086 when the Doomsday book was completed as a survey to determine who held what land and what associated tax liabilities under Edward the Confessor. Yet it was not until air photos were introduced as mapping tools in the late 1940s that scientists could begin monitoring land features with real images covering relatively large swaths of land. This technology "skyrocketed" in1972 with NASA's launch of the Landsat program and remote sensing became a land resource monitoring tool (Anderson et al., 1976).

In Europe, the crucial vehicle in the development of the land as an analytical component of research and policy has also been based on the advent of satellite imagery and remote sensing. The gathering and interpretation of satellite images was first proposed by the EC in the mid-1980s as a voluntary agreement to provide researchers and policy makers in multiple fields with an inventory of land cover based on satellite images (Bossard et al., 2000). The result has been the continued investment in the EEA managed Corine Land Cover (CLC) Program. This valuable resource has now been developed by the EEA for three time series' (1990, 2000 and 2006), with another expected in the coming few years. With pan-European coverage Corine (Co-ordination of Information on the Environment)makes a comparable analysis of land cover patterns and trends available to researchers and policy makers.

Yet keeping with the theme of typologies – which are defined as the classification of entities into types based on shared or common characteristics – it is imperative to comment on the manner in which the EEA makes CLC data available to the public. At the most basic level, data is provided as a downloadable raster image of Europe at 100 and 250 metre resolutions. But most important in this connection is the fact that with every raster cell is allocated a land cover classification value between 1 and 44 – corresponding to level 3 of the nomenclature of Corine land cover types. Further, these are then grouped in level 2 to 15 classifications, and to 5 classifications in level 1. The importance of the italicized words above – classification, value and groups[ed] – are to emphasize the manner in which the interpretation of satellite images into the CLC dataset already reflects a typology of land cover – a classification of satellite images based on the identification of shared or common characteristics. For instance characteristics such as the share of a 100 m area that is covered by buildings or land features that can be identified as different types of agricultural activity. However, what is notable in the nomenclature levels is how many of the names of many of the individual land cover types reflect on how the land is being used rather than on what is covering the land. This is a notable distinction that we will come back to.

Using the basic CLC data from 1990, 2000 and 2006 as a point of departure, the EEA has created a number of different typologies of land cover / use available to the public. As mentioned above, the idea is, in one way or another, to provide a simplified and descriptive interpretation of how land is covered or being used. For example, Figure 2.1showing a simple typology in relation to land cover based on the Corine land cover classification. In it, the 44 land cover classes have been merged and grouped into eight dominant land cover types as of the year 2000.

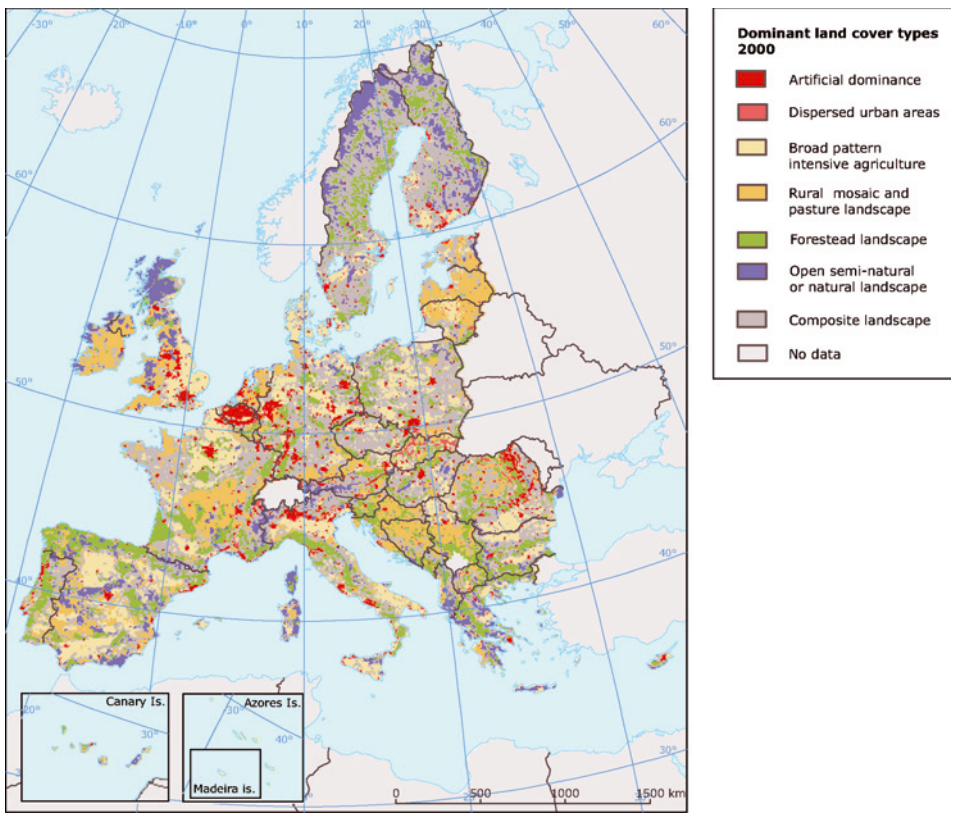


Figure 2.1. Dominant land cover types, based on CLC data from 2000.
Source: EEA (http://www.eea.europa.eu/data-and-maps/figures/dominant-landscape-types of europe-based-on-corine-land-cover-2000-1).

One potential role for such an analysis is to make links between land use/cover changes and environmental impacts. Here, the concept of 'dominant' landscape types has been introduced, where 'Dominant' reflects that a landscape type comprises one or more land cover types, which share more than the European

average plus the standard deviation of this particular land cover type. For example, a landscape type with a dominant agricultural character has to comprise more than 65% of cropland because the European average share of cropland is 33% and the European based standard deviation of this is 32%, which combined adds up to 65%. It should be noted that for urban land and grassland this dominance threshold is well below 50% so that in model cells that are dominated by either of these two land cover types, the cells may well be dominated by more than one land cover class. This however, reflects the nature of urban spaces – areas where a number of different land uses are combined in proximity to each other i.e. housing, roads, green space, etc.

Perhaps the most important contribution CLC data has made to the analysis of land cover and land use patterns has come with the advent of multiple time series. As such the 1990, 2000 and 2006 releases of Corine not only allow for the analysis of land changes, but also the extent with which these changes have hastened or slowed.

However, due to vast number of potential Corine land cover changes (where any one of the 44 land cover classes could, in principle, change into any one of the other 43 classes, thus creating 1892 possible one-to-one changes) a typology of land cover change accounts was needed to characterise these changes according to major land use processes. In doing so, the Land Cover Flow (LCF) dataset (available for the 1990-2000 dataset and provisionally for the 2000-2006 dataset) provides a quick and, more importantly, operational summary of the land change processes taking place in Europe. This was completed using a rather straightforward methodology, where all potential changes were identified using a flat matrix and then grouped according to feasibility studies and expert opinion. As a simple example, LCF2 Urban Residential Sprawl – Land uptake by residential buildings altogether with associated urban infrastructure from non-urban land – accounts for any land change from a non-artificial surface land cover type to continuous or discontinuous urban fabric. This alone accounts for any one of 66 potential land cover changes possible in the 44 x 44 matrix. Similar to the three-level classification structure of CLC types, the nomenclature of LCF's is organized on three levels: beginning with 50 individual LCF's, followed by 38, and at the most general level, 9 separate land cover flows.

Thus, we see above that the Corine project yields a vast number of land cover/land use classifications – each one of them an explicit land typology in their own right. In addition to land cover and changes (also synthesized through the aforementioned Dominant Landscape Type and Land Cover Flows) an inventory of the EEA website shows that they also provide access to various other land typologies with European coverage; many of which are based exclusively on Corine land cover data. These include:

- CDDA – known as the Common Database on Designated Areas it is an account of all nationally designated areas in Europe.
- Natura 2000 – a simple characterization of land showing the extent of Europe's ecological network of protected areas. It represents the areas of Europe

that are protected to ensure the survival of Europe's most valuable species and habitats. It is based on the 1979 Birds Directive and the 1992 Habitats Directive.

- Urban morphological zones and changes – entailing a 60-step methodology in ArcGIS, the UMZ project serves to determine the land comprising urban areas. In the simplest terms, the complex model it brings together all agglomerates all "urban areas" lying less than 200 m apart to distinguish the immediate "urban tissue of cities". It therefore can be said to pre-present the urban spaces of cities in Europe.
- Degree of soil sealing – raster data set of built-up and non-built-up areas including continuous degree of soil sealing ranging from 0 – 100% in aggregated spatial resolution (100 x 100 m).
- CORILIS – based on CORine and LISsage (smoothing in French), it is a method for providing land cover data generalization and analysis. In short, it uses a technique of aggregation to "intensities" or "potentials". In other words, for any given parcel of land (in this case 5 km^2) it provides the probability of any given CLC type accounting for any point of land in the parcel. Similar to the CLC nomenclature, it also has a three level nomenclature to allow for grouping of land cover based on various themes. One example of this is the Green Potential Background, which groups all of the green classes (i.e. not artificial surfaces or intensive agriculture)by simple addition to provide a reference of green areas in Europe.
- NATURILIS – Application of the CORILIS methodology using geospatial data that combines NATURA 2000 and CDDA to show the probability (thus intensity and potential) of protected land in a given area.

Two general conclusions come to the fore after a brief overview of land data and associated typologies provided by the EEA. First, it is abundantly clear that the information they provide centres on two thematic poles: the focus on measuring urban areas and their growth on one hand, and the location (and connection) of landscapes of environmental importance on the other. In principle, neither of these themes should come as a surprise; not least based on the fact that the EEA is exactly that, an environmental agency serving to promote the mutual benefits of environmental protection. But in addition to that, it also reflects that the issue of land use management is ultimately almost as simple as that: socio-economic growth (or the notion of development in general) must take place while limiting the amount of land that is consumed by particularly unnatural functions – particularly those that limit or, more often, completely eliminate the natural functions the land itself can provide. And with the understanding that eliminating land take is not possible, we must strengthen the environmental functions of landscapes that we can set from the possibility of urban development.

In many regards, the data available from the EEA serves as an unprecedented basis for accounting for land patterns in Europe. But with the fact that land is always going to be a factor in the discussion of achieving socio-economic prosperity, one missing element is a more comprehensive analysis of land use patterns that directly account for socio-economic changes taking place on the land itself. Or perhaps more accurately, a comprehensive analysis of the land uses patterns that occur as a resultof socio-economic changes.

A key shortcoming in this connection is abundantly clear: all of the land typologies presented above are raster-based, grid-level geo-spatial information that is independent of administrative bonds, while socio-economic data is, by nature, organized and measured via the multi-level administrative scales with which it is kept: be it the neighbourhood, municipal, regional or national level. As mentioned, this is a fundamental rationale for the EU-LUPA project – the opportunity to at least investigate the potential of connect these different forms of data to determine the performance and efficiency with which regions are able to grow while having as low an impact on the landscape as possible.

As we will see in the next section, the performance of Europe in terms of managing land take at least calls into question whether or not a lack of regionalized land accounts (into administrative bonds) has served to simultaneously restrict accountability and promote overconsumption. As also shown in previous sections, the fact that policy has also largely kept the land management theme implicit (rather than as an explicit and integrated reference across sector based policy) would appear to affirm such a belief.

2.2.4. Key highlights of information provided by the EEA

Bearing in mind that the most recent release of land cover data came from the EEA in 2006, their 2010 set of State and Outlook report on land use provides the most relevant overview of land consumption trends in Europe. The report is part of the series of 13 thematic assessments collectively titled: The European Environment: state and outlook 2010 (SOER) (EEA, 2010a), which includes a parallel series of country specific reports for each theme. In a pan-European perspective, the land use report contains a number of relevant observations based on a synopsis of the aforementioned land data provided by the EEA. With respect to the EU-LUPA project, the highlights of the report not only provide a general overview of land patterns occurring in Europe, but in doing so it serves as a formidable basis for undertaking the work. Therefore highlights from the reports should be commented on:

- For the 36 countries measured, 1.3% of the total land stock underwent change (68,353 km^2 of 5.42 million km^2) between 2000 and 2006. While this is a decrease compared the 1990s, significant national difference were notable.
- New agriculture activities 2000-2006 required an additional 5,410 km^2 of land in 2000-2006, but this was offset by a loss of 8,326 km^{2}of agricultural

land due to land abandonment, urban sprawl and afforestation. This quite clearly reflects the importance of CAP policies for supporting existing agricultural activities, not only in to promote food production, but also as a driver to curb unnecessary land take.

- Artificial surfaces – as the physical representation of urbanization – increased most in terms of percentage change from 2000-2006 (3.4%) and the rate of change increased compared to the 1990-2000 period. As expected, this came at the expense of a decrease of other main land types, particularly "arable land and permanent crops" (-0.2%) and "pastures and agricultural mosaics". This delineation is notable because it likely reflects the fact that agricultural mosaics of peri-urban landscapes generally characterized by intensive agriculture and horticulture on smaller land parcels due to increased property values caused by proximity to urban centres are most susceptible to land take from urban sprawl.
- In terms of artificial surface development, it is notable that while conversions for residential purposes decelerated compared to 1900-2000 there was an increase in conversions for economic sites and infrastructures. In fact, during 2000-2006 the growth was comparably more than twice the residential urban growth rate.
- Considering that latter are two aspects of land consumption that are certainly a finding worthy of more detailed investigation as they can generally be managed by coordinated planning efforts, and at the same time often the result of investment via European Policy schemes. In short, how can an increase in the rate of development of economic sites and infrastructures (representative of economic development) compared to a deceleration of residential areas (representative of social development) be sustainable from either a societal or an environmental perspective?
- The notable extension of economic sites and infrastructures reflects that development initiatives in Europe are using infrastructure and non-residential building development as engines (rather than effects) of growth. This seems to reflect that development as still driven by invasive infrastructure development such as expansive, sprawl inducing, fragmenting and polluting, while the potential to concentrate development in existing, underused areas that would "fill-in" and integrate European cities is still not being harnessed.
- Related to the notion of sprawl above which is both extremely troubling and indicative, the growth of urban areas is still taking place at a faster rate that population development. Consequently, the average population density of European cities continues to decrease, even though some cities have managed to accommodate growth by increasing population density.

- The impact of urbanization depends on both the amount and the intensity of land taken. For example, soil sealing within the Urban Morphological Zones (UMZ) of European capitals varies between 23% and 78%, with Eastern and southern cities tending to have more sealed surfaces than Northern and Western cities. Again, this emphasizes the importance of brown-field development *vis-à-vis* continued, unnecessary land take. Unfortunately CLC analysis appears showing that from 2000-2006, the land cover flow "Urban land management" (i.e. all internal conversions of existing artificial surfaces) was only 18.2% of total land take in Europe, and was below 10% in 17 Member States.
- In saying that the drivers of urban sprawl go well beyond being a direct consequence of an urbanizing population in Europe, the EEA emphasizes that the many drivers interact with each other in diverse and unique ways, thus making it difficult to pinpoint clear correlations between individual drivers and urban sprawl. With that being said, they highlighted some of the main drivers:

  a) Socio-economic drivers
  - Population growth coupled with declining household size
  - Preferences relating to quality of life and perceptions of inner-city safety and comfort
  - Economic growth providing rising livings standards as well as price of land
  - Relatively cheap energy for housing and transport
  - Availability of roads and increased car ownership

  b) Governance, planning and policy related drivers
  - Weak land use planning
  - Uncoordinated public subsidies for home ownership
  - Poor enforcement of existing plans
  - Competition between municipalities including lack of coordinated regional plans, both in design and implementation
  - Poor public transport
- In terms of outcomes, the reports reiterate an expectation that many of the same patterns will continue to take place in the coming decade. This will primarily be caused by the demand for more living space per inhabitant and improved transport infrastructure. Therefore, unless mitigated, urban sprawl will continue to be the trend. In this regard the role of creating high quality urban spaces (providing parallel functions catering to the live-work-play mentality) out of existing urban areas continues to be an unrealized potential in many European regions.

2.3. Shifting economies in Europe: distinguishing between land use and land cover

Up to this point, terms such as land cover, land use, landscape and, collectively, land management have been used more or less interchangeably, which is a common approach in the field of study. For instance, the EC's website[1] states how, "CLC describes land cover (and partly land use)according to a nomenclature of 44 classes organized hierarchically in three levels." Even though this indicates the difficulty in separating the meanings of the terms, it is crucial for beginning to acknowledge the importance of emphasizing the potentially multiple functions of single parcels of land. In a rural perspective, regions are being continually constrained by opportunities for economic growth and the aforementioned notion of multifunctional land use allows for an understanding of how being able to conceive of multiple land uses can provide growth opportunities. Land cover does not provide this opportunity. For urban regions, a well-known driver of sustainability is to promote mixed land uses rather than segregated spaces of society, economy and mobility.

Land cover is a term that reflects the bio-physical nature of the land surface. To determine the land cover is simply to ask one's self what is seen when looking to the ground. In its absolute sense it is therefore void of human perception and is placed in zero-sum terms. Examples of land cover could be given in relational terms (i.e. natural or non-natural) or in absolute terms (i.e. grassland or bare rock).

In contrast, a *land use* describes the manner in which the land is perceived by humans or consumed through human activities. For example, references to recreational, preserved or waste land are often legal entities but also speak to the human perception or valuation of land. Yet, describing land use also relates to describing the nature of human activities that use, exploit and consume land. For example, agriculture, industrial land, transport areas, pastures, agro-forestry, plantations and irrigated land all relate directly to the use of land in space. Here, human intervention does not operate in zero-sum terms and allows for the inclusion of multiple functions on a given piece of land. Again, we often hear the term mixed land use within planning policy as a way of describing the conditions and benefits of over-lapping land uses.

Perhaps acting as a bridge between notions of land cover and land use, and the connection of both to the environment, the European Landscape Convention defines landscape as "an area, as perceived by people, whose character is

[1] http://ec.europa.eu/agriculture/publi/landscape/about.htm

the result of the action and interaction of natural and/or human factors". It recognizes that landscape "constitutes a resource favourable to economic activity and whose protection, management and planning can contribute to job creation" and responds "to the public's wish to enjoy high quality landscapes and to play an active part in their development". Important in this context is to emphasize how the definition of landscape used by the ELC and the definition of territory used by EU regional policy come very close. It is therefore embedded in European concepts of landscape that, as people, we do not simply live in a physical reality of areas or territory but mainly in our perception of such areas: in landscapes (Moore and Whelan, 2007). Landscape includes the physical and the mental, the natural and the cultural (COE, 2003). As such it is a common good that visibly and invisibly frames everyday lives. For their health and wellbeing people need both, a suitable environment, and a liveable landscape.

In the discussion of characteristics and changes in relation to land use a very common approach is to draw a direct connection between land cover and land use. This infers a direct implication of land cover on the way that land is used. An example of this approach, as done by Lambin et al. (2003, p. 216) defines land use as "the purpose for which humans exploit the land cover". The key element in this connection is *vegetation* as a productive resource, which implies that CLC classes show information related to vegetation as a basis for production.

Historically, there have been many reasons for choosing such an approach to defining land use. First and foremost, it enables an analysis based on what is immediately visible through the land cover, which in turn provides a rather direct connection between land cover information and economic activities (at least to the extent that land cover actually reflects such a relationship). This however, has been the situation in predominantly agrarian societies, just as in societies where forestry and other direct land cover uses provide the main economic activities.

Typically this approach is very common in relation to discussions in relation to developing countries where these types of direct connections between economic activities typify the mainstay of both society and economy, see for instance Lepers et al. (2002), Turner et al. (2007), and more recently in a global scale by Lambin (2010). Similarly, a tradition has developed in relation to developed countries emphasizing the historical use of land as a background for understanding the present characteristics of rural areas. This has been documented in a European setting by Dovring (1960) and followed up recently by Reenberg (2009) among others.

However, the parallel increase of urbanization and the development of non-land-based production (e.g. the service, financial sectors as well as many high-tech industrial developments) have significantly constrained the validity of such an assumed synergy between land use and land cover. As a result new territorial-based logics beyond land cover now have the predominant role in determining how land is used. Thus, some of the most important elements are now what characterizes land use in already built-up areas, connectedness through proximity

to other cities, settlements and linking infrastructure, as well as increased demands for ownership, leisure and recreation.

The increased pressure to balance growth with environmental protection has also increased the divergence between the land use and land cover. For instance, there is increased demand for the production of energy from the landscape, which can involve significant sectorialtransitionsin terms of land uses while land cover often remains the same. In parallel, the role of improving land efficiency through increasing the functions that we can obtain from our land is also accentuated. These issues point to a major problem in this connection; namely that to base any land use analysis only on the Lambin et al. (2003), definition of "the purpose for which humans exploit the land cover" is insufficient. By doing so it leaves out what tends to be an increasing part – if not the determining part – of what characterizes the use of the land resources in our current socio-economic setting.

2.3.1. Deciphering land cover and land use using Corine data

While the land cover land use distinction above is straightforward, the use of Corine land cover data adds a layer of complexity. This is due to the fact that the diverse value of the resource – for economists, engineers, biologists, geographers and planners – means that the nomenclature has to balance the diverse interests of these users. By the EEA's own accord this has limited the ability for CLC nomenclature to strictly reflect land cover without introducing human usage into the nomenclature: "(…) However, it should be emphasized that due to the physiographic nature of CLC classes, and to a limited extent the functional distinctions that are introduced in the nomenclature it is hardly imaginable to fully match the CLC nomenclature starting from an automated classification procedure, without additional human interpretation work." (Bossard et al., 2000, p. 6)

The unavoidable consequence is that even though CLC data is often assumed to provide an 'objective' characterization of land cover, this actually isn't the case. Rather, human-related aspects (pertaining to human intervention on land) are used in conjunction with bio-physical (non-human) perspectives. In fact, in a majority of the 44 classes human interventions and perceptions are explicitly used to define land cover. For example, the class 'Agricultural areas' says very little about the bio-physical nature of the land surface, but says a great deal about planned or perceived *use* of the land. The Artificial surfaces class is also broken down to an entirely human perspective on use of land, which includes: Port Areas, Airports, Construction Sites, etc. This trend is taken a step even further with the EEA's production of Land cover flow data. By including flow types such as Urban Land Management, Urban Residential Sprawl and Withdrawal of Farming the classification is almost entirely based on a the above notion of land use rather than land cover.

2.3.2. Responding to limitations in the traditional analysis

Traditional approaches to land use do not sufficiently go beyond the uni-dimensional linkage between the "uses" of land only for production. As such, land cover is directly part of one type of production, and this disregards the fact that land is actually an important part of many human activities. Energy production via windmills is one example – it requires land for the situation of the tower and turbine, but its presence has an impact on the surrounding area in terms of human visibility, noise, danger to animals, etc. As such, other land activities such as hiking or other forms of recreation that could take place within proximity to the windmill are affected. Further, the "consumption" of land through these more discreet landscape qualities represents another way of perceiving land use characteristics; however they do not have a specific link to production activities and therefore cannot be appropriately recognized through such a uni-dimensional approach.

In order to overcome some of the major problems in the traditional approach to defining land use characteristics, at least four types of linkages would need to be emphasized and considered in connection with the definition of land use categories:

- *The use of land as ameans of production:* This group of activities is similar to the definition by Lambin et al. (2007), where qualities of the land itself becomes an important contributor in connection with questions regarding to land intensity and value.
- *The use of land as locus standii for production purposes:* This includes activities that are localized, but not necessarily directly linked to a "consumption" of the qualities and productive forces of the land itself. Instead, qualities such as the questions of accessibility, proximity, water, sewage disposal, etc. are important issues. In the case of windmills mentioned above several of these issues are at stake.

Another example is evident with the CLC class Artificial surfaces, which is subdivided in classes where specific functional qualities have been used in determining the class qualities. However, while those activities connected to urbanized activities are directly reflected, while many other activities are still missing.

- *The use of land as a means of recreation:* This group includes land areas where the consumption of land areas is important in relation to recreational purposes. Here, recreational purposes are seen in a dual perspective, both in terms of environmental functions for recreation in the current society but also in terms of recreating (preserving) the environment for future development. In this connection a number of sub-groups could include:

– *Reproduction directly connected to socio-economic growth:* This group includes housing, recreational parks, amusement parks, sports facilities not only in near-urban areas, but also including summerhouses and second homes in rural areas. As such, a key issue in this connection is the transformation of areas into land cover characteristics defined by human activities or perceptions. Some of these activities are already included in the CLC classification Sports and Leisure Facilities, but this could be extended to rural areas in order to reflect, for instance, environmental protection. Protected areas are not included as a CLC class, but new types of protection are being implemented that were not foreseen when existing CLC classifications were decided.

2.3.3. The Land use concept in the EU-LUPA project

It is now clear that even though a CLC-prescribed notion of land cover can be used to infer land use such an approach leaves room for improvement for meeting the multiple elements of a comprehensive and up-to-date definition of land use. This would be a notion that simultaneously reflects direct and indirect uses, mono- and multi-functional uses, and especially, its contribution to socio-economic production which is not explicitly related to the consumption of land.

In fact, one may argue in line with Verburg et al. (2008) that the term land functions would be a more suitable concept when referring to the goods and services provided by the land systems. Their view is that land functions "not only include the provision of goods and services related to the intended land use (e.g. production services such as food and wood production), but also include landscape goods and services such as the provision of aesthetic beauty, cultural heritage and preservation of biodiversity that are often unintended by the owner of the land.

The concept of land use intensity is introduced into the EU-LUPA project to acknowledge and respond to the understanding that while socio-economic growth is less and less attributed to land-based production; it is an ever-increasing driver of land changes. Seen from this perspective, it is not only important to know how much land is changing, but it is crucial to know if land changes reflect minor changes (which usually reflect on-going socio-economic processes) or if they reflect major shifts in land cover (which are often part and parcel with structural socio-economic changes or environmental impacts). Furthermore, it is important to consider that increased human landscape intervention is among the strongest pressures on biodiversity (Environment Council, 2010), that maximizing land use efficiency is a direct means of improving the sustainability of land use in general.

This aim is in direct relation to a key question of the project; namely, how and to what extent land cover changes interact with on-going changes in the ways the landis *used* for socio-economic purposes. This in turn raises questions of how

the typologies in the EU-LUPA project can reflect on both the physical characteristics of land patterns and the socio-economic dynamics of land use that are behind these changes.

In light of this, land use intensity is defined as: the degree of human intervention caused by activities taking place on a given parcel of land - activities that, in most cases, do not have a direct and one-to-one implication on the characteristics of land cover. Therefore, the intensity is not related to the amount of input used – a driver that usually leads to an increase of production from a piece of land (cf. Gabrielsen, 2005). As described at length above, such a characterization would be reminiscent of what we are trying to avoid – land use characterization that is preferential the inputs and outputs of land-based production. But at the same time, land use intensity is not only related to the per capita use of artificial surfaces, for this is also too narrow a concept which tells more about the efficiency of land use than is does about intensity (cf. Prokop et al., 2011).

In contrast, the quantitative assessment of land use intensity is created based on the inference that the ordering of the CLC classes – from CLC 34 – Glaciers and Perpetual Snow to CLC 1 – Continuous urban fabric – are representative of an increasing land use intensity. Listed below, the ordering is based on a conservative set of guidelines, rationales and assumptions:

- CLC classes between 35 and 44 (Wetlands or Water bodies) have not been considered due to uncertainty over the associated socio-economic activities taking place on these land cover types.
- In total, seven intensity scales have been generated – three levels in the Artificial surfaces class and two classes in both the Agricultural areas and Forest and Semi Natural Areas classes.
- For Artificial surfaces, Continuous urban fabric is the most intensive land cover type because it represents urban cores and centres of sub-urban areas where over 80% of the land is impervious (Bossard et al., 2000). Likewise, these are areas that are known to support a majority of economic activity in Europe, as well as being the home to a high share of the European population.
- CLC classes 3-9 (Industrial, Commercial and Transport Units or Mine, Dump and Construction Sites) are ranked in second place because they classify land that is highly manipulated and related directly to meeting the needs of socio-economic production.
- CLC classes 2 and 10-11 represent the third most intensive urban type. Class 2 – Discontinuous urban fabric – accounts for land that is between 20% and 70% sealed (Bossard et al., 2000). It therefore represents transitional, suburban, peri-urban areas where the intensity of human intervention is reduced relative to Continuous urban fabric. Green urban areas and Sports and leisure facilities are also included in this group due to their proximity to urban areas, and thus heightened contribution to social functions.

- Agricultural classes are mostly grouped together due to the fact it is difficult to differentiate agricultural intensities because regional topographical, territorial, cadastral and economic (land value) conditions are such strong drivers determining agricultural land structure (see Gabrielsen, 2005). The only distinction that has been made within the 11 agricultural classes is where the land classes in the group's Arable land and Permanent crops are allocated an intensity score of 4 and Pastures and Heterogeneous Agricultural areas are given a score of 5. The former group is indicative of agricultural areas that are strictly dedicated to food production through cropping. In agricultural terms this is characterized as an intensive activity demanding high inputs, especially fertilizer, water, labour and management (Gabrielsen, 2005). In contrast, pastures dominate area in the latter group, which is and is an activity characterized as being relatively low-input (Gabrielsen, 2005). Agricultural areas with significant areas of natural vegetation and Agro-forestry areas are also included in the latter group.
- Forest and Semi-natural Areas classes are broken down into two groups, with CLC classes 23-25 and 29 having a score of 6 and the remainder having a score of seven. The reason for prioritizing the first group is their representation of an economic production dynamic in the forest sector; where harvested forest areas are classified as Transitional Woodland-shrub. The remaining classes encompass landscapes either covered by vegetation without a specific production potential or by little or no vegetation as all. In turn, they are essentially natural landscapes with minimal prospects for substantial human intervention.

To assess land changes in terms of intensification or extensification of land use, all land changes are accounted based on the consumption intensity score (what the land changes from) and the formation intensity score (what the land changes to). By subtracting the formation intensity score from the consumption intensity score the intensity score of each land change is determined. For example, a change from Natural Grassland (CLC class: 26, intensity score: 7) to an Airport (CLC class 6, intensity score 2) is an intensification of five. Likewise, a change from Pastures (CLC class 18, intensity score: 5) to Natural Grassland (CLC class 26, intensity score 7) is and extensification of negative 2. Thus, it provides an indication of how land change processes reflect the magnitude of human intervention on the landscape; or in other words, how intensively the land is being used.

Table 2.1. Ranking of CLC classes based on Land Use Intensity.

GRID CODE	CLC CODE	LABEL1	LABEL2	LABEL3	Intensity Code
1	111	Artificial surfaces	Urban fabric	Continuous urban fabric	1
2	112	Artificial surfaces	Urban fabric	Discontinuous urban fabric	3
3	121	Artificial surfaces	Industrial, commercial and transport units	Industrial or commercial units	2
4	122	Artificial surfaces	Industrial, commercial and transport units	Road and rail networks and associated land	2
5	123	Artificial surfaces	Industrial, commercial and transport units	Port areas	2
6	124	Artificial surfaces	Industrial, commercial and transport units	Airports	2
7	125	Artificial surfaces	Mine, dump and construction sites	Mineral extraction sites	2
8	126	Artificial surfaces	Mine, dump and construction sites	Dump sites	2
9	127	Artificial surfaces	Mine, dump and construction sites	Construction sites	2
10	141	Artificial surfaces	Artificial, non-agricultural vegetated areas	Green urban areas	3
11	142	Artificial surfaces	Artificial, non-agricultural vegetated areas	Sport and leisure facilities	3
12	211	Agricultural areas	Arable land	Non-irrigated arable land	4
13	212	Agricultural areas	Arable land	Permanently irrigated land	4
14	213	Agricultural areas	Arable land	Rice fields	4
15	221	Agricultural areas	Permanent crops	Vineyards	4
16	222	Agricultural areas	Permanent crops	Fruit trees and berry plantations	4
17	223	Agricultural areas	Permanent crops	Olive groves	4
18	231	Agricultural areas	Pastures	Pastures	5
19	241	Agricultural areas	Heterogeneous agricultural areas	Annual crops associated with permanent crops	5
20	242	Agricultural areas	Heterogeneous agricultural areas	Complex cultivation patterns	5
21	243	Agricultural areas	Heterogeneous agricultural areas	Land principally occupied by agriculture, with significant areas of natural vegetation	5
22	244	Agricultural areas	Heterogeneous agricultural areas	Agro-forestry areas	5
23	311	Forest and semi natural areas	Forests	Broad-leaved forest	6
24	312	Forest and semi natural areas	Forests	Coniferous forest	6
25	313	Forest and semi natural areas	Forests	Mixed forest	6
26	321	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Natural grasslands	7
27	322	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Moors and heathland	7
28	323	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Sclerophyllous vegetation	7
29	324	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Transitional woodland-shrub	6
30	331	Forest and semi natural areas	Open spaces with little or no vegetation	Beaches, dunes, sands	7
31	332	Forest and semi natural areas	Open spaces with little or no vegetation	Bare rocks	7
32	333	Forest and semi natural areas	Open spaces with little or no vegetation	Sparsely vegetated areas	7
33	334	Forest and semi natural areas	Open spaces with little or no vegetation	Burnt areas	7
34	335	Forest and semi natural areas	Open spaces with little or no vegetation	Glaciers and perpetual snow	7
35	411	Wetlands	Inland wetlands	Inland marshes	N/A
36	412	Wetlands	Inland wetlands	Peat bogs	N/A
37	421	Wetlands	Maritime wetlands	Salt marshes	N/A
38	422	Wetlands	Maritime wetlands	Salines	N/A
39	423	Wetlands	Maritime wetlands	Intertidal flats	N/A
40	511	Water bodies	Inland waters	Water courses	N/A
41	512	Water bodies	Inland waters	Water bodies	N/A
42	521	Water bodies	Marine waters	Coastal lagoons	N/A
43	522	Water bodies	Marine waters	Estuaries	N/A
44	523	Water bodies	Marine waters	Sea and ocean	N/A

2.4. Validation of the intensity concept

While this relatively simplified approach may be criticized for being too simplistic (See for instance: Lambin, et al., 2000), the structure of the CLC as an overall hierarchy showed tendencies towards the intensity interpretation during a validation exercise carried out during the project. This exercise used indicators to infer the value of land in relation to the range of socio-economic activities it provides, especially those which are not related to land-based production. Two indicators that best serve this purpose are population density and gross domestic product (GDP).

For the former, the presence of greater concentrations of people is quite clearly indicative of higher land use intensity; not least through the development of artificial surfaces in order for people to establish their everyday lives and routines in space. As mentioned, the desire for increased living and recreation space reiterates that increased population in a given area creates more intensive land use – which through the creation of impervious surfaces reflects the complete manipulation of land, issues that are discussed in relation to urbanization by Stankowski and Trenton (1972) and Kasanko, et al. (2006) in two different historical contexts, and in relation to environment and "naturalness" by Renetzeder et al. (2010).

An underlying problem in relation to population density being an optimal indicator of social intensity is that individuals are only registered in one location, usually characterized as their primary place of residence. But for most people their activities are not only related to the land in and around this place; for instance, suburb residents within commuting distance to larger towns or cities who have their daily activities tied to different places. And a similar problem exists in connection with vacations, visits to parks where several locations are involved, and not the least in connection with second homes where space for residence is allocated in more than one place, but registration only done in one.

GDP is also a good indication of land use intensity because of the safe assumption that increasing economic output is equal to situations of greater land intervention (See for instance: Krausmann et al., 2004). This is not only placed in terms of land-based production but also incorporates the role of urban areas as areas of relatively high economic output. However, one of the problems in relation to GDP being a perfect indicator of intensity is that economic outcome of the land use activities may not always be registered where the economic activity takes place. For instance, the registration of the economic outcome of production from a factory may depend on whether it is registered where the production takes place, where the workforce is living, or where the central office of the factory is situated. Similarly, the energy outcome of a windmill may be registered where it is situated or where the owner of the mill is residing.

In many cases population density and GDP indicators can be considered as measures basically showing the same issue – intensity of human activities. There is, however, an important potential territorial distinction between them: While population density shows a continuous presence of humans involved in the use of the land either for production or reproduction related activities, the GDP indicates human exploitation of land which does not necessarily require such a continuous presence, or showing that even a low level of population density may result in an intensive use of the land. This is for instance shown in rural areas where high levels of GDP are maintained in situations with declining population because a continuous intensification in land use is taking place through the replacement of manpower by technology. Accordingly, it is valuable to utilize both indicators in this validation exercise as they show two important aspects of the concept of intensity.

2.4.1. CLC intensity relations to socio-economic indicators

By intersecting the gridded distribution of CLC classes with regional boundaries a regional average of land use intensity has been calculated at the NUTS 2/3 level. This allows for the simple correlation between intensity and the GDP and Population Density. This is shown by the correlation coefficients in 2000 and 2006 respectively results in (Open spaces with little or no vegetation = 7) while low levels indicate high intensities (Continuous urban fabric = 1).

It is important to emphasize that even though the numbers in Table 2.2 below may be seen as low, they are significant ($p < .0001$).

As shown in the column (Number of regions) not all Member States have provided sufficient GDP and Population density data to Eurostat. As such, only those regions providing aggregated data on intensity, GDP and Population density have been included in the analysis. In all cases the correlations are clearly statistical significant ($p < .001$), and the differences between the two years, 2000 and 2006, are very small, showing that it is not so much the absolute levels – GDP in 2006 considerably larger compared to 2000 – but the regional differentiation that is important. The correlation coefficients are negative due to the fact that high values for intensities actually indicate the least intensive land covers (Open spaces with little or no vegetation = 7) while low levels indicate high intensities (Continuous urban fabric = 1).

Population Density: The level of correlation is generally much higher in relation to population density compared to GDP, for instance being at a level of -0.38012 for Population density in 2006 while it is -0.23137 for GDP in 2006. Even changes in demographic parameters may differ across regions, they are much more stable over time compared to shorter term changes in economic performance, and in this context, are primarily influenced by the territorial characteristics connected to urban versus rural structures. Even mobility influences the population densities the changes are rarely short term and abrupt to an extent that will be able to result in marked changes within the time frames we are look-

ing at here. Consequently regional variations are less tied to national settings and more to regional characteristics, which obviously show through a higher regional correlation.

Table 2.2. Correlation between intensities and GDP and Population Density in 2000 and 2006.

Pearson Correlation Coefficients Prob>|r| under H0: Rho=0			
	Correlation Coefficient between intensities and:	**Probability of rejection**	**Number of regions**
GDP 2000	-0.2113	<0.0001	674
GDP 2006	-0.23137	<0.0001	604
Population Density 2000	-0.38166	<0.0001	618
Population density 2006	-0.38012	<0.0001	648

Gross Domestic Product: In contrast, regional economic performance is fluctuating much more because it is influenced by long term as well as short term changes where only a portion of capital is fixed, and therefore is less bound to specific territories. As a consequence the national setting – and thereby the more recent history – results in differences between nations which tend to fluctuate to a greater degree that population density. This results in differences in national levels, which in the end show as lower level of correlation at the regional level.

2.4.2. Elimination of national differences

The elimination of these differences is necessary in order to enable a more precise comparison between regions. A simple way to do so is by calculating national indexes for the parameters where such national differences exist. These index values are then used instead of the original GDP values in order to show more comparable regional variations in GDP.

A transformation procedure has been applied in relation to Population density as well. Due to the very large differences in population density between urban dominated and rural dominated regions, the densities have been re-calculated by a logarithmic function (log10) whereby a data structure resembling a linear structure is achieved. The results of these two sets of calculations are shown in the Table 2.3 below.

Table 2.3. Values and correlations of intensity and regional socio-economic parameters in 2000 and 2006.

Upper part: Overview of intensities and original and re-calculated values for GDP and Population Density in 2000 and 2006. The average intensity of each prevailing land use type is shown in column 1, the original averages in GDP in 2000 and 2006 are shown in columns 2 and 4, just as the original averages of population densities in 2000 and 2006 are shown in columns 6 and 9, the calculated index values for all four values are shown in columns 3, 5, 8 and 11. Finally, the logarithmic re-calculation of the population densities is shown in columns 7 and 10. The useof colors (red-yellow-green are used to rank the values in each column.

Lower part: Correlation matrix of Overview of intensities and original and re-calculated values for GDP and Population Density in 2000 and 2006.

Intensity and regional socio-economic parameters - GDP and Population density - in 2000 and 2006

	1	2	3	4	5	6	7	8	9	10	11	12
Land types	Inten-sity	Inten-sity index	GDP in 2000	Regional Index GDP in 2000	GDP in 2006	Regional Index GDP in 2006	Popu-lation density 2000	Log10. Pop density 2000	Regional Index Pop. Density 2000	Popu-lation density 2006	Log10. pop density 2006	Regional Index Pop. Density 2006
Values												
01, Urban cores and metropolitan areas	3.80	0.79	23,874	1.75	31,621	1.74	5,207	3.72	11.26	5,077	3.71	10.37
02, Suburban areas	4.51	0.95	19,707	1.05	24,600	1.07	638	2.80	1.56	657	2.82	1.55
03, Suburban or peri-urban areas	4.80	0.99	22,228	1.24	29,037	1.20	856	2.93	4.47	832	2.92	4.02
04, Arable land in peri-urban and rural areas	4.43	0.91	10,019	0.96	15,150	0.87	122	2.08	0.36	120	2.08	0.34
05, Arable land and pastures in predom, rural	4.69	0.96	11,035	0.91	15,752	0.92	115	2.06	0.40	115	2.06	0.37
06, Rural arable with perm, crops and forest	5.01	1.01	9,115	0.91	12,079	0.91	107	2.03	0.55	108	2.03	0.55
07, Rural mix dom, by pastures with arable	5.03	1.03	19,184	0.95	24,120	0.93	121	2.08	0.31	129	2.11	0.34
08, Rural pastures and complex cult, patterns	5.36	1.08	16,919	0.86	20,650	0.87	62	1.80	0.16	63	1.80	0.15
09, Diverse land use in rural areas	5.29	1.03	12,067	1.04	18,795	1.01	103	2.01	0.87	105	2.02	0.84
10, Diverse rural forest intersected by other	5.55	1.07	10,427	0.98	14,801	0.96	109	2.04	0.59	110	2.04	0.57
11, Arid mixed forest	5.46	1.04	11,355	0.97	18,818	0.99	73	1.86	0.50	105	2.02	0.56
12, Sparse vegetation with forest and pasture	4.48	0.87	5,081	0.80	20,120	1.05	72	1.86	0.51	79	1.90	0.49
13, Rural (Northern) forest	5.22	1.03	25,044	1.01	30,904	1.02	17	1.23	0.40	17	1.23	0.38
14, Sparsely vegetated areas	3.47	0.81	na	na	na	na	13	1.10	0.14	13	1.12	0.14
Correlations												
Intensity	1.000											
GDP in 2000	-0.185	-0.045	1.000									
Regional Index GDP in 2000	-0.576	-0.562	0.617	1.000								
GDP in 2006	-0.346	-0.294	0.888	0.639	1.000							
Regional Index GDP in 2006	-0.652	-0.687	0.521	0.945	0.674	1.000						
Population density 2000	-0.473	-0.549	0.481	0.944	0.552	0.956	1.000					
Log. Pop density 2000	-0.226	-0.275	0.389	0.838	0.413	0.810	0.791	1.000				
Regional Index Pop. Density 2000	-0.435	-0.504	0.525	0.971	0.609	0.974	0.975	0.836	1.000			
Population density 2006	-0.472	-0.548	0.481	0.944	0.552	0.956	1.000	0.793	0.975	1.000		
Log pop density 2006	-0.212	-0.267	0.374	0.834	0.409	0.812	0.787	0.998	0.831	0.789	1.000	
Regional Index Pop. Density 2006	-0.434	-0.504	0.524	0.971	0.607	0.976	0.977	0.838	1.000	0.977	0.834	1.000

2.4.3. Correlations of intensities of Types of Prevailing Characteristics and the socio-economic parameters

Based on the calculated values shown in the upper part of Table 2.3 a correlation matrix has been calculated and shown in the lower part of the table, and some substantial improvements in correlations have been the result of the new calculations. First and foremost: The correlation between Intensity and the indexed GDP in 2000 and 2006 has increased to -0.576 and -0.652 respectively, which is very substantial. The indexing procedure has eliminated the fact that national levels of GDP in both years have differed substantially due to many reasons, for instance level of industrialization, technological development, level and time of involvement in EU etc. And the higher value in 2006 compared to 2000 can be explained through regional policies during the 6 year period – first and foremost in an EU setting and primarily in relation to recent members – eliminating some of the regional differences which have no relation to land use intensity.

In relation to Population density an indexing of the national values does not really change anything. For population density in 2000 the correlation was -0.473 while a correlation based on indexed values actually drops to -0.435. And in 2006 the correlation changes from a correlation value based on the absolute data of -0.472 to an indexed correlation of -0.434. Again a small drop in correlation, and in both cases illustrating that settlement and population structures are changing much more slowly, so when aggregated at the regional level stay persistent in relation to the factors which have been shaping the overall population structures during many centuries, and mostly based on production potentials of land.

As mentioned above the re-calculation of population densities by means of a logarithmic scale seems to indicate a substantial drop in correlation with intensities, but this is due to the fact that correlations in this context are based on linear relations between the parameters which are not the case when we are dealing with logarithmic functions.

As indicated by the graph there is a very clear relationship between the two components: regional indexes and intensities. And, furthermore, that the best description of the regional trend is a power function of intensity. In both years only one major outlier appears, marked by number 1 being the urban cores and metropolitan areas where the level of GDP deviating so much from the other landuse categories that it is difficult to make it fit into any general trend. The other categories relating to urban sprawl are situated very well in the graph, still, however, representing some minor variations.

The change in trend from 2000 to 2006 show that the gap to the urban cores and metropolitan areas is minimizing. Greening of city cores and urban sprawl into adjacent areas contributes to a more even distribution of the population in relation to land cover characteristics. While former urban sprawl has been characterized by replacement of one mono-function – typically agriculture – by another

mono-function – residential areas – the present trend in relation to urban sprawl is increasingly characterized by co-existence of different land uses, which in practice means multi-functionality.

In relation to population density Figure 2.3 show how the logarithmic relationship between intensity and population density generates the best fit. Only two categories are significantly deviating. It is the regional land use types with maximum (point 1) and minimum (point 14) population density respectively represented by regional land use type 1 (Urban cores and metropolitan areas) and type 14 (Sparsely populated areas).

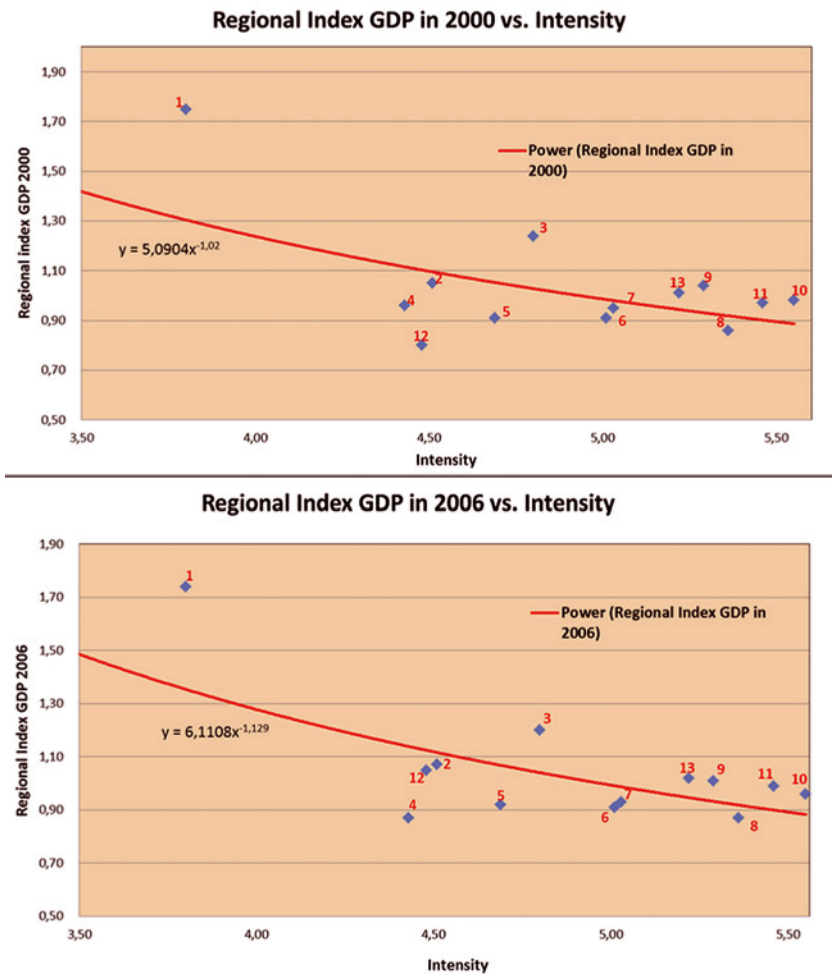


Figure 2.2. Graph showing relationship between Regional Index of GDP in 2000 and 2006 and calculated intensities for the types of prevailing characteristics. Each of the points has been numbered according to the land type they represent.

The reason behind outlier 1 is similar to what was described by the GDP graphs, while outlier 2 has to do with the fact that even these regions are sparsely vegetated many regions in both Iceland and Norway are situated in this category, and showing as well high economic performance and high population density due to that a substantial part of the population are situated in the coastal regions and depending on non-land based activities.

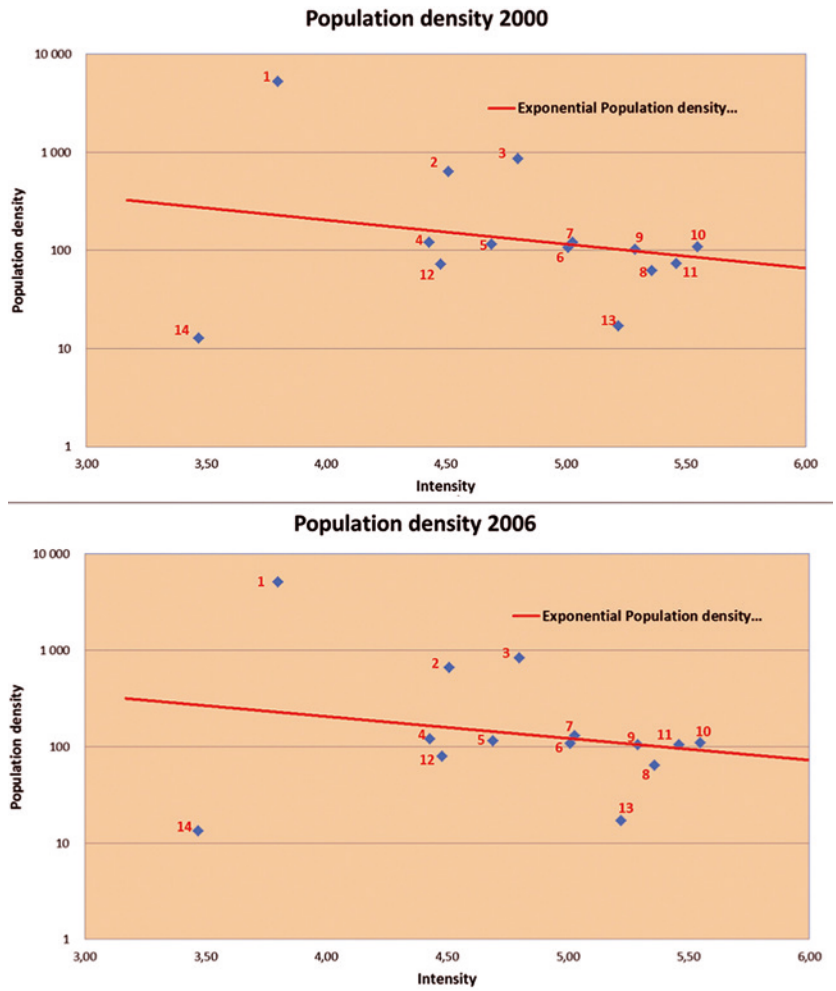


Figure 2.3. Graph showing relationship between Population Density in 2000 and 2006 and calculated intensities for the types of prevailing characteristics. Please note that the y-axis is logarithmic. Each of the points have been numbered according to the land type they represent.

Outlier 13 is in many ways defined by the same characteristics described above. It can be discussed whether the dots marked as outlier 2 and 3 actually are outliers. Both relates do urban characteristics, outlier 2 identifying regional land use type 2 (Suburban areas) and outlier 3 identifying land use type 3 (Suburban or peri-urban areas). Presently they deviate from the trend but urban sprawl characterized by co-existence of parallel uses of land may result in a situation where the two outliers become parts of a general trend.

2.4.4. The two dimensions of intensity

GDP and Population density reflects two characteristic of intensities in relation to the use of land, and as documented above the intensities of land use reflected through the Land use types are clearly correlated to both population density and to GDP. It is also clear that it may be relevant to differentiate between them, and use the differences as an important indicator. In Table 2.4 the intensity has been subdivided in three categories (Low – 33%, Medium – 33%, High – 33%) where it is important to remember that high intensity means high levels of population density and economic activities and identified by low score in the Corine classification where 1= continuous urban fabric, while low intensity means low level of population density and economic activities and identified by high score in the Corine classification where 7= open spaces with little or no vegetation. Furthermore the two components Population Density and GDP have each been subdivided in two categories (Low – 50%, High – 50%).

Table 2.4. Relations between intensity, population density, and GDP and the 14 Regional land use types.

Regional Land Use type	Intensity	Population density	GDP	Description of regional land use types
1	1. low	2. High	2. High	01, Urban cores and metropolitan areas
2	1. low	2. High	2. High	02, Suburban areas
4	1. low	2. High	1. Low	04, Arable land in peri-urban and rural areas
12	1. low	1. Low	2. High	12, Sparse vegetation with forest and pasture
14	1. low	1. Low	2. High	14, Sparsely vegetated areas
3	2. Medium	2. High	2. High	03, Suburban or peri-urban areas
5	2. Medium	2. High	1. Low	05, Arable land and pastures in predom, rural
7	2. Medium	2. High	1. Low	07, Rural mix dom, by pastures with arable
6	2. Medium	1. Low	2. High	06, Rural arable with perm, crops and forest
10	3. High	2. High	1. Low	10, Diverse rural forest intersected by other
11	3. High	1. Low	2. High	11, Arid mixed forest
13	3. High	1. Low	2. High	13, Rural (Northern) forest
8	3. High	1. Low	1. Low	08, Rural pastures and complex cult, patterns
9	3. High	1. Low	1. Low	09, Diverse land use in rural areas

Table 2.4 shows which of the two main socio-economic categories are dominant in explaining the intensities determined for the Regional land use types. This is an exercise that may be very useful not only in characterizing the Regional land use types, but also to locate where in Europe the major socio-economic functions have been influential on the regional land use changes.

The high/high categories are land use types 1, 2 and 3, with the two first being in the high intensity class as urban categories while type 3 as peri-urban functions is a mixed category with substantial land areas combined with suburban functions.

The land use types 8 and 9 are characterizing the low/low end, with low levels of both population density and GDP, and obviously situated in the low intensity category.

In the high intensity category, three land use types are situated with either high population density and low level of GDP (type 4) or high level of GDP and low population density (type 12 and 14). The two latter categories are situated in sparsely vegetated area shaving large scale industrial and extractive activities resulting in the high GDP, while type 4 shows a high population density, but with low level of GDP generation being regions serving as residential areas for nearby urban areas, but with the economy generated through activities related to arable land.

In the low intensity category show either high population density or high level of GDP characterized by mixed land use types where high population density (land use type 10) are forested areas but with intersections of other rural activities, while the high level of GDP (type 11 and 13) are related to land use with high economic value but sparsely populated, for instance forestry or forest related types of crops such as olives, nuts etc.

And finally, in the medium intensity class are primarily relatively densely populated land use types (type 5 and 7) with low economic productivity, or a single type (type 6) showing relatively high economic performance from permanent crops requiring less permanent labour force, and therefore characterized by low population density.

3.

Analysis of land use and land use change dynamics in the EU-LUPA project

Ryan Weber and Rasmus Ole Rasmussen

3.1. Integrating and analyzing land use information: typologies

Typologies are defined as the classification of entities into types based on shared or common characteristics. Here, through the use of CLC data, they are used to characterize land use and land use change patterns in Europe, thereby serving as an analytical tool to support the development of land use policy recommendations for Europe. However, their uniqueness is highlighted by the analysis of land patterns and changes in the previous chapter – where all typologies and geospatial data was raster-based, grid-level information that is independent of administrative bonds. The problem lies in the fact that socio-economic data is, by nature, organized and measured via the multi-level administrative scales with which it is kept. This inherent obstacle is an underlying rationale for the EU-LUPA project, where we have been tasked to operationalize the connection of these datasets into regional typologies of land use patterns in Europe.

In achieving this, the objective has been to create indicative typologies that can be used to interpret and analyse land patterns in relation to the drivers, effects, challenges, or put more plainly, the general conditions of regional development. More specifically, to attribute these land processes to shifting regional socio-economic characteristics and identified changes in policy and politics. This can help to address major territorial challenges and political priorities in order to increase land use efficiency at the European, national and regional levels.

In looking to develop typologies the answers to three central questions are sought:

- What are the general characteristics of land use in Europe?
- What characterizes land use changes?
- How are land use patterns connected to socio-economic development?

By responding to the first two questions the EU-LUPA typologies provide an optimal characterization of land use patterns that reflect the impact of socio-economic dynamics on land use patterns in Europe. This in turn reveals additional insight into the nature of land use patterns and their relationships with socio-economic development.

3.2. Working with Corine

We use the word typologies because in order to provide simple, operational and highly explanatory results we must use multiple typologies to sufficiently characterize each of the dimensions required. One typology is necessary to interpret the prevailing characteristics of land use while another is needed to account for land use changes. Furthermore, in order to provide regionalized findings, the point of departure for the typology exercise is finding a way to aggregate and regionalize CLC data. Here we say aggregate and regionalize because the typologies must also be available in a gridded format to integrate different dimensions of territorial structures. This is needed to acknowledge land multifunctionalities taking place in overlapping or close proximity and for pursuing intra-regional analyses in the case studies, which are put in focus in the next chapter.

The result is that this task uses CLC data in multiple ways to map spatial patterns of land use patterns in Europe:

- In relation to the prevailing characteristics of land use: answering the question, based on the distribution to CLC data 1990-2000-2006 what characterizes the land use in Europe? The results are two typologies:
  a) The prevailing characteristics of land use at a $1km^2$ grid level
  b) The prevailing characteristics of land use at a NUTS 2/3 level
- In relation to the amount of land use change, as a percentage of the total areas of NUTS 2/3 regions. To answer the question, how much land is changing, and where?
- In relation to the intensity of land use change in NUTS 2/3 regions, to answer the question, what is the degree of human intervention on the land in order to meet the needs of our socio-economic activities?
- Combining the two previous outputs, a basic typology showing Hotspots of land use change. It generalizes regions based on a matrix of absolute change (by area) and intensity of change. This provides a generalized picture of which regions stick out in terms of high levels of physical land change, in terms of the degree of human intervention on the land, or both.
- In relation to a Land use change typology: this is the cornerstone of the EU-LUPA land use characterization and it answers the question, based on the regional clustering of classes of land cover flows (LCFs), and changes in land use intensity, what characterizes land use changes for NUTS 2/3 regions in Europe?

One limitation of CLC data is that the spatial coverage is not entirely consistent for each time series. This prevents full European coverage of the typologies for the entire 1990-2006 time series. As a result, the typologies are constructed at all three time scales to provide the fullest extent of European coverage possible. Yet, this is also advantageous for identifying changes in land patterns that have

taken place through time; for instance based on trajectories of regional development related to entering EU membership.

3.2.1. Aggregating CLC data to 1 km² land types

One of the best assets of CLC data is its ability to produce very high resolution results for such a wide area. Land cover classification is available at both a 100 m and 250 m grid for each CLC in all three time series. However, in some cases such a high resolution is not advantageous because it provides very fine, fragmented land cover results that fail to identify dominating land cover patterns. In our case, dominating land patterns are important to identify because they indicate the socio-economic uses of the land. This is especially crucial for identifying dominant land cover classes that are often relatively discrete in their distribution but have disproportionately high roles in a socio-economic perspective. The foremost example of this situation is that of artificial surfaces – areas that cover only 4% of Europe's land but accommodate an increasing majority of people and economic activity (EEA, 2010a).

Thus, the first step in building the typologies was to aggregate CLC data from a 100 m^2 to a 1 km^2 grid-level. This harmonization is based on the principle that when aggregating CLC data it is not possible to represent the entire mosaic of land cover classes or land cover changes for each 1 km^2 cell. As such, the process represents a simplification of the data that is necessary for analyzing important trends taking place on regional, national and European scales. And at the same time acknowledge that the distribution of data is not random but representing different associations of land characteristics which mean that for instance simple calculations such as mean values or most dominant land cover would not pay attention to this fact.

Aggregation to a 1 km^2 grid was calculated using the CLC class (from 1-44) of the 100 grid-cells comprising each 1 km^2. Yet, relying on only one method of calculating an aggregated CLC class for a 1km^2 cell leaves open the possibility of significant mischaracterization. Figure 3.1 provides a hypothetical example showing how CLC classes at a 100 m^2 grid can be aggregated based on the maximum, minimum, median, mean and majority land class. Choosing between these values reflects the ability of each to enhance and/or maintain different land cover characteristics in each of the 1 km^2 areas. A minimum aggregation value of two corresponds to Discontinuous urban fabric while a maximum aggregation value of 41 corresponds to Water bodies. Median and majority classification result in different characterizations of Agricultural areas.

Each of the aggregation methods has their own advantages and disadvantages. For example, the maximum and minimum represent the span of CLC classes represented in a 1 km^2 – information which to some extent is indicative of the landscapes represented. Furthermore, the minimum aggregation determines if the area possesses any form of urban or agglomeration characteristics – a benefit that identifies discrete but crucial land classes that may otherwise disappear due to domi-

nance of other classes. In contrast, the maximum aggregation provides a very good impression of where extensification thresholds could be impactful.

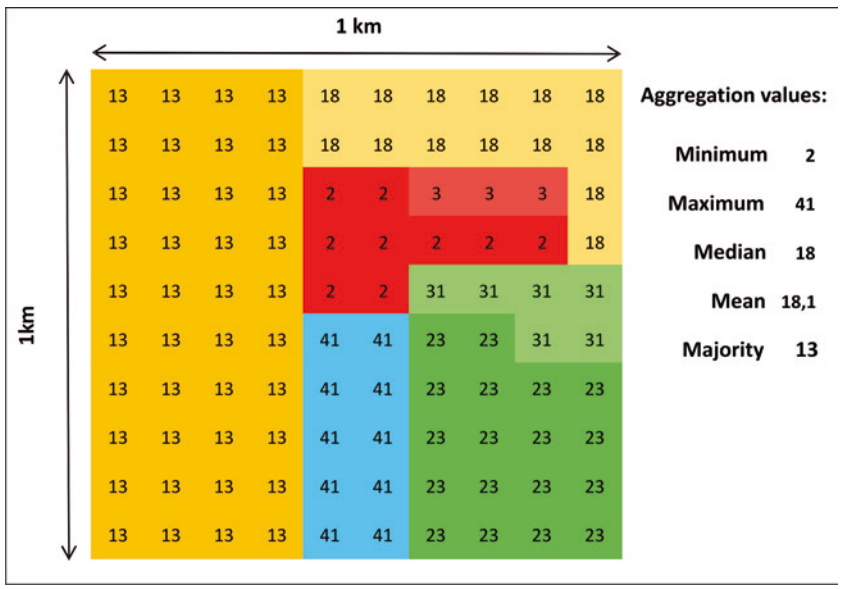


Figure 3.1. Hypothetical example of aggregating a 100 m² grid to 1 km² using five aggregation methods.

The median aggregation shows the dominant (majority) CLC class if one land type accounts for more than 50% of the cells in a given area. If this is not the case then it reports the CLC class that most likely dominates the area. As such, it limits the pull tendency of deviating outlier land classes in a given area and provides statistical results that come closest to reflecting the reality of the dominant CLC class. Yet most importantly, and in contrast to a majority aggregation that shows the most frequent CLC class in a given area, it also reflects on the associations of land cover classes in each cell, an issue that may become important when generalizing larger territorial structures based on a number of individual grid cells.

Most importantly, however, the aggregation possibilities highlighted above show that no single aggregation procedure effectively captures that land dynamics operating within a given area. This is a crucial component to the use of the aggregated CLC data in the typologies as the Maximum, Minimum, Median and Majority aggregations will be used together to formulate the prevailing land cover type at a 1 km² scale.

3.3. Prevailing characteristics of land use

3.3.1. Grid level

The term "prevailing" is important in this connection because it implies that the unchanged elements of European land cover as well as any changes that take place are included in the typologies. The alternative approach would be to use data from a base year (e.g. 1990) to imply a point of departure for all observed land changes. The advantage of the former approach is that it provides a comprehensive interpretation of land cover that does not infer that land change is a fixed process with a clear beginning and end, but rather a dynamic and on-going *process* through time and space.

As shown in Figure 3.3, creating the prevailing characteristics of land use typology begins with the previously discussed aggregation procedure, followed by an algorithm step and a clustering procedure. This is broken down in the following steps:

– The first step is to select the aggregation data to be used in the clustering. As described above, the maximum and minimum aggregations represent the span of land cover types in each 1 km^2 area, while the median and majority aggregation most effectively characterize the dominant land characteristics, as well as the association of vegetation characterizing the grid cell without being affected by outlier land covers. Therefore, these four datasets are used as inputs in the first clustering procedure.

It is also important to acknowledge the issue of gaps in the CLC data. One of the objectives of the prevailing characteristics typology is to provide a full European coverage while using CLC data going back to 1990. In order to achieve this data from the 2000 release of CLC is used in countries missing either 1990 or 2006 data.

– The four datasets for each of the CLC time periods are then analysed using an algorithm that identifies similarities and differences between each of the Maximum, Minimum, Median and Majority aggregation procedures. The reason for this exercise is to emphasize the role of urban areas. Considering that artificial surfaces cover only 4% of Europe, it has a very low extent compared to its socio-economic impact. In order to ensure its proper representation in the cluster results any 1 km^2 grids showing an Artificial surfaces CLC class in at least two of the four aggregation processes is characterized as an urban cell. Similarly, an urban cell is identified if the average of the four clustering processes is between the values 1-11, i.e. one of the artificial surfaces CLC classes. Any cell not identified as urban is considered a rural cell.
– Next, two cluster procedures are completed; one for the 815,590 urban cells and one for the remaining rural cells. In both procedures Ward's cluster me-

thod is used to combine the four aggregation datasets for all three years[1]. The result is the generation of six clusters with an urban component and seven rural clusters. The clusters results are then smoothed using a GIS tool called Majority Filter. This tool runs a 3 km^2 x 3 km^2 filter over the raster data and assigns the dominant cluster value to each of the nine 1 km^2 cells in the matrix. As with the intention of the aggregation procedure, this limits the singular occurrence of cells which can be considered "territorial outliers", and thereby eventually blur the general picture and make interpretation difficult.

– The cluster results are named and transformed from 13 clusters into 11 land use types – a reduction of two because two types include the grid cells from two clusters together. These cover the spectrum of landscape in Europe – from dense urban cores with intensive human intervention to sparse and remote natural landscapes. The naming process is in many ways a subjective process that makes use of the statistics characterizing the clusters, first of all the mean and standard deviation values of the dominant value for the cluster, as well as tables showing the distribution of the 44 CLC classes[2] for each cluster. These tables are summarized in Figure 3.2 to show the composition of land attributes in each cluster.

– As shown in Figure 3.3, the 4-step methodological flow presented above includes a 5th step in order to regionalize the gridded typology to the NUTS 2/3 level. First, the 13 land cover categories are summarized based on the per cent distribution in each region. Based on these regionalized distributions interregional similarities were identified through an additional clustering procedure (Ward's method, Cubic Clustering Criterion). This clustered the regions according to similarities in the percentage distribution of the 13 categories of land cover. The result was an initial identification of 16 clusters which eventually was reduced to 13 clusters in order to balance between showing distinct characteristics and providing sensible group sizes for each cluster. Additionally, an algorithm was added emphasizing the urban component by providing an additional category of urban sprawl into predominantly rural areas. This category emphasizes regions with urban and infrastructure land (Corine classes 1-11) above a threshold of ½ standard deviation above the European mean.

[1] Datasets for 4 aggregation datasets times 3 time periods equals 12 CLC classification values for each cell in the cluster procedure.

[2] The distribution of the grids among the 44 CLC classes is shown using the Majority aggregation method.

The result is 14 clusters, which have been subjectively named and transformed in to regional land use types. The naming is based on the composition of CLC classes in each cluster, which is shown for the CLC 2006 time series in Table 3.1.

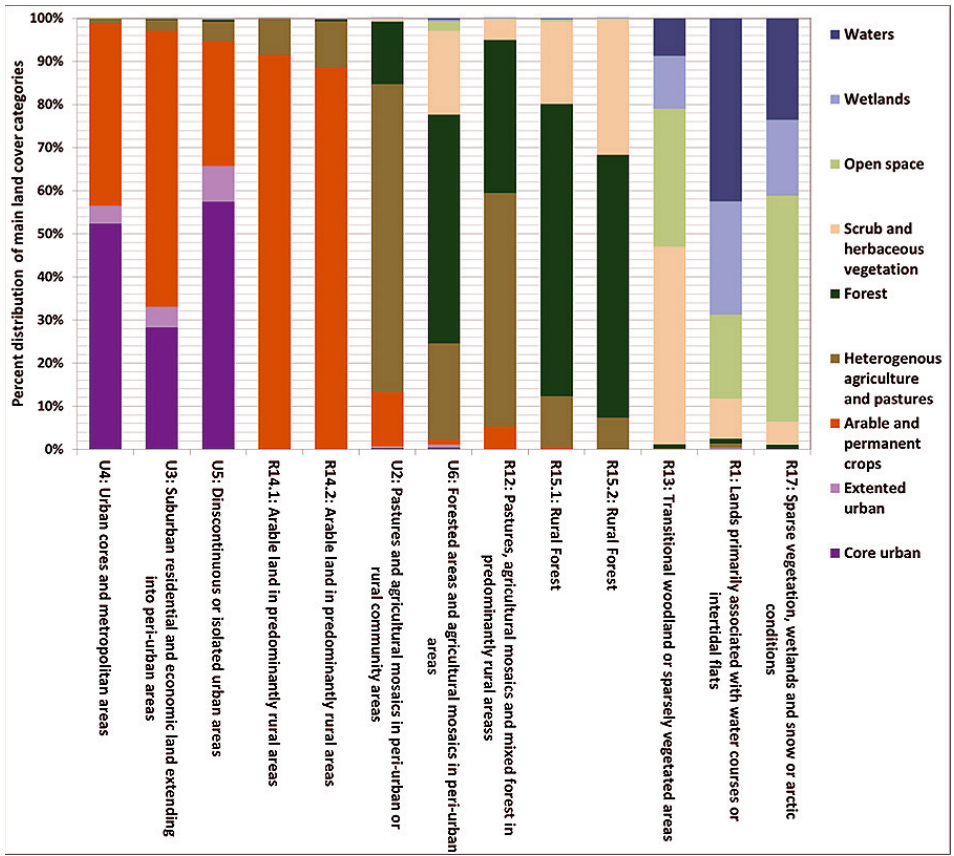
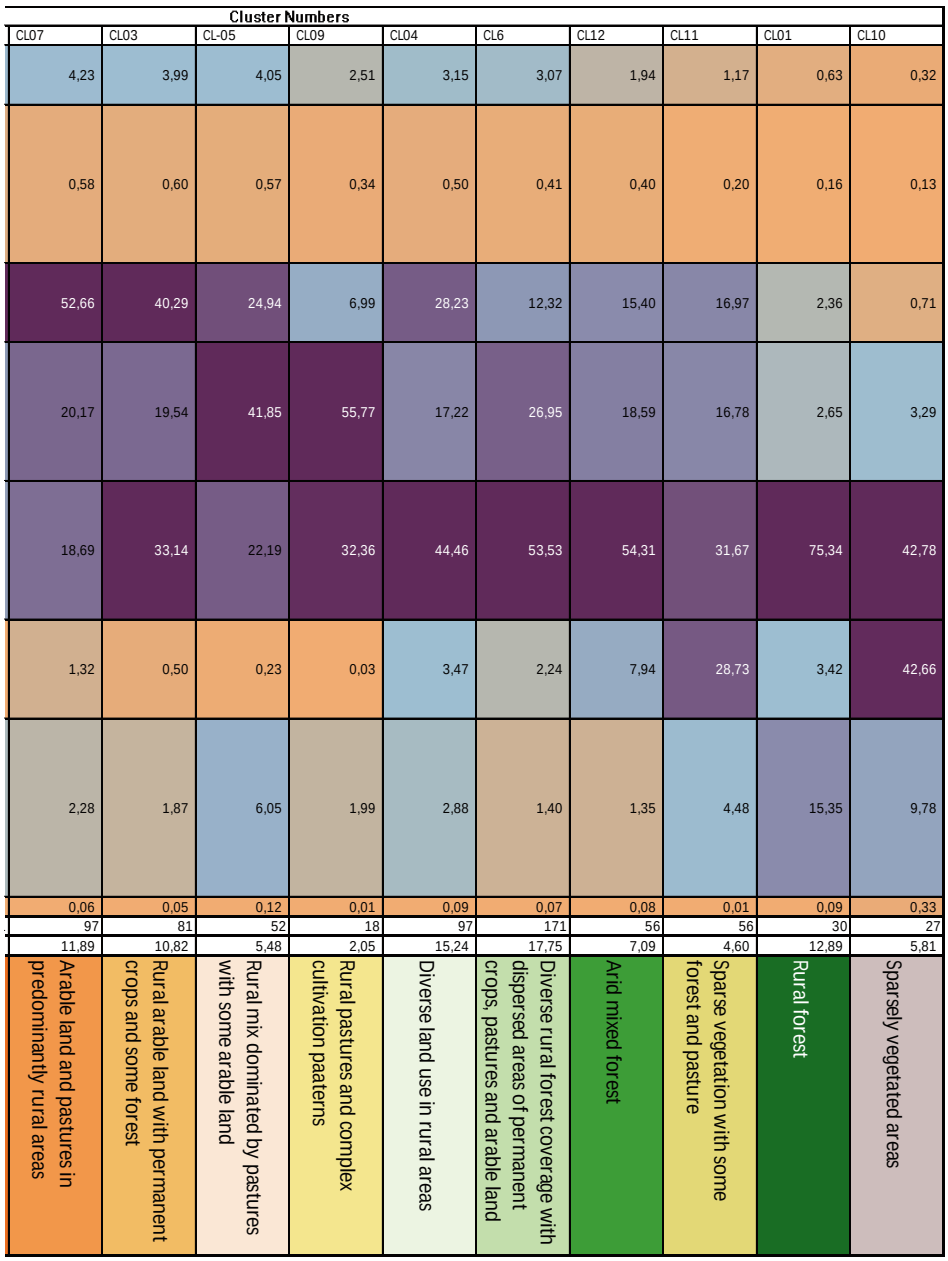


Figure 3.2. Distribution of main land cover classes (based on CLC classes) in each cluster used to generate the gridded prevailing characteristics of land use typology.

Table 3.1. The distribution of CLC 2006 classes within each regional cluster (noted in the top row), leading to the formation (naming) of regional land use types (noted in the bottom row). The purple – orange colour scale shows the share of each CLC class group for each cluster and regional land use type.

	CLC classes		CL15	CL16	cl20	CL02
1	Artificial surfaces	Continuous Urban Fabric				
2	Artificial surfaces	Discontinuous urban fabric	52,41	18,15	13,38	4,78
3	Artificial surfaces	Industrial or commercial units				
4	Artificial surfaces	Roads and rail networks and associated land				
5	Artificial surfaces	Port areas				
6	Artificial surfaces	Airports				
7	Artificial surfaces	Mineral extraction sites	11,05	2,65	3,36	0,82
8	Artificial surfaces	Dump sites				
9	Artificial surfaces	Construction sites				
10	Artificial surfaces	Green urban areas				
11	Artificial surfaces	Port and leisure facilities				
12	Agricultural areas	Non-irrigated arable land				
13	Agricultural areas	Permanently irrigated land	11,75	32,98	27,53	71,61
14	Agricultural areas	Rice fields				
15	Agricultural areas	Vineyards				
16	Agricultural areas	Fruit trees and berry plantations				
17	Agricultural areas	Olive groves				
18	Agricultural areas	Pastures				
19	Agricultural areas	Annual crops ass. With permanent crops	9,97	23,81	27,99	10,22
20	Agricultural areas	Complex cultivation				
21	Agricultural areas	Agriculture with sign. Areas of natural vegetation				
22	Agricultural areas	Agro-forestry areas				
23	Forest and semi natural areas	Broad leaved forests				
24	Forest and semi natural areas	Coniferous forests				
25	Forest and semi natural areas	Mixed forests				
26	Forest and semi natural areas	Natural grasslands	9,57	18,74	25,36	9,26
27	Forest and semi natural areas	Moors and heathland				
28	Forest and semi natural areas	Sclerophyllous vegetation				
29	Forest and semi natural areas	Transitional woodland shrub				
30	Forest and semi natural areas	Beaches, dunes, sands				
31	Forest and semi natural areas	Bare rocks				
32	Forest and semi natural areas	Sparsely vegetated areas	0,10	0,10	0,25	0,09
33	Forest and semi natural areas	Burnt areas				
34	Forest and semi natural areas	Glaciers and perpetual snow				
35	Wetlands	Inland marshes				
36	Wetlands	Peat bogs				
37	Wetlands	Salt marshes				
38	Wetlands	Salines				
39	Wetlands	Intertidal flats	4,94	3,54	2,00	3,02
40	Water bodies	Water courses				
41	Water bodies	Water bodies				
42	Water bodies	Coastal lagoons				
43	Water bodies	Estuaries				
44	Water bodies	Sea and ocean	0,21	0,03	0,12	0,19
		Number of regions	29	32	21	41
		Percent of Europe	0,22	1,38	1,20	3,57
			Urban cores and metropolitan areas	Suburban areas	Suburban or peri-urban areas	Arable land in peri-urban and rural areas


Cluster Numbers
CL07
CL03
CL-05
CL09
CL04
CL6
CL12
CL11
CL01
CL10
4,23 3,99 4,05 2,51 3,15 3,07 1,94 1,17 0,63 0,32
0,58 0,60 0,57 0,34 0,50 0,41 0,40 0,20 0,16 0,13
52,66 40,29 24,94 6,99 28,23 12,32 15,40 16,97 2,36 0,71
20,17 19,54 41,85 55,77 17,22 26,95 18,59 16,78 2,65 3,29
18,69 33,14 22,19 32,36 44,46 53,53 54,31 31,67 75,34 42,78
1,32 0,50 0,23 0,03 3,47 2,24 7,94 28,73 3,42 42,66
2,28 1,87 6,05 1,99 2,88 1,40 1,35 4,48 15,35 9,78
0,06 0,05 0,12 0,01 0,09 0,07 0,08 0,01 0,09 0,33
97 81 52 18 97 171 56 56 30 27
11,89 10,82 5,48 2,05 15,24 17,75 7,09 4,60 12,89 5,81
Arable land and pastures in predominantly rural areas
Rural arable land with permanent crops and some forest
Rural mix dominated by pastures with some arable land
Rural pastures and complex cultivation paaterns
Diverse land use in rural areas
Diverse rural forest coverage with dispersed areas of permanent crops, pastures and arable land
Arid mixed forest
Sparse vegetation with some forest and pasture
Rural forest
Sparsely vegetated areas

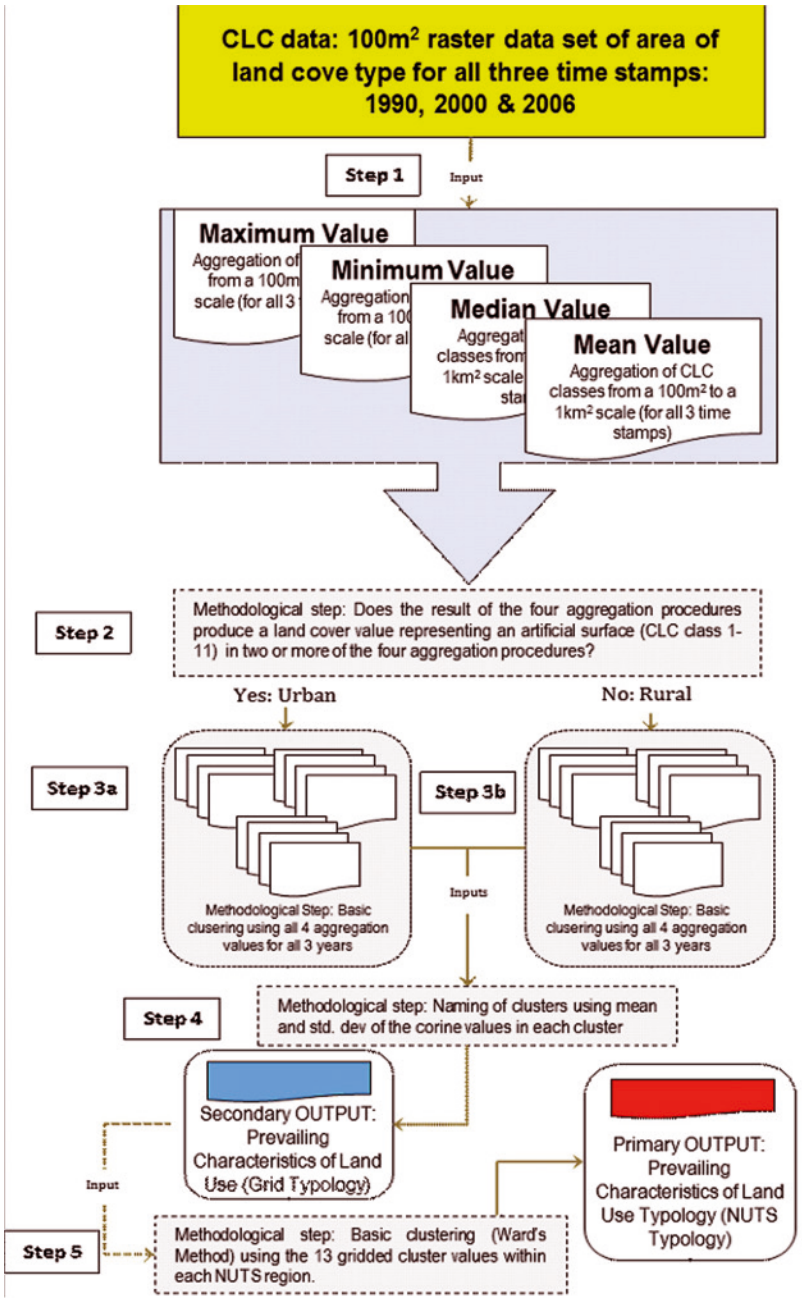


Figure 3.3. Methodological flow used to analyse prevailing land use characteristics.

3.3.2. Results at grid level

Overall, spatial characteristics of land cover appear very clear on the map shown on Figure 3.4. For example, differences between urban versus non-urban as well as different types of rural landscapes are striking. This is especially true in relation to geography and topography, but also in terms of identifying different types of rural landscape. The plethora of forest in the Nordic countries, in Scotland, and northern Spain also provides a preamble for the importance of the forest sector in these regions.

The differences between arable land with a higher production potential (shown in orange) compared to less productive pasture, mosaics and mixed vegetation (shown in beige) are also notable. Another very interesting observation is noted by the distribution of the land cover types among the first three "urban" land types where, artificial surface land covers are almost exclusively paired with areas characterized as having some sort of agricultural function. In contrast, the statistical results show that an extremely small amount of forested areas are grouped in "urban" land types. This further validates the typology by reaffirming that a vast majority of land surrounding urban settlements is dominated by land use types reflecting some sort of socio-economic consumption.

Besides enabling a detailed overview of the distribution of dominant land types across the European landscapes, the main utility of the grid-level analysis is to serve as an input into the generation of prevailing land types at the regional level. At the same time, the gridded results have also been valuable for characterizing landscapes at the regional and local level in the case studies. As such, further analysis of the results is available through each of the four case studies.

1. U4: *Urban cores and metropolitan areas* – This land type is dominant for an average of 3.2%[3] of the land in Europe. Over two thirds of all "CLC – continuous urban fabric" is accounted for in this land type and over 55% of the area is characterized as "CLC – artificial surfaces". As shown in the maps of Madrid, London, Copenhagen and Milano this land type quite clearly conspires to what is generally viewed as the urban configurations of these city regions. The dark purple fills the city centres and expands outwards according to higher urban densities and transport infrastructure.

Each of the images in Figure 3.5 show that the urban cores and metropolitan areas land type "picks up" some land area that penetrates into suburban and peri-urban areas. This is reaffirmed by the graph in Figure 3.2 showing that over 40% of this land type is actually typified as arable land and permanent crops. Again, this is viewed as an advantage of this typology in that it is achieving its aim of identifying the *prevailing land use type* across the European landscape.

[3] The "average" is calculated based on the statistical dominance each land type shows across the range of available CLC data from 1990, 2000 and 2006.

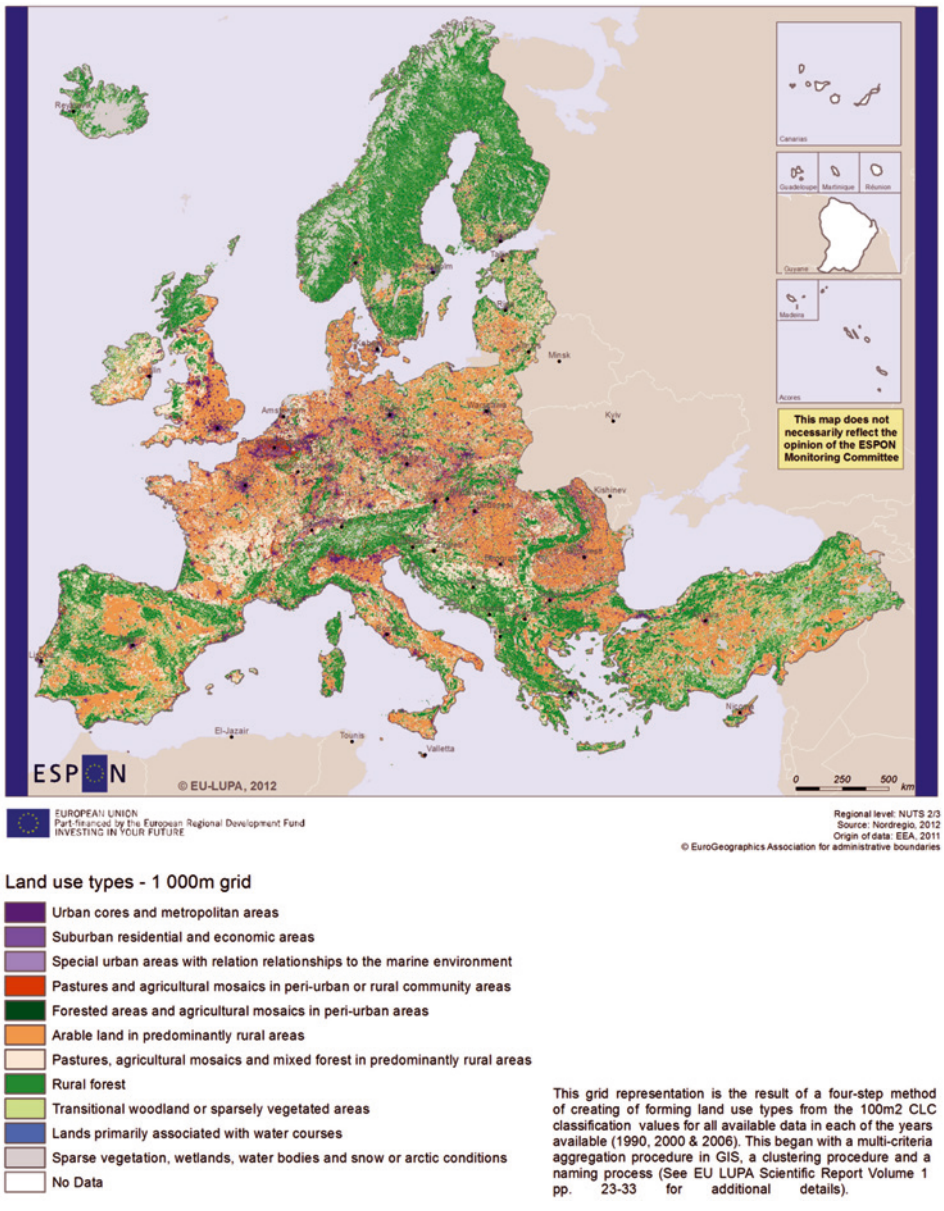


Figure 3.4. Grid typology for the prevailing characteristics of land use.

2. U3: *Suburban residential and economic areas* – Slightly higher than urban cores and metropolitan areas, this type is dominant for an average of 3.31% in Europe. Yet looking at the map of the urban cores above, it is quite easy to see its distinction from the previous land type. Whereas the urban cores and metropolitan areas basically accounts for exactly what its name implies, the lighter purple accounts for suburban and peri-urban conditions that are extending into the countryside. This is especially noticeable in the urban maps below where Madrid, Milano and to a lesser extent Copenhagen show that a "sprawled" urban configuration into the rural hinterland appears to be evident. In contrast, this seems to be less prevalent in London where satellite towns with a denser urban fabric seem to be the norm.

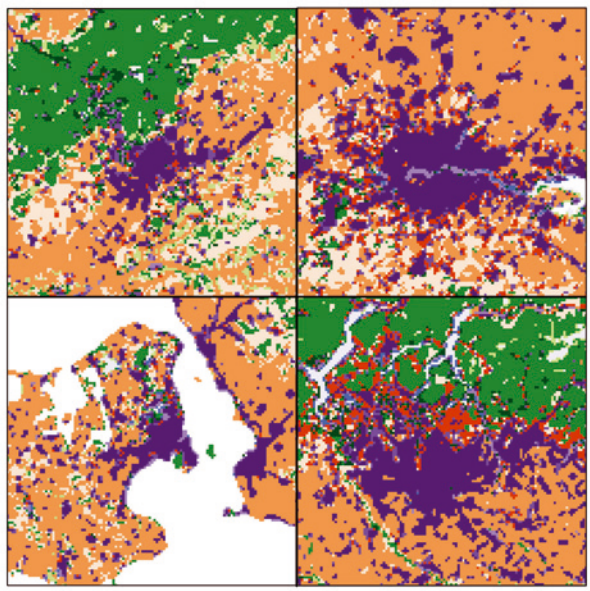


Figure 3.5. Urban cores as shown through the results of the gridded typology on the prevailing characteristics of land use. Clockwise from top-left: Madrid London Copenhagen Milano.

3. U5: *Special urban areas with relationships to the marine environment* – Accounting for an average of only 0.7% of Europe's land, this is a very interesting urban land type. Even though the statistical results in Figure 3.2 indicate a very low inclusion of waters or wetlands (less than 2%), analysis of the spatial distribution of this land type shows that the cluster analysis has identified land dominated by urban processes in that are in direct proximity to marine environments. As shown by the maps above, the urban area in direct proximity to the River Thames in London is included in this type, just as are the port and coastal areas surrounding Copenhagen. This pattern extends to all port,

river, lakeside and coastal areas in Europe. The statistical results presented in Figure 3.2 validates this land use type by showing the comparatively low inclusion of non-artificial surface land types (less than 30%). It also accounts for roughly 70% of land classified as port areas by CLC 2006 data.

4. R14.1 & R14.2: *Arable land in predominantly rural areas* – This land type accounts for an average of 22.36% of land in Europe. As shown in Figure 3.2 above, it is the result of merging two individual clusters that showed to have quite similar characteristics. Over 85% of the land in both clusters relates to land classified as "arable land" or "permanent crops" by the aggregated CLC data. The remaining area is almost exclusively related to pastures and rural mosaics. Figure 3.4 show that high concentrations of arable land are notable throughout continental Europe but excluding the Nordic countries, the Alps region, Northwest Spain and the western Balkans where forest land cover is more dominant.

5. U2: *Pastures and agricultural mosaics in peri-urban areas* – Unlike arable land in rural areas, this land type accounts for only 3.28% of Europe. Based on its distribution in the urban core maps above it is clearly noticeable that it also has a much different cadastral structure compared to the more homogeneous distribution of arable land in rural areas. In this case land is separated much more heterogeneously into pastures and arable areas that are close proximity to urban conurbations. Both of these factors indicate that the relatively small land plots could be related to higher property values associated with their urban proximity.

6. U6: *Forested areas and agricultural mosaics in peri-urban areas* – At only 1.7% it is similar to the previous land type in that it covers a comparatively small area of Europe compared to rural forest. As is noticeable in the case of Milano and Copenhagen above, this relates to the fact that it accounts for land dominated by forested areas, but which is located in quite close proximity to larger urban areas.

7. R12: *Pastures, agricultural mosaics and mixed forest in predominantly rural areas* – Covering an average of 21.61% of Europe, this is the third most extensive land type in Europe. Similar to the previous land type (Forested areas and agricultural mosaics in peri-urban areas) it is a very diverse land type in which statistically significant proportions of land are covered by non-irrigated land, pastures, agricultural mosaics and forest land cover. It appears that this land type is accurately accounting for rural areas that have quite diverse, transitional or heterogeneous land functions across a variety of sectors (e.g. diverse types of farming, forestry, tourism, etc.).

8. R15.1 & R15.2 *Rural Forest* – With an average coverage of 32.4% of Europe this is the most extensive land type. Similar to arable land in predominantly rural areas, this is the second land type that involves the amalgamation of two clusters into one land type. Figure 3.2 visualizes the justification for this by

showing that both clusters have broad leaved, coniferous or mixed forest covering over 60% of the landscape. The only difference between the two clusters is a trade-off between the amount of land covered by scrub and/or herbaceous vegetation associations and that which is covered by pastures heterogeneous agricultural areas.

9. R13: *Transitional woodland or sparsely vegetated areas* – Accounting for an average of 5.7% of Europe the statistics indicate that this land type is mainly transitional woodland and scrub, which is often associated with forestry activities, as well as open spaces with little or no vegetation. Spatially, this land type is concentrated in Sweden (likely associated with transitional woodland related to logging activity) and Ireland, southern Spain, and Turkey (likely related to areas of little very sparse vegetation and large areas of open land.
10. R1: *Lands primarily associated with water courses* – As shown by Figure 3.2 a majority of this land type is explained by the dominance of inland waters and this land type accounts for areas that that are in direct proximity to inland watercourses. Statistically it is rather insignificant as it only accounts for less than 0.3% of the space mapped by CLC data.
11. R17: *Sparse vegetation, wetlands, water bodies and snow or arctic conditions* – This land type accounts for roughly 7% of Europe and it is quite clear on Figure 3.4 that this is concentrated in areas with seasonal or perpetual snow cover, such as Iceland, the Alps and Norway. Large inland lakes such as those in Sweden are included in this land type, as well as the expansive intertidal flats in The Netherlands and Denmark.

3.3.3. NUTS 2/3 level

As shown in Figure 3.3, the 4-step methodological flow includes a 5th step in order to regionalize the gridded typology into the NUTS 2/3 level. While the first four steps worked with gridded data the first part of step 5 was a summarizing for each NUTS 2/3 region of the grid based land cover categories followed by a calculation of their percentage distribution for each region. Based on these regionalized distributions a second part of step 5 was the identification of similarities between the NUTS 2/3 regions. This was handled through an additional clustering procedure transformed into where a first regionalized classification of the land use characteristics was provided by means of using a basic clustering procedure (Ward's method, Cubic Clustering Criterium). This clustered the regions according to similarities in the percentage distribution of land cover categories.

The result is shown on Figure 3.6 below, not only identifying distinct characteristics of the categories, but at the same time provide a sensible group sizes for each of the clusters. The resulting 14 clusters have been subjectively named and transformed in to regional land use types.

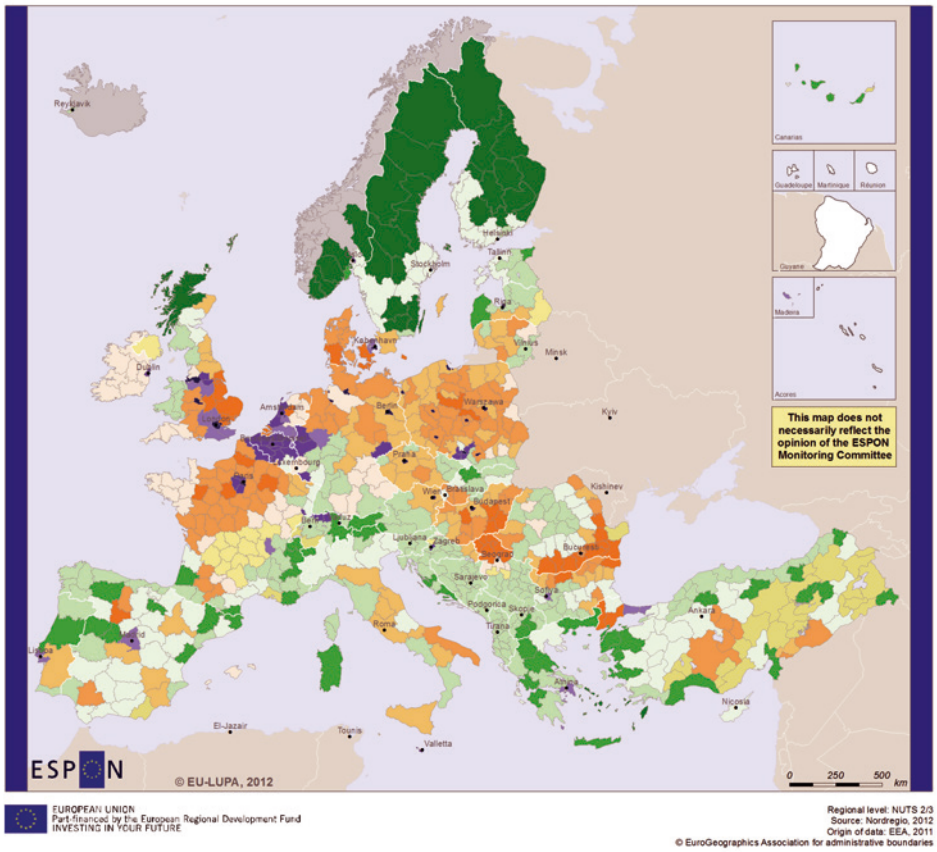


Figure 3.6. Regional typology of the prevailing characteristics of land use.

1. *Urban cores and metropolitan areas* – 29 regions – show a situation where almost 60% of regions have land characterized as urban cores and metropolitan areas in the grid-level typology. As such, their spatial distributions are quite similar. At the same time, when grid data are summarized at the administrative level, it becomes very evident that urban cores in larger regions are becoming overshadowed by more dominant (rural) land types. As a consequence regions in this type are generally smaller regions which can be characterized as regional city-states, where peri-urban areas and rural hinterland is accounted for in neighbouring regions. Thus, the urban land features in this type are influential not only for the social, economic and environmental performance of regions within this type but also those regions within near proximity.
2. *Suburban areas* – 32 regions – Urban land types have the dominating influence in these regions and there is a clear connection to the gridded type "Suburban residential and economic land extending into peri-urban areas". Urban and infrastructural related land typically consumes 15-20% of the region and as a result, activities related to urban and infrastructural settings are highly influential in characterizing overall land use in the region. The distribution of regions in this type – for instance, most of Belgium – reiterates a noteworthy characteristic when regionalizing grid level results.

The results of the cluster analysis emphasize the vast difference in the size of NUTS regions throughout Europe. Even though the NUTS 2/3 hybrid helps overcome some of the problems with disproportionate regional sizes it is quite clear that heterogeneity is an unavoidable factor influencing the cluster results. For example, relatively small regions (in terms of area), such as those around Brussels and especially city-states have proportionately high shares of urban land covers compared to relatively larger regions, even if they are home to larger cities as well; such as regions in Spain, France, Italy and the Nordic countries. As a result even though a city such as Madrid has an extensive urban area and a huge regional (and even national) influence, it can only be characterized as a "suburban or peri-urban" region because rural land covers still dominate in a physical perspective.

3. *Suburban or peri-urban areas* – 21 regions – Regions in this cluster are either situated in near proximity to large urban centres – such as London or Paris – or are similar to the previous land type in the sense that they have a higher urban land component because of the relatively small area of the region. The urban and infrastructural component typically covers around 15% (and up to 20%) of the land. Relatively high levels of artificial surfaces are also evident in certain regions where large urban areas are situated in relatively large regions (by physical size). For example, regions in Spain or those adjacent to city-states such as London fall into this group. Other examples include larger industrial areas, for instance in southern Poland, or further north in the UK where the region between Liverpool and Manchester serves as a densely populated hinterland for the city activities.

4. *Arable land in peri-urban and rural areas* is dominated by the very high content of arable land defined through CLC classes 12 to 15. These categories cover more than 70% of the land in the 41 regions characterized by this type. The historic role of the agricultural production potential of this land use type for Northern Europe, Central Europe and the Balkans is clearly indicated through its distribution as the immediate hinterland around the major urban centres in the Central-North, and the matrix which constitutes the core population areas along the rivers in the Balkan area.

It is also notable that this land use type is becoming swallowed up by the sprawl of urban and residential related activities; especially in Central Europe. Being among some of the more fertile areas in Europe, the high intensities of crop growth has demanded a process where intensification is supported through increasing land prices. This, in conjunction with better loaning opportunities has limited the options for more traditional land use approaches. As such, these regions are an object of continued speculation in relation to future development and policy related to non-agrarian production and reproduction land uses.

5. *Arable land and pastures in predominantly rural areas* includes 97 regions that share many similarities to the "Arable land in peri-urban and rural areas" type discussed above. Both types are structured by combinations of the two grid typologies of "Arable land in predominantly rural areas" and "Pastures and agricultural mosaics in peri-urban or rural community areas". They show a clear dominance of arable land in combination with permanent crops and some forest land. Both types also have CLC classes 1-3 covering over 4% of the regional area. The main difference however, is that while arable land covered more than 70% in the previous land use type it is down to 50% while pastures, permanent crops and forested areas make up for the remaining differential.

In a von Thünean perspective of concentric farming types around urban areas it is likely that, compared to the previous land use type, we are moving to the next intensity level of concentric circles around the major cities. It seems common that regions in this type could still be highly influenced by the major cities and their constant expansion, though.

Also, compared to the previous type, the land use mix is slightly more diverse and has a slightly lower production potential than strictly arable land. While this is a predominant characteristic of more peripheral areas in Northern Europe, it has occasional appearance in Southern Europe, for instance with coverage in Spain, Italy, Turkey and Greece, but especially in the Balkan region where it constitutes a natural continuum from the more fertile lowland towards the more mountainous parts of the countries. Nevertheless, it is clear that agricultural activity is still quite prevalent in these regions, but the relatively arid climate for many of the regions means that agriculture is often dominated by less intensive permanent crops.

6. *Rural arable land with permanent crops and some forest* is characterized by a mix of arable land, pastures, mosaics and some forest in the 81 regions covered by this regional type. Even with the risk of stretching the von Thünen analogy too long, these regions seem to add a further step in the von Thünen intensity ladder as it is very much a continuation of the trend noted in the previous types, where the dominance of agriculture is waning toward increased presence of agricultural mosaics, often associated with permanent crops, pastures and dispersed forest areas. Compared to the previous regional type, this one shows an increased reduction in arable land – even though it is still dominant with a percentage of around 40, followed by forest areas above 30% while permanent crops are around 20%.

This type has a very diverse extent, stretching from southern Sweden and Finland through eastern, central and Western Europe, while also playing an important role in the south. Its coverage is notable throughout Spain, in central as well as in northern Italy, Romania, Greece and Turkey. This type of diverse spatial coverage adds credence to the notion of it being a very diverse land structure, both in terms of rural land covers, but especially in relation to the mixed role of urban and rural landscapes.

7. *Rural mix dominated by pastures with some arable land* show a diverse land cover throughout its 52 regions. Again, this is a continuation of the trend in the previous three types where arable land, pastures, agricultural mosaics and sporadic forest are being replaced by first and foremost the permanent crops and forest land covers. However, given that no land type accounts for more than 43% of the areas in these regions it is safe to assume a quite diverse land mix in these regions.

Spatially, regions in this type are situated together with the following regional type in the border zone between northern and southern land production types. This seems to indicate a production zone where on-going changes in climate could result in important changes both positively and negatively.

What is even more interesting is the connection to the land situated in coastal areas stretching from Ireland through south-western England, Normandy, northwest coastal areas in The Netherlands and Germany, as well as down to the Spanish isles in the Mediterranean. It also appears to have relations to inland water and watercourses in central Europe. In both cases the interaction between land and water are important as they generate challenges as well as new opportunities. For example, opportunities exist in relation to tourism and possibilities for different types of renewable energy production.

8. *Rural pastures and complex cultivation patterns* is a relatively small but distinct type which to some extent covering 18 regions. It resembles the previous regional type by having a very high component of permanent crops in combination with some arable land as well as pastures, some agricultural mosaics and mixed forest. Its absolute dominance in south-central France and more occasional appearance in Latvia, Northern Ireland, Romania, as

well as in a few regions in central Balkan show that land is dominated by pastures, agricultural mosaics and mixed forest, while the presence of arable land is significantly diminished compared to the previous regional land types. This seems to point toward a few conditions that could be influencing the rural consumption of land. It is quite clear that pasturing is likely the dominant form of rural land use and the presence of forest may not be as high as compared to Estonia, Latvia or Romania where mix between forest and pasture activities is evident.

9. *Diverse land use in rural areas* is among the three major types encompassing a total of 97 regions, but actually represented through two distinctly different types – a northern and a southern type. These show similar overall coverage characteristics, but representing very different landscapes. Being one of the major categories represented in southern Europe and Turkey, it depicts what best can be characterized as typical Mediterranean landscapes. There is a diverse mix of land cover types with statistically significant levels of arable land (25-30%), permanent crops (15-20%) and forests (40-50%).

Similar characteristics account for the distribution of this type in the Balkans, primarily in Romania and Bulgaria. The northern landscape encompassing this type is characterized by the same mix of land cover, but with arable and grazing land being the dominant characteristic compared to forest and scrub coverage in the southern regions. Furthermore, from southern Scotland, across Norway, Sweden, and Finland, as well as into the Baltic States this type is connected to the expansion of more urban activities into former rural areas previously dominated by forestry.

10. *Diverse rural forest coverage with dispersed areas of permanent crops, pastures and arable land* is by far the largest type represented by a total of 171 regions in Europe, and mainly related to mountainous regions dominated by forest. More than 50% of the land is forested, but substantial input of permanent crops (25-30%) and arable land (10-15%) provide a basis for other economic input. However, such a large number of regions in a single clustering with such large variation in terms of landscapes and accessibility make it difficult for further generalization.

11. *Arid mixed forest* – represented through 56 regions, this type is in many ways a continuation of the southern type of the diverse land use in rural areas, but with a higher percentage of forest (50-60%) and it is situated in areas with more mountainous characteristics. It stretches across the whole Mediterranean area from Portugal in west to the most eastern regions in Turkey.

12. *Sparse vegetation with some forests and pastures* has been identified throughout mountainous parts of Europe, and with a major part of the 56 regions situated in Turkey, while the others are dispersed over most of Europe. The regions are characterized by a mixture of forests (30-35%) in combination with sparse vegetation (25-30%) and with scattered areas of arable land (15-20%) and permanent crops (15-20%). It seems safe to assume the land-based production potential could be quite low in terms of traditional rural activities.

13. *Rural forest* typifies 30 regions with a clear northern orientation and where forest covers more than 75% of the areas, while water and sparsely vegetated areas constitutes the rest. In a Nordic setting these areas are responsible for a major part of forestry in the north stretching from Scotland through Norway, Sweden and Finland.
14. *Sparsely vegetated areas* constitute a total of 27 regions, mainly situated in Norway and Iceland, being characterized by a split between sparse vegetation and forest.

3.4. Land Changes

As is immediately noticeable in Figure 3.7, the production of spatial data of land changes involves four regionalized outputs that, when put together, provide an understanding of how different patterns of land change are distributed throughout Europe. These include: Amount of land change, Intensity of land changes, Land change hotspots and the Land use change typology.

1. As shown by Figure 3.7, the method to produce the Amount of change maps is quite self-explanatory. All CLC changes are summed at the NUTS 2/3 level. These totals are then divided by the area of the region to determine percentage of each region undergoing land change. To accentuate regions with high share s of change, only those with changes totalling above the European average for NUTS 2/3 regions are shown.

2. The intensity of land change maps show that average change of intensity for all CLC changes in each NUTS 2/3 regions then provides the regionalized land use change intensity. This does not consider the size (area) of the change, only the change of intensity. This is an important step because, as described earlier, the use of the intensity measure accounts for the consideration of how land changes are corresponding to socio-economic development.

3. Following from the two previous outputs, hotspots show regions where high degrees of intensification or extensification are coupled with increasing levels of overall land change. A 5x5 matrix classes intensity change on the on the y-axis and the amount of regional change (in per cent) on the x-axis. Regions in white are considered to have relatively stable land use characteristics while increasingly darker shades of green or purple identify "hotspots" of change where high intensifications or extensifications are coupled with increasing levels of overall land change. The scales of intensification and physical change were selected based on the wish to have a simple and consistent classification.

4. The Land use change typology begins with the EEA's production of land cover flow (LCF) typology. Out of the 1892 possible combinations of land cover changes the nine types of land cover flows provides a good point of departure for analyzing land changes. The nine LCF types are:

LCF1 Urban land management
LCF2 Urban residential sprawl
LCF3 Sprawl of economic sites and infrastructures
LCF4 Agriculture internal conversions
LCF5 Conversion from forested & natural land to agriculture
LCF6 Withdrawal of farming
LCF7 Forests creation and management
LCF8 Water bodies creation and management

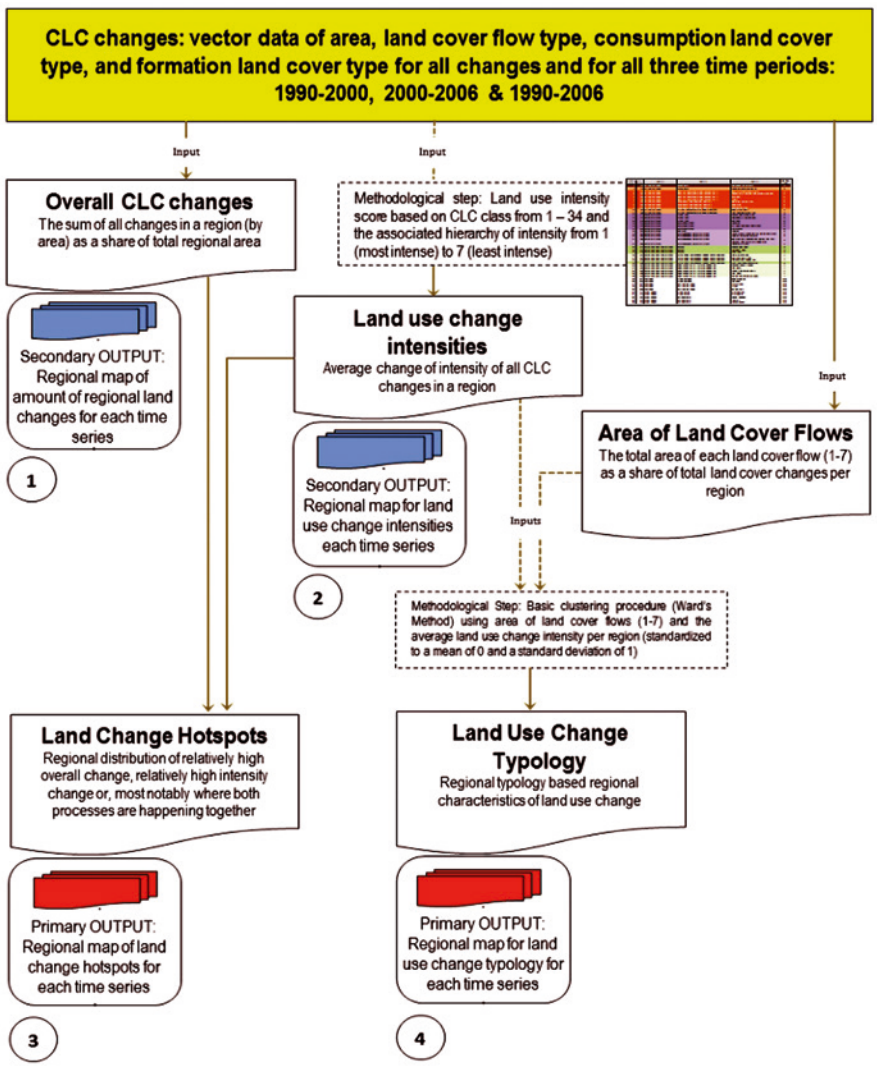


Figure 3.7. Methodological flow to analyse land changes in the EU-LUPA project.

LCF9 Changes of Land Cover due to natural and multiple causes

For our typology we have not added LCF8 and LCF9 due to uncertainty over the drivers of such land changes.

The Land Use Change Typology does not include a 1990-2006 time series because coverage of CLC data is neither unanimous nor consistent for the three time periods. As such, only including regions with CLC representation would not sufficiently cover the extent of the ESPON territory. The ability to keep the typologies separate for each CLC time series also improves the analytical capability of the typologies by allowing for more detailed analysis of the interplay between the temporal, spatial and socio-economic dimensions that both drive and react to land use change.

To begin, the first 7 LCFs are intersected by the NUTS 2/3 administrative areas in order to regionalize the data, showing their percentage of the total land cover change in each NUTS 2/3 region (both by area and as a share of all changes in each region). In order to add the socio-economic dimension to the typology, the average change in land use intensity of all changes in each region is considered. In order to bring the intensity data to a numerical level comparative to the shares of LCF classes mentioned above, it has been standardized to a new mean of 0 and a standard deviation of 1.

The Ward's Method of clustering was then conducted with a query to form 10 clusters. The rationale to choose 10 (rather than 5 or 15) was to on one hand limit outliers with only single or a few NUTS 2/3 regions, while at the same time preventing too large clusters that do not allow for major regional variations to be highlighted.

As shown in Table 3.2 for the 1990-2006 time series, the statistical results of the clustering were organized into tables in order to interpret the results and organize the clusters into Land use change types. It is important to point out that the land use intensity perspective is crucial to our method as it allows us to incorporate the notion of land use into the typologies. As such, the colour-coding of the row labelled "Average change in land intensity for each land change" shows that the clusters are ordered from the highest level of intensification down to the highest level of extensification. This is transposed into the nomenclature of the Land use change types so that the each reflects a kind of hierarchy of change in terms of land use intensity (human intervention on the land for socio-economic purposes).

Nevertheless, the results of the cluster analysis produced 10 clusters in each of the three time series. However, this posed the initial challenge of how to group the 30 clusters into explanatory and policy relevant groups. But as the process unfolded iteratively, it became clear that the similar processes (but happening at different intensities and in comprising different regions) were typical in clusters across multiple time periods. As such, the focus was to identify patterns (groups of clusters) in the 1990-2006 data, and then determining how the other two time series' corresponded to the full time series.

Using the table 3.2, the 10 clusters for the 1990-2006 time series were first organized into seven groups based on a qualitative assessment of statistical simila-

rity and difference between the clusters. This procedure represents a further generalization of the land change processes beyond what is delivered by the clustering procedure itself. It was first and foremost based on the share of total land changes that were related to urban processes, and consideration on the average change of land use intensity for regions in each cluster.

Table 3.2. Statistical results of the cluster procedure used to identify and interpret the Land use change types – 1990-2006. From top to bottom: first, we see the number of regions in each cluster, followed by the distribution of how much each LCF accounts for the land changes for the regions in each cluster. The next set of data shows how much each LCF in the cluster results accounts for the total changes in each cluster of regions. The orange-blue colour ramp is used to reiterate which LCF's – and in which clusters – explain the highest shares of land change.

Next, the grouping of the clusters into Land use change types is presented. Under this, the aggregated averages for the percentage of changes in each type recorded as LCF1, LCF2 or LCF3 – any land change resulting in an artificial surface – is recorded. This is followed by the average change in land intensity caused by the land changes in each cluster, as well as the percentage of the total area of regions undergoing change in each cluster. A red-green colour ramp is used to show the pattern of these indicators through the ten clusters.

1990-2006	**Percentage of the total area of NUTS273 regions corresponding to each Land Cover Flow**									
Land Cover Flow Type	**Cluster 10**	**Cluster 9**	**Cluster 8**	**Cluster 1**	**Cluster 4**	**Cluster 5**	**Cluster 7**	**Cluster 3**	**Cluster 2**	**Cluster 6**
Number of regions	2	9	31	36	71	42	87	86	178	19
LCF1 Urban Land Management	0,07	0,06	0,37	0,12	0,19	0,17	0,11	0,09	0,02	0,01
LCF2 Urban residential sprawl	0,25	0,26	0,61	0,52	0,36	0,29	0,17	0,12	0,03	0,02
LCF3 Sprawl of economic sites and infrastructures	0,28	0,44	1,06	0,54	0,58	0,55	0,37	0,27	0,10	0,09
LCF4 Agriculture internal conversions	0,00	0,13	0,34	0,26	0,50	0,40	0,82	0,92	0,80	2,88
LCF5 Conversion from other land cover to agriculture	0,01	0,15	0,18	0,12	0,10	0,14	0,25	0,13	0,06	0,05
LCF6 Withdrawal of farming	0,00	0,00	0,14	0,09	0,06	0,12	0,20	0,15	0,19	0,52
LCF7 Forests creation and management	0,00	0,08	0,46	0,56	0,56	0,93	1,51	1,97	2,23	2,05
	Percentage of each Land Cover Flow accounting for the total land change in regions									
LCF1 Urban Land Management	12,10	5,48	10,27	5,15	7,40	5,97	2,99	2,35	0,55	0,24
LCF2 Urban residential sprawl	41,00	22,70	17,23	22,71	14,12	10,33	4,79	3,11	0,94	0,37
LCF3 Sprawl of economic sites and infrastructures	45,63	38,89	29,81	23,29	22,52	19,27	10,22	6,87	2,86	1,61
LCF4 Agriculture internal conversions	0,00	11,23	9,51	11,51	19,42	14,14	22,62	23,59	22,84	50,73
LCF5 Conversion from other land cover to agriculture	1,01	13,48	5,18	5,01	3,84	5,01	6,95	3,36	1,73	0,82
LCF6 Withdrawal of farming	0,00	0,16	3,97	4,02	2,36	4,21	5,55	3,91	5,42	9,15
LCF7 Forests creation and management	0,00	6,64	12,95	24,26	21,72	32,81	41,91	50,67	63,42	36,01
Land Use Change Type	1	2	2	2	3	4	5	6	6	7
Average percent of change urban (LCF 1-3)	98,73	58,51			44,04	35,58	18,00	8,34		2,22
Average change in intensity for each land change	4,17	1,84			1,09	0,85	0,62	0,20		-0,29
Average amount of change (%) (LCF 1-7 only)	0,61	2,33			2,58	2,83	3,61	3,70		5,68

No.	Land Use Change Types	Cluster Number 1990 - 2000	Cluster Number 2000 - 2006
1	Very high intensification - land take, often from natural areas	7 and 10	9 and 10
2	High intensification - continued urban land take from rural land	9	5 and 7
3	Moderate/high intensification - urbanizing areas while maintaining rural functions	8 and 2	6
4	Moderate intensification - rural conversions combined with notable land take	N/A	4
5	Moderate/low intensification - mainly rural conversions with low levels of land take	3	3
6	Low intensification - rural conversions with negligible land take. Some agricultural withdrawal	1, 4 and 6	1 and 2
7	Extensification - rural conversions with significant levels of farm withdrawal	5	8

No.		Average Percent Urban Change			Average Intensity Change		
	1990 - 2006	1990 - 2000	2000 - 2006	1990 - 2006	1990 - 2000	2000 - 2006	1990 - 2006
1	10	88-96	96	99	3,08 - 4,29	2,81 - 4,69	4,17
2	1, 8 and 9	73	56-61	51-67	1,98	1,75 - 2,11	1,40 - 2,45
3	4	49-37	67	44	1,09 - 1,52	1,3	1,09
4	5	N/A	36	36	N/A	0,95	0,85
5	7	22	22	18	0,72	0,64	0,62
6	2 and 3	6-11	4 - 12	4 - 12	0,20 - 0,44	0,06 - 0,32	0,05 - 0,35
7	6	3	9	2	-0,35	-0,35	-0,29

Legend of all Land use change types. The left column shows the name of each type, followed by three columns showing the grouping of cluster value(s) corresponding to each type. The next three columns show the percentage of land change (by area) that involves some process of conversion into an artificial surface (Either LCF1 – urban land management; LCF2 – urban residential sprawl; or LCF3 – sprawl of economic sites and infrastructures. The three columns on the right show the average level of change in intensity for changes in each cluster of regions.

Once this was completed, the cluster results from the 1990-2000 and 2000-2006 time series' were grouped with the goal of maintaining the statistical characteristics identified by the 1990-2006 grouping. As shown in Table 3.2 above (in the three columns under the heading "Cluster Number", all but one of the seven groups contains at least one cluster of regions from each time series (the only exception being for the 1990-2000 time series where "Moderate intensification – rural conversions combined with notable land take" isn't included). The rationale for this will be taken up after the description of each Land use change type below.

As again shown in Table 3.2, the seven groups were then named based on their internal distribution of land cover flows, the degree of changes toward artificial surfaces (urbanization), and not least, their hierarchy of inferred land use intensity changes. Analysis of these elements therefore converted the groups of clusters into *types* with an explanatory value. The naming of the types has sought to be descriptive of the predominant changes in each type as well as the key differences between the types.

3.4.1. Amount of land change

Figures 3.6-3.8 emphasize regions where the percentage of change is above the European average for each time period. Within the entire 16-year time period it is notable that in some regions almost 30% of the total area has reported change. The spatial distribution of these changes is also quite territorialized, where vast changes are especially evident in areas such as Spain, Portugal, the Czech Republic, The Netherlands and Ireland. What will be very interesting is to determine the socio-economic and environmental contexts of changes in these different national and regional contexts. This will be drawn out by investigating the intensity and types of changes that define these volumes.

Some of the most significant changes between 1990 and 2000 took place on the Iberian Peninsula. Starting with the agrarian reforms taking off during the 1970s and culminating in the late 1980s, the changes are, in part, likely due to the ascension of Spain and Portugal to the EU in 1986. This resulted in a pro cess where the former agricultural structure was broken up and in many places turned into more intensive forms of production. Also the land ownership reforms in Eastern Central Europe during the 1990s resulted in marked changes, a process which was further fuelled by the expectations regarding future membership of EU in the period up to and after the membership in 2004. These are important observations because they highlight the types of changes that can be expected by current or future candidate countries.

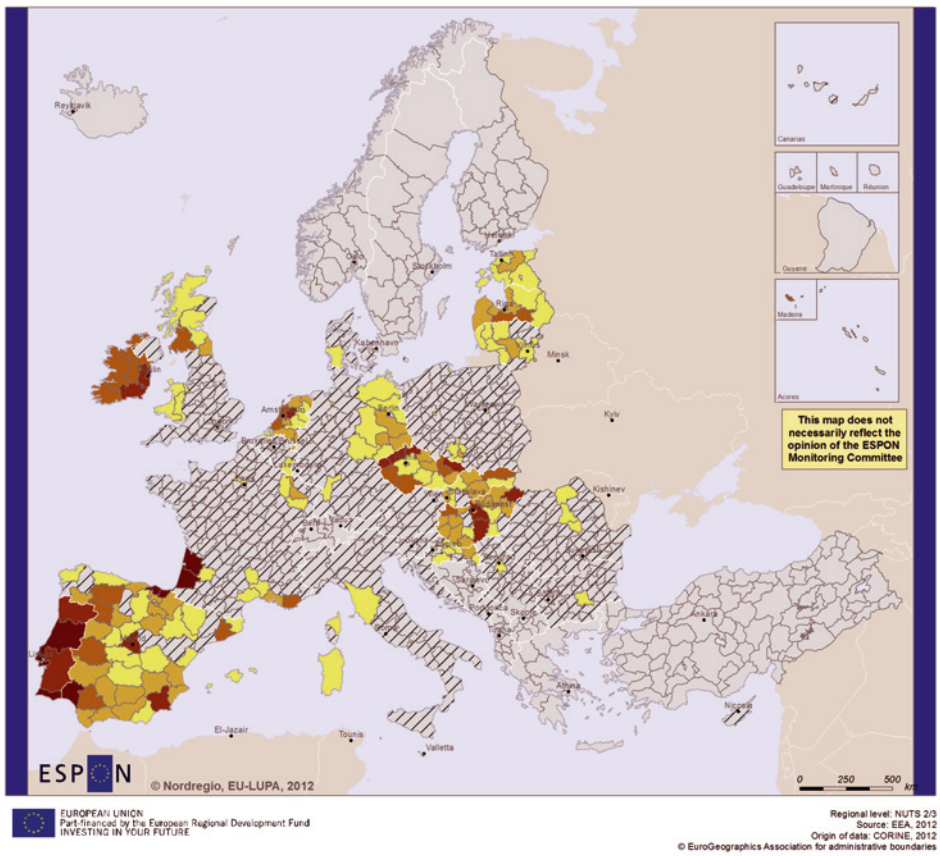


Figure 3.8. Regions with cumulative land cover change that is above the European Average (1990-2006).

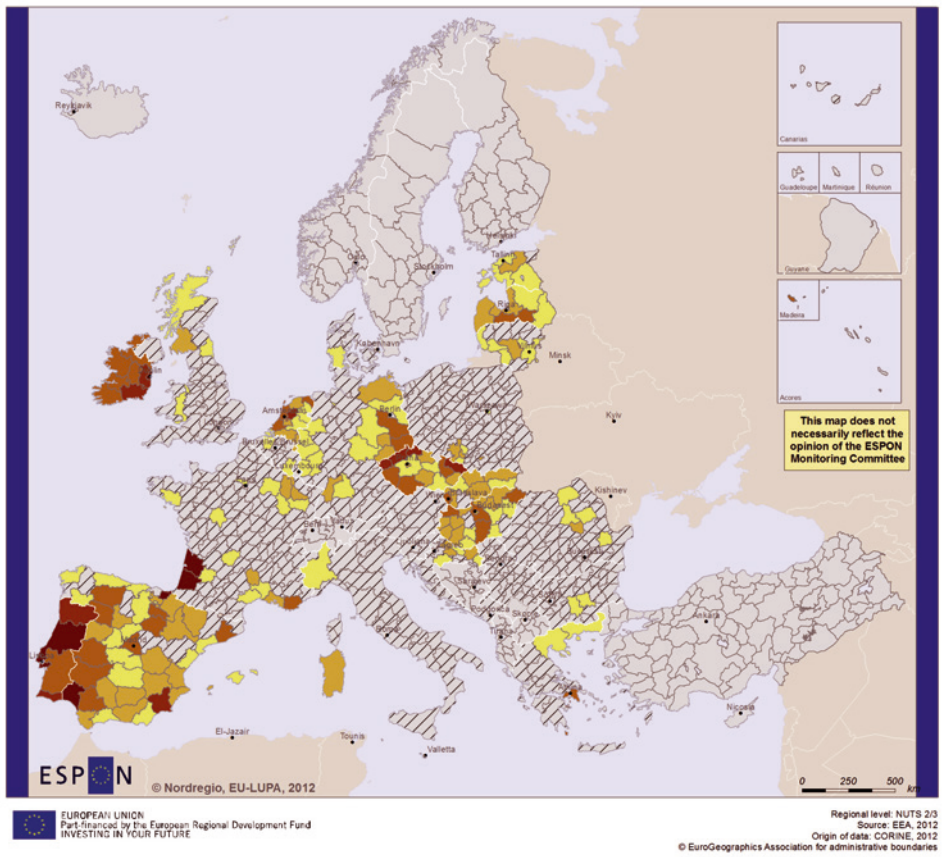


Figure 3.9. Regions with cumulative land cover change that is above the European Average (1990-2000).

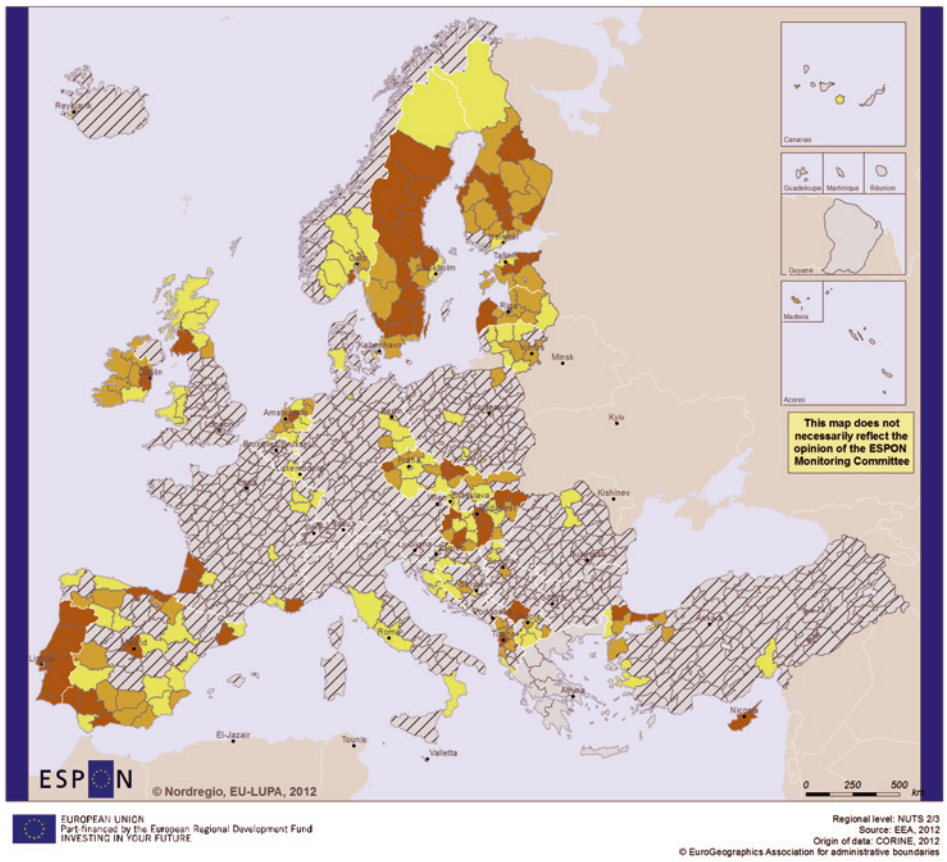


Figure 3.10. Regions with cumulative land cover change that is above the European Average (2000-2006).

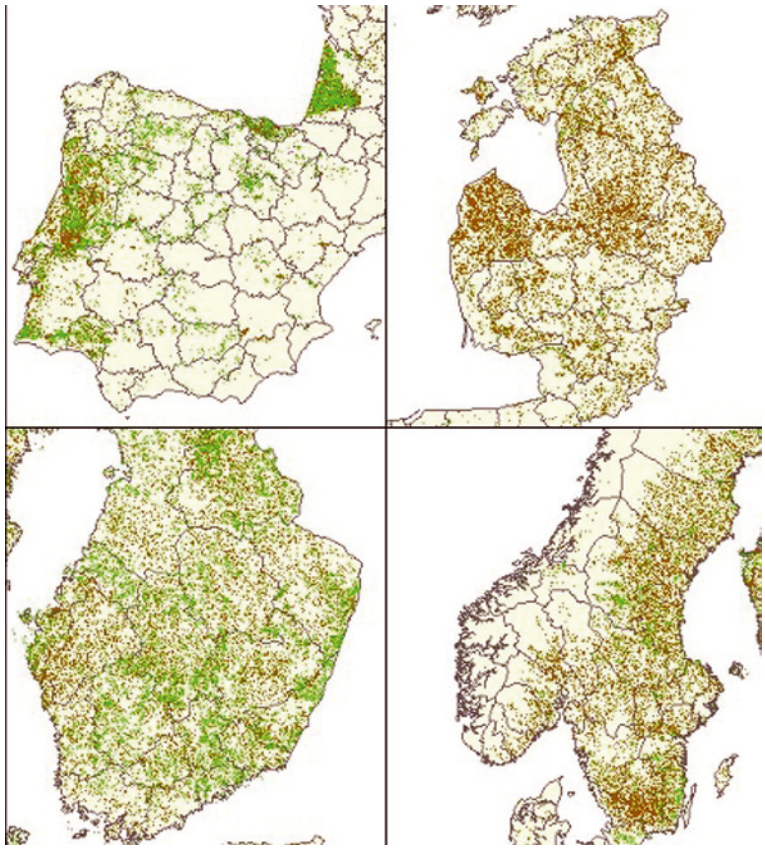


Figure 3.11. Selected areas showing land forest land cover changes. Areas in green reflect afforestation while areas in brown reflect recent felling. Clockwise from top-left: Iberian Peninsula and Lithuania, Latvia and Estonia (CLC 1990-2006), as well as Sweden / Norway and southern Finland (CLC 2000-2006).

Similar changes are not yet observed regarding the Balkan countries as discussions and uncertainties regarding membership in 2007 did not provide the same expectations. Therefore more limited changes during the 2000-2006 periods are noted.

Returning the Iberian Peninsula, the conversion of agricultural and forest land are the primary drivers of land change. Forest conversions are particularly notable throughout Portugal and in northern Spain where a steady balance of land into and out-of forested land covers is notable (EEA, 2011a). This is in fact an essential element to consider when investigating overall land cover changes in Europe.

As reflected in Figure 3.11the overwhelmingly dominant driver of land cover changes by area is related to the transition of forests. This is mainly due to ongoing logging activities, but also includes land being set aside for a return to natural land cover. In terms of the former, forest areas are classed as CLC 23-25 (Forests), however after they are logged they become CLC 29 (Transitional Woodland and Shrub) before eventually return to forested areas. Without such and understanding of this formidable driver of land change, regions in countries where forest activities are present would appear to have a dynamic, less-stable land cover situation. As a consequence, an otherwise continuous land use process will appear as regions showing significant change during individual snapshots of time.

As also shown in Figure 3.11 the production cycle of many decades or even centuries related to forestry is responsible for a substantial part of the major changes registered in for instance Sweden and Finland, but also in Latvia, Estonia, Portugal, Spain and southwest France (See 2000-2006 time period below). It is also very interesting to see the different stages of the felling-afforestation-re-felling transformation cycle the four regions appear to be situated. While a relative dominance of afforestation appears to be taking place on the Iberian Peninsula and in southern Finland, recent felling appears as dominant in southern Sweden and especially in Latvia. It is clear that situations with continued felling without a balance of afforestation are an unsustainable land cover trend. Among the present changes in forestry in connection with energy production is the process of continuous thinning of vegetation which provides more continuity.

However, the most dramatic land change process taking place in Europe is predominantly driven by Europe's path of socio-economic development, which is taking place due to globalization and its effect on the global division of labour. The result has been the continued decline of land-based economic production – i.e. agriculture, forestry, mining and quarrying, etc. – in favour of knowledge-intensive, innovation-driven and service-based economies on the other hand. And this is where the notion of intensity adds to the understanding of processes and mechanisms behind land changes.

3.4.2. Intensity of land change

Each of the three Figures 3.12, 3.13 and 3.14 shows the regional change of land use intensity, where the changes in regions in white are characterized as relatively stable. In these regions, a relatively high number of changes taking place are between CLC classes grouped with the same, or nearly the same, intensity score. As such, it is likely that drivers of land change processes – urbanization or industrial change for instance – have either already taken place, are not yet taking place or are not likely to take place at any point in the near future.

Regions in deepening shades of green are undergoing land changes that cause increases in the socio-economic intensity of land use – toward increased property values and growth of urban areas (artificial surfaces). Conversely, shades of brown

indicate regions where reductions of the intensity of land use are incurred by land changes. In reality, this situation could be due to economically driven processes where activities are no longer profitable, or where policies have had an effect on land use.

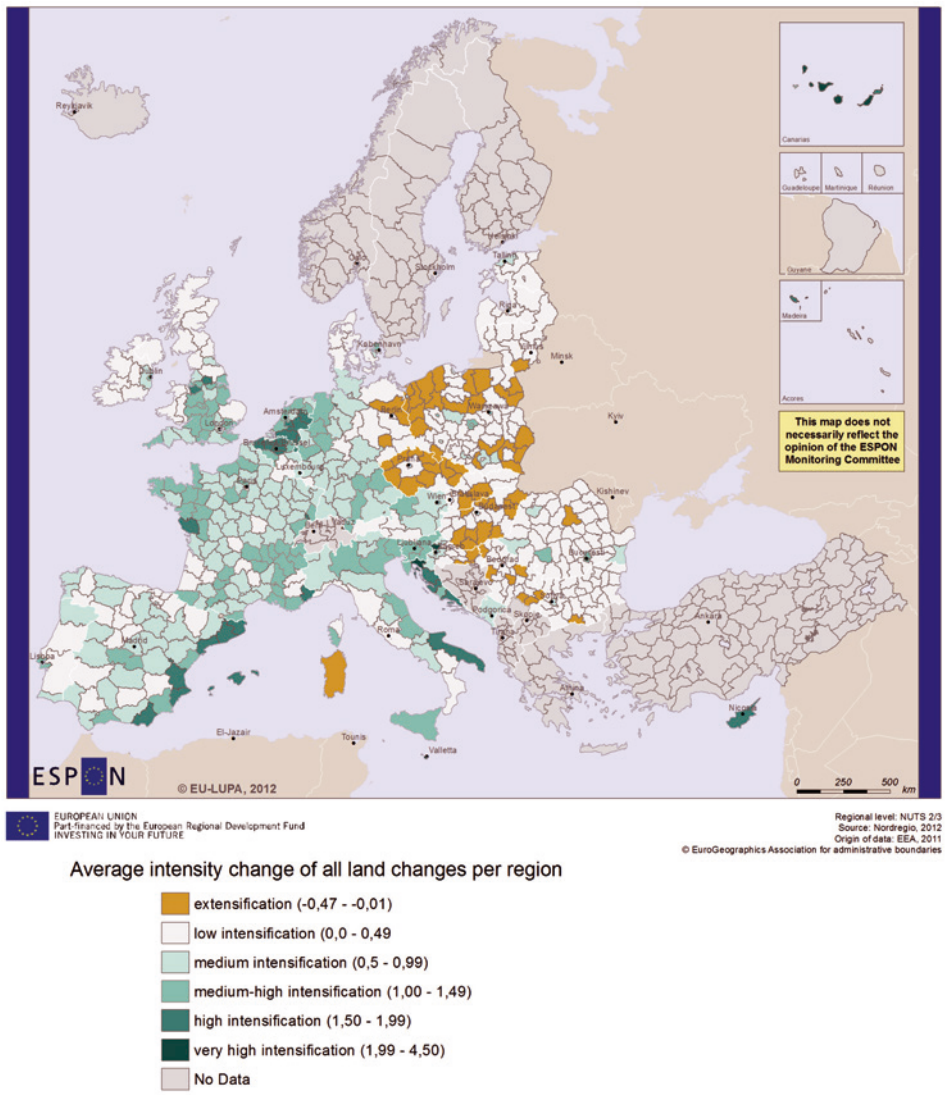


Figure 3.12. Land use intensity change (1990-2006).

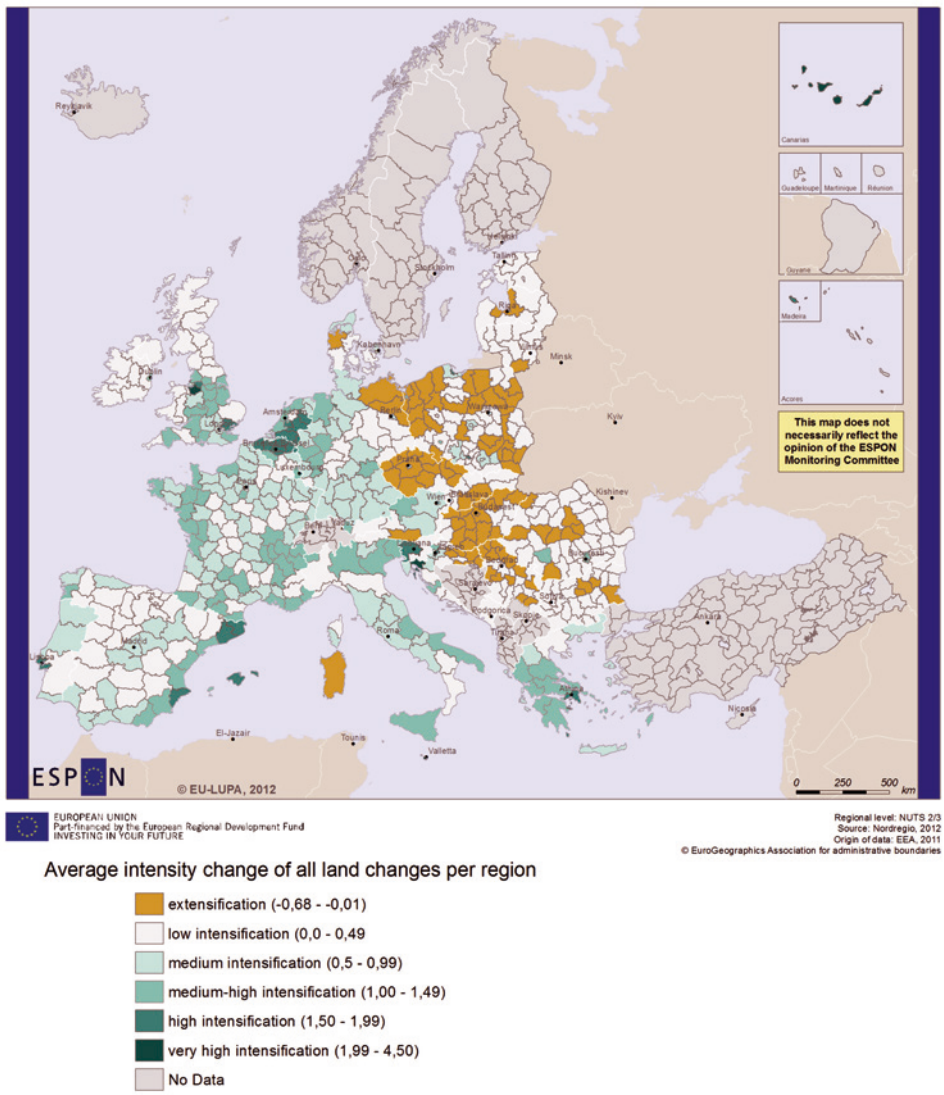


Figure 3.13. Land use intensity change (1990-2000).

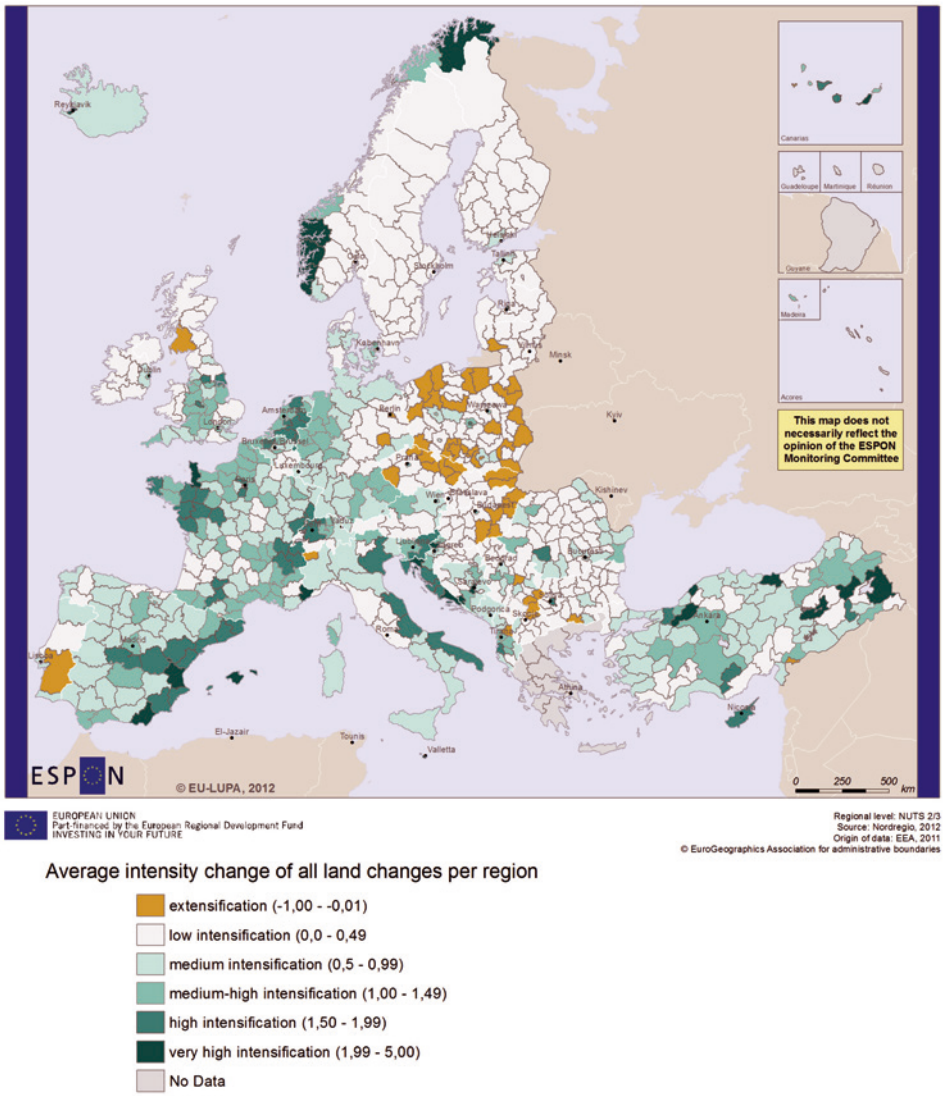


Figure 3.14. Land use intensity change (2000-2006).

In terms of intensifications, in 1990, 4.1% of the EU territory was classified as artificial surface – a share that increased to 4.4% (an 8.8% increase) by 2006. Even more telling is that the European population grew by only 5% in the same time period (Prokop et al., 2011). This 3.8% differential represents an increased per capita land take as a result of the demand for newer and bigger housing, more roads, and growth of business locations; each of which represents the effect of development on the European landscape.

However, national or regional performance for limiting the extent of artificial surfaces cannot simply be judged based on total area or percentage of growth, especially over such a short window of time as 1990-2006. One issue is that the development of sealed surfaces is path dependent on socio-economic positioning and comparing rapidly developing regions against already established ones would be short-sighted and unfair to those regions that are "catching-up". Established regions have already undergone this process, it's just that they have done so in the decades or centuries prior to 1990.

Another issue is that the percentage of artificial surfaces in a given region is highly related to population density. As such it is not surprising that Member States with the highest rates of intensification include ones with regions that are relatively small in area but include relatively large urban areas.

But in terms of per capita urban land take – which is a much more relevant indicator in terms of measuring efficiency or performance of land - the main influences are the existence of second homes, large touristic infrastructures and a dispersed settlement structure. Relatively large shares of second homes are notable to varying degrees in the Mediterranean regions, as well as in Finland, Estonia, Denmark and Sweden, often tied to coastal or mountainous areas where former small scale primary sector activities within fisheries, farming, and forestry have been or are in decline. Meanwhile, extensive touristic infrastructure coupled with a very high average population density is the driver of such a high degree of urban land take in Malta and coastal zones especially around the Mediterranean Sea.

Some of the highlights noticeable in Figures 3.12-3.14 include:

- There is a clear east-west dimension in each of the maps. Large volumes of land use extensification are almost exclusively found in Eastern European member states; particularly in Poland, The Czech Republic and Hungary. This pattern is very dominant in the 1990-2000 periods but continues in 2000-2006 as well.
- High volumes of land use intensification are especially notable in countries such as The Netherlands, Brussels, Spain, Portugal and Croatia. In Spain, this is especially evident for regions along the south and east coast as well as the island regions. On regional/territorial level it is evident that intensification is associated with the growth (sprawl) of urban areas and their associated artificial surfaces. But furthermore – and in a very high degree in, for instance in Portugal, Spain and other Mediterranean areas, the issue of ownership reforms

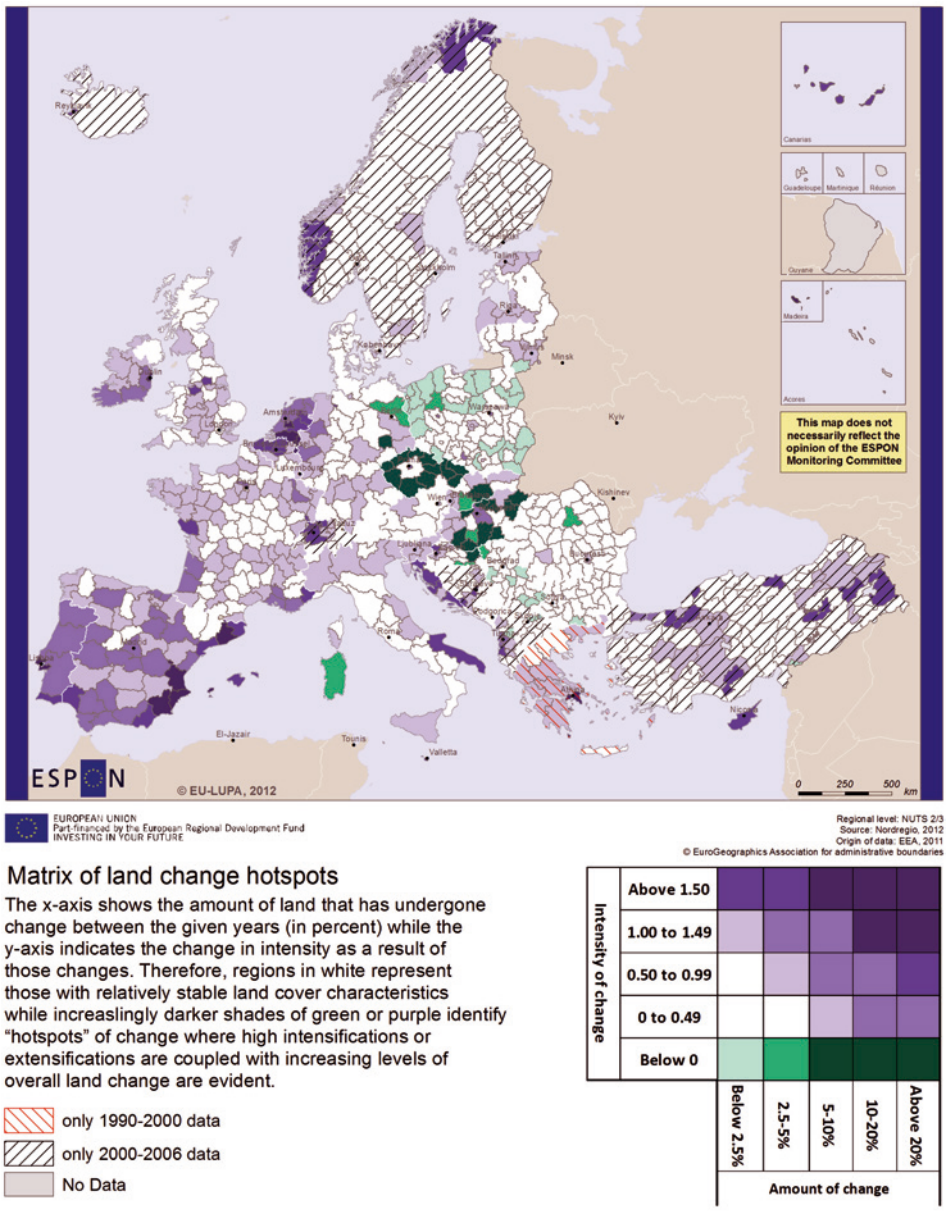
and characteristics of land tenure are a driver of intensification. This issue will be dealt with in more detail in relation to the identification of land change hotspots. Intensification also appears to take place in a greater degree for coastal regions (cf. in Spain, France, and Croatia). It is possible that this pattern is related to the growth of the coastal tourism in these regions, but additional validation is necessary.

- In the Czech situation it is interesting to point out the seemingly high degree of rural extensification being countered by urban-related intensification in the capital region of Prague. Further, when comparing the 1990-2000 and the 2000-2006 results (Fig. 3.13 and 3.14), even while taking into account the much larger time span in the former time period) it appears that extensification processes have slowed for the country as a whole. EEA country analyses show that the main driver of extensification has been the conversion of different crop areas into land for pasture. This is a process which has been driven by national policy that uses subsidies to encourage the grassing of arable and extensive grassland management.

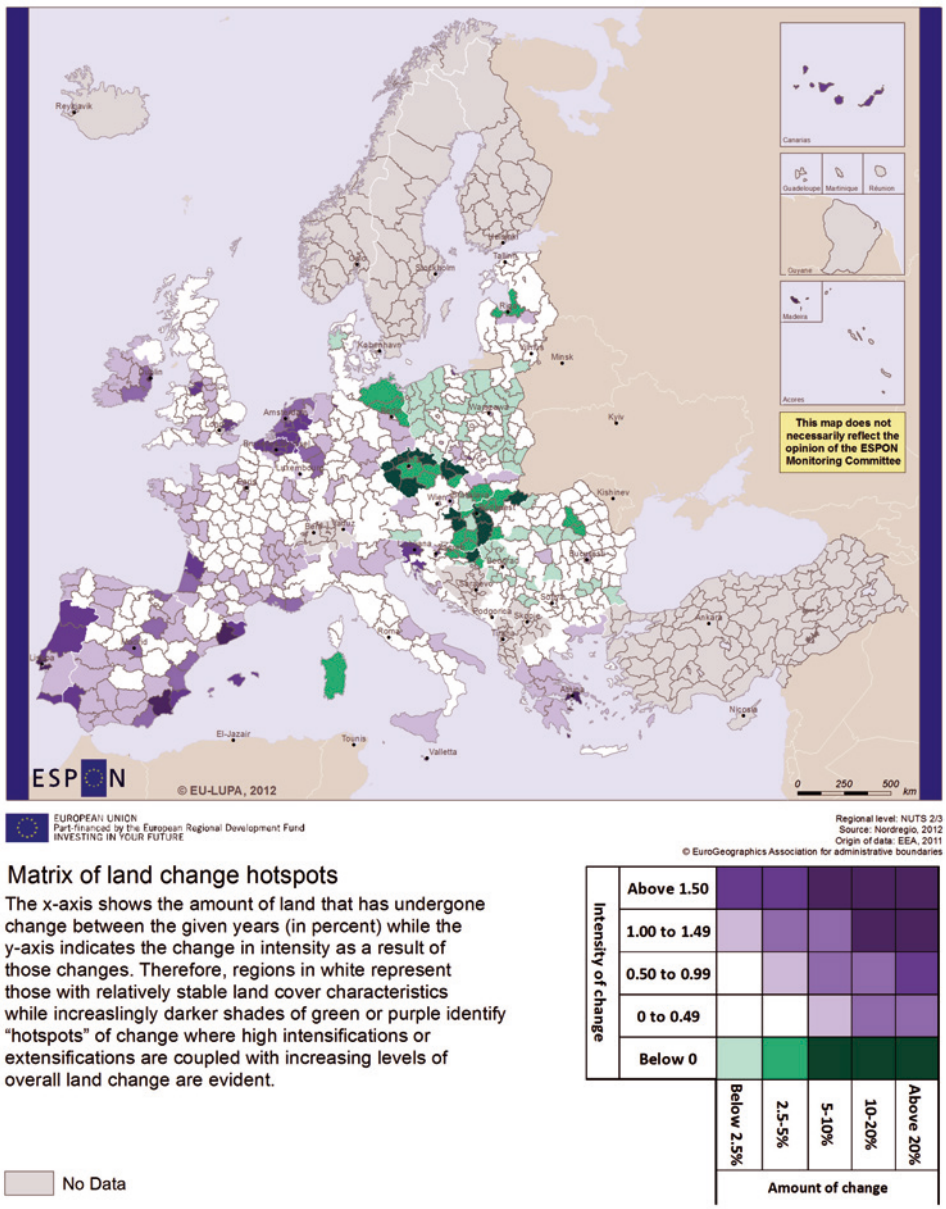
In the 2000-2006 time series (Fig. 3.14) very significant intensification is especially notable in particular regions of Norway. These are regions that, based on Figures 2.1, 3.4, 3.5 we know have undergone relatively little amounts of land change (by area); however the changes that have taken place were very intensive. This is due to the development on intensive mining, hydrocarbon extraction and other heavy industrial activities in rural and remote locations. Interestingly, these intensifications are not taking place in parallel with extensification of other land covers in these areas, which indicate that these are "new" economic activities that are taking place on previously stable and unchanged land.

- Quite high rates intensification is notable for many regions in Spain in all three time series. The highest levels of intensification have taken place for coastal regions along the Mediterranean and for the island regions. This is clearly related to the growth of artificial surfaces in urban areas. CLC flow data and EEA land cover analysis (EEA, 2011a) indicates that much of this intensification is due to the sprawl of economic sites and infrastructures (which both construction areas and transport infrastructure are grouped).
- For agricultural withdrawal, abandonment processes have been most pronounced in the central-south and north-east regions of Hungary (between 2000 and 2006), on the Italian island of Sardinia (between 1990 and 2000), and in Ireland and southern Portugal to differing degrees throughout the 1990-2006 period.

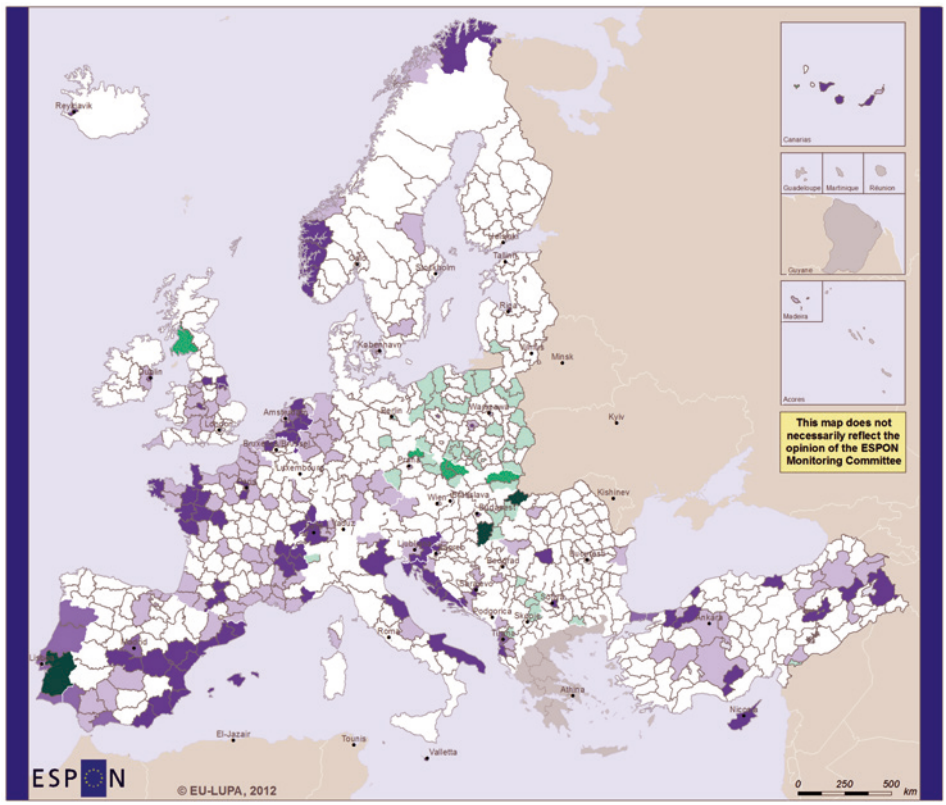
3.4.3. Hotspots of land use change



Figures 3.15. Hotspots of land change (1990-2006).



Figures 3.16. Hotspots of land change (1990-2000).



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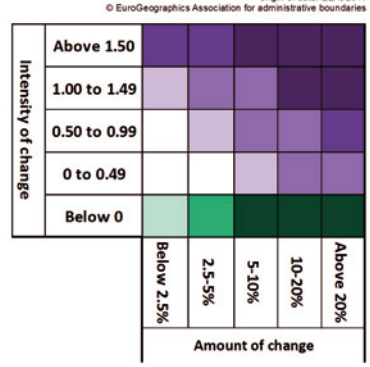
Regional level: NUTS 2/3
Source: Nordregio, 2012
Origin of data: EEA, 2011
© EuroGeographics Association for administrative boundaries

Matrix of land change hotspots

The x-axis shows the amount of land that has undergone change between the given years (in percent) while the y-axis indicates the change in intensity as a result of those changes. Therefore, regions in white represent those with relatively stable land cover characteristics while increaslingly darker shades of green or purple identify "hotspots" of change where high intensifications or extensifications are coupled with increasing levels of overall land change are evident.



No Data

Figures 3.17. Hotspots of land change (2000-2006).

– The question of land ownership and land tenure has been extremely important in relation to the registered changes in Southern Europe, and especially on the Iberian Peninsula. Until the late 1970s and 1980s in Spain and Portugal land ownership was characterized by Latifundias, i.e. extremely large private estates with the owner usually living in the larger cities and, generally speaking, very low land use intensity. In Portugal, Agrarian Reform in 1975 was an important part of the "Carnation Revolution", and laid down the principles for the expropriation of land from the Latifundias and distributing ownership to former workers or tenants. While some intensification took place the attempts to establish cooperatives had a limited effect. However, a breakthrough in relation to market based economy followed by reformed Agrarian law enacted by the parliament in late 1988 enabled the new ownerships to move towards more intense production structures. At the time of EEC membership in 1986, low land and labour productivities were the most striking features of Portuguese agriculture (Mykolenko et al., 1987). Especially in areas close to urban centres were the first places to take advantage of the opportunities connected to the CAP (Diogo and Koomen, 2010).

Consequently, all regions in Portugal are identified as hotspots – albeit to differing degrees – in all of the time series. Consultation with the maps showing total land change by area shows that this is mainly due to the fact that all regions show very high levels of overall change. Conversely, the intensity maps above show more stable patterns with the exception of two regions, Lisbon and Alentejo. In the former, intensification is predominantly related to residential sprawl between 1990 and 2000; a process that has slowed considerably since then (EEA, 2011a). In Alentejo, relatively high land change is characterized as an extensification process. This is due to the fact that land abandonment due to the withdrawal of farming activities (EEA, 2011a).

– Besides processes similar to the above described, where a clear divide between Latifundios (dominating in the south) and Minifundios (dominating in the north) both have been characterized by low productivity the membership of EU has had some of the same land use consequences as in Portugal. Intensification due to structural changes in land ownership has been an important factor, and this combined with the CAP accounts for much of the intensification taking place in rural areas. As emphasized by Montiel Molina (2002, p. 2), however, "Land tenure is, after decentralization, the second most important supporting/impeding factor for National/Regional Forest Programmes in the Mediterranean regions". In the case of rural Spain the changes can be illustrated through the example of the Dehesas, a traditional, low-input, extensive agroforestry system (Meeus, 1995, here from Plieninger and Schaar, 2008) combining forestry with extensive livestock grazing and farming. Low productivity and low intensity has been an easy target for intensification whe-

re the most influential force being the Common Agricultural Policy, which supported the production of cereals and cattle, sheep, and goat husbandry in the dehesas. Again an important process adding to explaining the changes in intensification.

- On the Iberian Peninsula, but definitely also in other parts of Southern Europe, a starting point characterized by very low land use intensities in rural areas and farming practices more related to subsistence and local markets than to European and World Market conditions have been an obvious starting point for a process of land use intensification in rural areas that took off before 1990, peaked in the period 1990 to 2000, and now being more or less "normalized" except for regions in Portugal where intensification of rural areas are still on-going. And instead of rural intensification related to rural activities many of former rural areas – especially in coastal areas – are exposed to a new category of intensification related to urban sprawl.
- In contrast to the situation on the Iberian Peninsula, the immediate effects of the inclusion of East-Central European countries – previously part of the "East Block" mostly characterized by state and cooperative ownerships – are reflected through a drastic decline in intensity over substantial areas in the period from 1990 to 2000. In contrary to the situation in Spain and Portugal the basic land reforms distributing former estate land to small and medium scale farming had taken place pre Second World War, and in many cases during the 19th century. The structural changes connected to the post WW2 reforms in ownership instead resulted in the establishing of state farms and cooperatives. It had some immediate consequences in relation to both intensity and productivity, and was paralleled by regional policies in relation to rural areas due to the state interests in maintain a high level of production to serve the requests from the Soviet Union through COMECON. And as a consequence transfer payments and subsidies enabled intensities and productivities that were unrelated to market conditions. So the development from 1990 and onwards abandoning the former state and cooperative ownerships forms has had some immediate consequences in relation to intensity. On one hand that many of the new private farms were small and did not have the necessary means to ensure a high intensity in land use. And on the other hand that the larger farms with intensification potentials in many cases involved foreign investments which did not necessarily lead to intensifications. The situation in Poland being different in this respect because of a dominance of private land use activities, and as a consequence effects as described above only relating to the relatively smaller areas owned by cooperatives and a few state holdings as well.

- The situation in Poland was, however also affected through the lack of funding for investments in many of the small farms functioning more as subsistence bases for a still older population – a situation that can be found in rural areas, not the least in regions remote to the capital regions or in mountainous areas in most of the former "East Block". And several of the regions where this has been the dominating characteristic has continued being regions of decreasing intensity through the 2000-2006 periods as well. One important element in this connection has in Poland been the small size of a substantial part of the already private farms. The advantage in other parts of East-central Europe has been that in the aftermath of the first round of extensification the new private farms were able to establish themselves not as subsistence activities but as professional and capital intensive farms on previous state or cooperative owned large scale farms. And similar situations have appeared in relation to other types of land use.
- Ireland being a "hotspot" for IT development during the 1990s had some spin-off in relation to increased intensification of activities related to land use. Partly because the attraction of labour force away from direct land use to industrial activities required adjustment in land related activities requiring technology to replace the missing workforce. With a partly collapse of the IT-adventure after 2000 the process described above came to a halt, and the shift is apparent when comparing the 1990-2000 and the 2000-2006 situations.
- While missing data for Sweden, Finland and Norway for the period 1990-2000 does not allow a comparison between the two periods, an important issue of the effects of increasing activities related to resource extraction, especially in relation to oil and gas development, is very apparent for the 2000-2006 period shown for Norway. While fisheries used to be a mainstay for coastal communities in Norway the picture today is a high degree of dependency on the sea, but in relation to energy resource extraction. This leads to the inclusion of large areas for on-shore production facilities, but requires at the same time related economic activities – processing, investigation, planning, education etc., which shows through inclusion of still larger areas for housing.
- European tourism is an activity requiring still larger areas, and the development of the Spanish coastline illustrates that it is not only a question of short term changes, but seems to have been a consistent development process throughout the whole period from 1990 to 2006.

While the hotspots enables us to identify places in Europe where marked changes have been taking place during the last 16 years, the development of a typology which is able to capture these changes and provide a connection between types and processes of change, an important planning instrument will be at hand. So the next step is to turn the focus on such a typology.

3.4.4. Regional Typology of Land Use Change

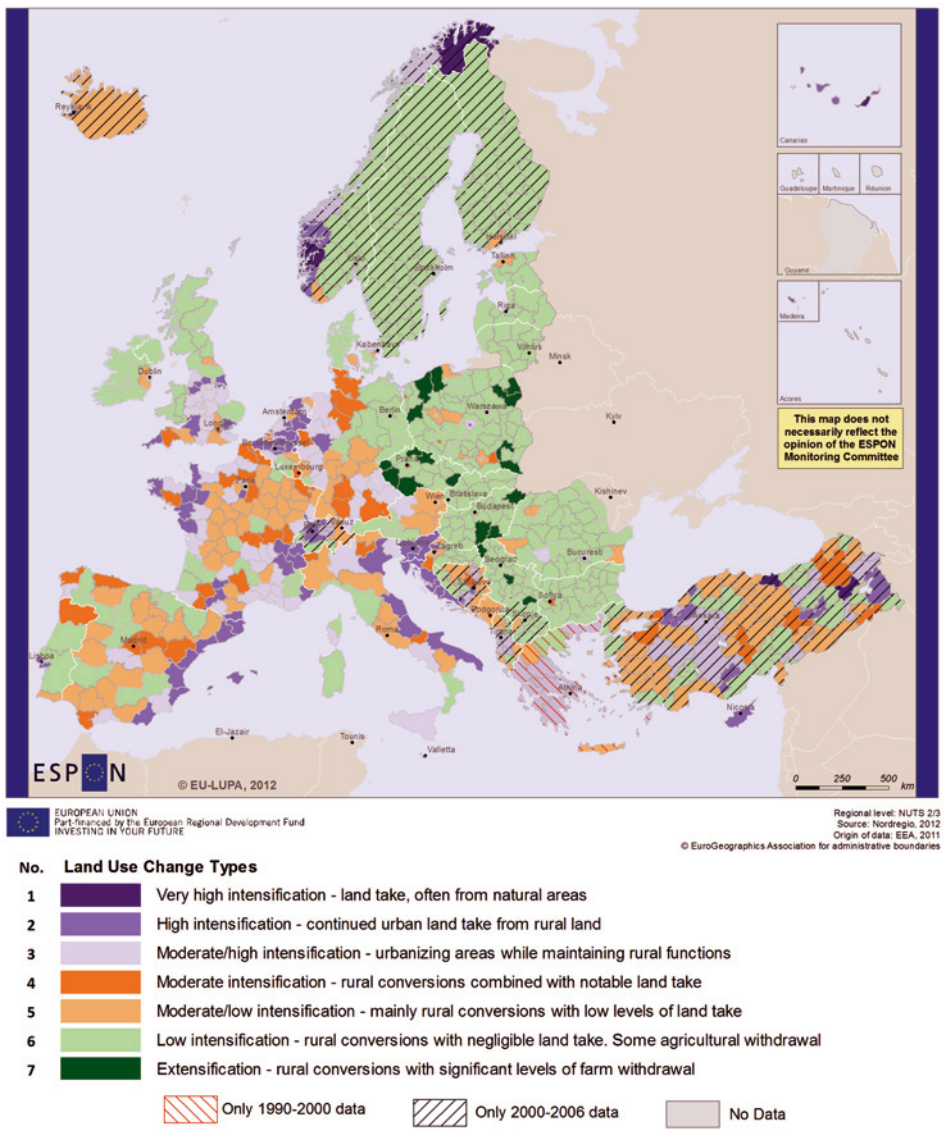


Figure 3.18. Land Use Change Typology (1990-2006).

Figure 3.18 shows the distribution of Land Use Change types among NUTS 2/3 regions for the 1990-2006 time series. However, only 561 of the 772 NUTS 2/3 regions have CLC data for all three time periods. Regions missing data for one of the periods are filled using data from either the 1990-2000 (Greece) or the 2000-2006 (all black cross-hatched regions) time series.

Using Table 3.2 as a basis, each of the Land Use Change types are interpreted in relation to the 1990-2006 time series below. It should be noted that the presentation of the information box for each type covers the statistical breakdown of the 1990-2006 data only, while, as mentioned, the map above has filled the gaps using typology results from the other available time series'.

Following the description of each Land Use Change Type the presentation of the individual time series' (1990-2000 and 2000-2006) will help to identify some of the changing patterns of land use change for Europe.

Table 3.3. Type 1: Very high intensification – land take, often from natural areas.

Cluster number	10
Number of regions	2
Average Per cent Urban Change	99%
Average change of intensity	4.17

Table 3.2 shows that the three regions in this cluster are very unique. The land changes that have taken place are almost exclusively related to development of artificial surfaces, and especially the extension of these surfaces on previously natural land (only 12% of the changes are changes from one form of urban surface to another, while 87% relate to sprawl into previously unsealed surfaces. This pattern is reflected by the average intensity change of four. The very high level of intensification indicates the formation of these land uses results from the consumption of very low intensity land covers; most likely natural landscapes. Presence of this Land Use Change Type is limited to the Canary Islands and northern Norway.

Table 3.2 also shows that the area of the change is very small, thus indicating very concentrated developments. This is substantiated when looking at the regions in this type (Grand Canarias, and Malta for the 1990-2006 period, but also including coastal regions in Norway and two regions in Turkey). In the case of the Spanish regions and Malta it is clear that sprawl of touristic infrastructure into natural landscapes is taking place. In Norway, it is clear that the typology reflects the continued development of infrastructure needed to support the growing oil and gas development as well as the mining sectors. These activities are expected to expand further in sparsely populated areas of most of the Nordic countries in the next decades.

Table 3.4. Type 2: High intensification – continued urban land take from rural land.

Cluster number	1, 8 and 9
Number of regions	71
Average Per cent Urban Change	51-67%
Average change of intensity	1.40-2.45

This type includes regions from three clusters, each where more than 50% of the land changes resulted in a further urbanization (15%, 57% and 67% for clusters 1,8 and 9 respectively). This is also reflected by the high intensity scores, which together show that the dominating process taking place is land take and thus urbanization. Interpreted through Figure 3.18 we see that this type reflects at least two types of regions: first, those regions encompassing national capital or large urban centres (or in daily commuting distances). This reflects the reality of growth of urban regions in Europe and is especially evident in the U.K., The Netherlands, Belgium, Switzerland and France. In this context, the term "continued" is used in the naming of the type to reflect that many of these regions could already be defined as containing dominant "urban functions" prior to the 1990. The fact that very few "rural" land changes (forest conversions or agricultural changes) appear to be taking place also insinuates that these are already established urban areas.

In this context it is also interesting to point out that large, global cities (which are NUTS 2/3 regions in and of them) are not characterized through these Land use change types reflecting intensive, urbanizing land changes. In contrast it is the surrounding, functional region where the most intensive land changes are occurring, which reflects the process of sprawl associated with growing urban regions.

In addition to these existing urban centres, and like the regions in the previous type, this type also includes regions where land change processes are clearly dominated by a growing tourist economy. For example, almost all of the regions accounting for the Spanish Mediterranean coast and the Balearic Island are included, while the same holds true for coastal Italy, throughout Croatia and in Cyprus. This is substantiated by a recent report on best practices for limiting soil sealing (Prokop et al., 2011) where the main driver of high soil sealing per capitais the experience economy (second homes, touristic infrastructures, etc.). Not underestimated as a driver of land use change in these regions is the development of large infrastructure projects, such as highways, which we know to be responsible for land take in Spain and Croatia among other countries.

Table 3.5. Type 3: Moderate/high intensification – urbanizing areas while maintaining rural functions.

Cluster number	4
Number of regions	72
Average Per cent Urban Change	44%
Average change of intensity	1.09

The distribution of LCF's 1-7 in this type are quite diverse, yet it is possible to make some general characterizations, especially when considering the spatial distribution of the 72 regions making up this type in the 1990-2006 data (again, additional regions are added when using 1990-2000 and 2000-2006 data to fill the gaps). Here, we clearly see that, apart from regions in the "blue banana" with land changes reflected in the previous two types, this type fills in much of the remaining gaps (e.g. the southern half of the U.K., through The Netherlands and Western Germany, and south into France and Switzerland and extending to the large NUTS 3 region where Milan is situated).

In addition to the blue banana we also see this type extending through southern France, in two "peri-urban" regions surrounding Madrid, throughout Greece (in the 1990-2000 data) and, notably, in selected urban regions in city-state regions (or those directly surrounding them) in Poland (i.e. Warsaw, Łódź and Poznań). In general we also see that this land use type is predominantly located in Western European regions.

The statistical information from Table 3.2 shows that a relatively high percentage of the changes, 7.4%, relates to LCF1 – Urban land management. This insinuates that these regions have established urban activities, likely in contrast to very recent processes of urbanization, and that the sprawl of housing, economic sites and infrastructures (LCF2 and LCF3, totalling 37%) is taking place around established centres of socio-economic activity. Yet while this 44% of changes are attributed to urban processes, it is notable that rates of both agricultural formation (LCF5) and withdrawal of farming (LCF6) are very low (under 4% of total changes for each). Coupled with moderate levels of agricultural internal conversions (LCF4 – 19%) and forest creation and management (LCF7 – 22%) we can conclude that these rural land functions are still important contributors to socio-economic development, and that these processes appear to be quite stable.

Table 3.6. Type 4: Moderate intensification – rural conversions combined with notable land take.

Cluster number	5
Number of regions	42
Average Per cent Urban Change	36%
Average change of intensity	0.85

Unlike the previous clusters, a threshold has been crossed where the average level of land use intensity change is now less than 1. Similarly, the share of "urban" land changes is reduced to 36%, but is still a notable impact of land change. As such, regions in this type appear to have mainly rural land functions but urban changes are perhaps increasing in number and are important for meeting development goals. Further, it seems that this type, along with the next type as well, indicate regions with very diverse constellations of land changes taking place.

As mentioned previously, the statistical characteristics of this type were found in the 1990-2006 and the 2000-2006 data, but not in the 1990-2000 time series. As will be discussed below this could be indicative of a further "mainstreaming" of urbanization throughout a wider share of previously rural regions in Europe compared to the 1990-2000 period.

However, we also see that many of the regions in this group are relatively large area-wise. As such this could indicate an unavoidable constraint of the typology classification for relatively large regions: where rural land changes take place over broad areas trump urban land change processes that are very intensive but take place on a comparatively smaller scale. This reiterates a key challenge of the project: to attempt to merge spatial phenomenon which operates relatively independent from administrative/political spatial structures with administrative boundaries that are hugely disproportionate in size.

For example, we know that regions with large cities in their borders, such as Madrid, are regions where a vast majority of people live in the urban centre, and where urban sprawl is taking place. Yet due to the large surrounding areas within the administrative border the region appears with non-urban land changes as dominant.

Table 3.7. Type 5: Moderate / low intensification – mainly rural conversions with low levels of land take.

Cluster number	7
Number of regions	87
Average Per cent Urban Change	18%
Average change of intensity	0.62

The land use change characteristics in this type are similar to the previous type except the rural land change process processes increase in their role of defining regional changes ("urban" land changes in LCF's 1-3 decrease by 50% from the previous type and are mostly replaced by agricultural conversions and forest creation and management). This appears to emphasize a transition toward regions that are understood as mainly rural from a socio-economic perspective.

Similar to the each of the previous types there is quite a clear east west dimension to this type as well. However, it is interesting to note that while this type is dominant in Western Europe (it is the most common type in continental Western Europe) it characterizes the land use changes in selected regions in selec-

ted Eastern European Member States as well. For example, we know that Poland has continued to shift toward the socio-economic standards defining regions in Western Europe – and has done so to a greater degree than other New member States such as Romania, Latvia Estonia, Bulgaria, Slovakia, etc. Consequently, we see more orange regions – with at least a medium level of relative intensification toward urban land uses – in Poland (compared to the green regions in the other Member States, which show that rural land changes still dominate).

This adds credence to a type of processional shift in land use that could be an almost unavoidable impact of socio-economic development toward a modern economic economy. If this holds true we could expect that future regional land use changes types in Poland (which became a Member State in 2004) could reflect those shown for inland Spain (which joined the EU in 1986).

Table 3.8. Type 6: Low intensification – rural conversions with negligible land take. Some agricultural withdrawal.

Cluster number	2 and 3
Number of regions	264
Average Per cent Urban Change	4 - 12%
Average change of intensity	0.05 - 0.35

Table 3.8 shows that regions in this type are characterized by land changes that, put together, and result in a very neutral level of intensification. However, based on the discussion above rural land changes trumping urbanization in relatively large regions, we know that this low intensification could be the result of two different trends. For example, the Skåne region in southern Sweden is in this type, but as reflected in the case study on the Øresund region in the next chapter, we know that quite high urban development took place around the City of Malmö during and following the construction of the Øresund Bridge. However, the large amount of agricultural conversion in the rural parts of the region appears to mask this development in the typology results. Again, this reflects the difficulty of attempting to formulate a typology that can overcome both the scale factor (differing size of regions), the time factor (results of rapid changes take time to be registered) as well as the underlying reality that a diverse set of land uses and changes (which are often completely isolated from one another in space) are occurring in the same region.

Nevertheless, the more common representation is of regions that are rural and with urbanization land changes accounting for only 4-12% are, for the most part, are staying that way. The changes that do take place predominantly relate to forest and agricultural conversions (mainly forest in the Baltic Sea Region and mainly agricultural in most of continental Europe. However, we do begin to see a slight rise in LCF6 – withdrawal of farming, which implies that certain regions in this type are being exposed to pressures of changing socio-economic realties, not least population loss due to the increasing supply of jobs in urban centres.

Table 3.9. Type 7: Extensification – rural conversions with significant levels of farm withdrawal.

Cluster number	6
Number of regions	19
Average Per cent Urban Change	2%
Average change of intensity	-0.29

Regions in this "extensification" type are unique and important to acknowledge because they highlight regions where cumulative land changes in have resulted in an extensification of socio-economic activities taking place on the landscape. For a vast majority of the regions, if not all, the dominant driver is the reduction of agricultural activities. On average, 9% of the land change in these regions is related to agricultural withdrawal – a significant share indeed. Not surprisingly, this trend is driven by urbanization, particularly of younger people to urban centres in search of higher quality jobs but to some extend also through withdrawal of activities which have been kept "alive" through different supporting mechanisms. Consequently, traditional jobs in rural areas suffer from low replacement rates of an aging labour force. As such, land use changes seem to reveal a socio-economic trend of rural stagnation and decline as rural land-based activities are being replaced by growth that is concentrated in urban areas.

Regions in this type are exclusive to Eastern European and new member states, with notable distributions in Poland and the Czech Republic. What is important to consider however, is that the processes of urban development (the purples and oranges in the typology) and the processes of rural stagnation or decline (the greens in the typology) do only reflect independent drivers. From a theoretical perspective of Growth Poles, a clear example of this is in Poland where urbanization processes in selected regions appears stronger than in other New Member States. However, to meet this growth urban centres are plucking their labour force from rural regions, therefore leading to extensification of rural area.

As such, a common challenge of land use change reflects the polarization of economic activity: rural areas could continue to experience significant agricultural withdrawal while urban centres will continue to expand as population growth and economic activities continue to be concentrated in them. Another important challenge is related to future situations where policy measures in relation to for instance re-organization of the CAP, change in regional supporting mechanisms from block grants to targeted issues such as poverty, environmental protection, or change in perceptions of what are "liveable landscapes" etc. may have on the direction of land use change. In these context typologies where measures of intensities combined with basic socio-economic accounts such as population density and GDP seem to be very useful.

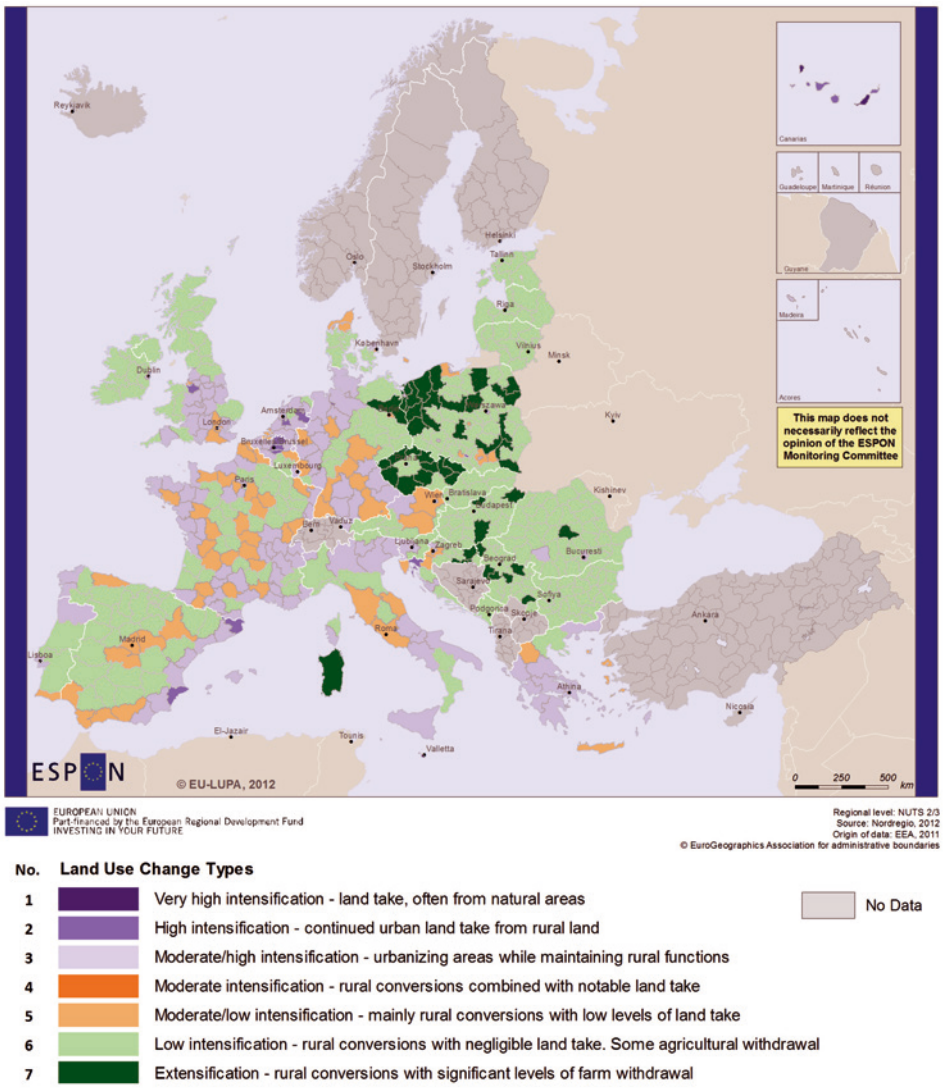


Figure 3.19. Land Use Change Typology (1990-2000).

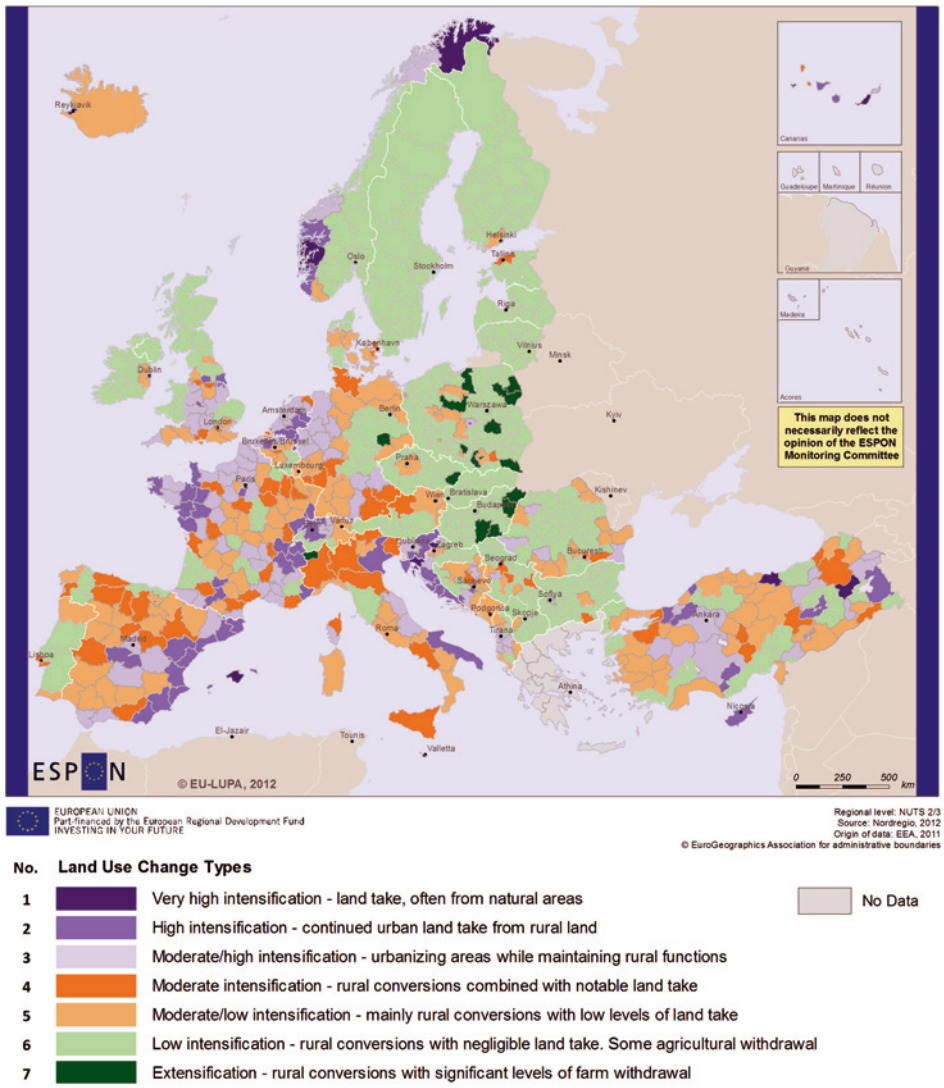


Figure 3.20. Land Use Change Typology (2000-2006).

In addition to showing the main Land Use Change Typology for the 1990-2006 time series it is advantageous to show the 1990-2000 and 2000-2006 time series' as well. On one hand, this data has been used to fill gaps in the main typology where CLC data is unavailable. But it also highlights important spatial trends of land use development.

For example, it was mentioned that the Land use change type "Moderate intensification – rural conversions combined with notable land take" is the only type not included in all three of the time series (it is not included in the 1990-2000 time series, but is prominent in the 2000-2006 time series). Likewise, it is clear to see the much higher number of regions in the "High intensification – continued land take from rural land" type in the 2000-2006 time series compared to the 1990-2000 time series as well.

Both of these observations indicate that processes of urbanization are becoming a more mainstream, and dominant phenomenon defining the general direction of land use changes for more regions. This is reiterated by EEA's State and Outlook Report on land use, which described that land take for urban area and infrastructure accelerated from 0.57% per year during 1990-2000 to 0.61% for 2000-2006 (EEA, 2010a). This is supported by the fact that the clusters in the 1990-2000 time series have urban changes (LCF's 1-3) accounting for over 50% of all land changes, compared to five clusters in the 2000-2006 time series.

A closer observation of the maps of the two time series' above shows that the acceleration of changes dominated by urban formation is uneven throughout Europe. It is especially true for regions in Spain, France, The Netherlands, Denmark, Poland and in Luxembourg. This does not necessarily mean that more land is actually being covered by artificial surfaces in these regions, but it does imply that a greater share of land changes is resulting in urbanization.

The increase of land use change types showing a much more diverse and heterogeneous pattern throughout especially Central and Southern Europe in 2000-2006 compared to the 1990-2000 also seems to indicate that the "older newcomers" to EU have reached development characteristics complying with most of EU. At the same time that many of the "newer newcomers" are still in the process of adjusting, but haven't reached the same level of regional diversity. Furthermore, the sparsely populated areas in Northern Europe are in a situation where land use intensities differs so much from the rest of Europe that special change typologies may be needed in order to capture details in land use changes in these regions.

A second observation is that the number of regions in the Land use type "Extensification – rural conversions with significant levels of farm withdrawals" appears to decrease quite significantly in the 2000-2006 period compared to the 1990-2000 period, especially in the Czech Republic and in Poland. In the case of the Czech Republic we know that that the extensification in the 1990s driven by policy to convert crop land into pastures in order to promote grassland formation. But as emphasized above it takes time for newcomers to EU to adjust to the new conditions. And as mentioned before, some were more prepared and

ready than others and are in the process of moving towards similar patterns as in the rest of Europe, while others are proceeding at a slower pace.

3.5. General conclusions of land use typologies

At the most general level, the results of the analyses above provide innovative approaches to regionalizing Corine land cover data into the NUTS administrative structure. This alone, and especially in terms of the Prevailing land use, Hotspots and Land use change typology provides a completely new dimension to the study and interpretation of land use patterns in Europe, which can be used in various ways as tool for regional policy makers. It opens up for the option of monitoring changes in intensification which goes far beyond the traditional focus on agricultural activities as a measure of land use activity, and takes into account the fact that increasingly a multiplicity of functions takes place in the landscape. Qualitative measures of land use functions enables a characterization of which types of functions may take place, but does not say anything about the direction and velocity of changes, while the Hotspots enables a quantitative measure of both direction and velocity. And not least, it serves to show some of the land impacts of policy investment, particularly in terms of structural transitions that take place with for instance the ascension of new member states.

A great volume of spatial output and analysis has been provided by the results above, which makes it important to reflect on how each component relates to each other. Likewise, to protect against potentially unfounded conclusions being drawn from the maps it is also important to comment on the limitations of the outputs. This provides a basis for more general comments on how this evidence base fits together to provide a set of information that benefits ESPON's collective knowledge of regional studies and territorial analysis.

First, the typology on the Prevailing characteristics of land use provides a state-of-the-art on the current picture of land use at the regional level. For instance, it says that, based on CLC data, a given region has a certain generalized characteristic and these other regions in Europe share this same characteristic. It also provides a platform for investigating land use changes in individual regions. Results provided at the gridded level contribute to sub-regional analysis of land use and land use changes in taken up in the case studies.

In terms of land use changes, it quickly became clear that no single regional output could capture all of the necessary dimensions of land use change; especially not how land use change coincides with socio-economic changes. As a result, the analysis of land use change was built up starting from a basic measure of how much land is changing in European regions, which showed quite clearly how amounts of physical land change are based on policy agendas and political changes. We see in the maps that there are very clear disparities between neighbouring countries, but also high differences between many neighbouring regions. For instance, for France *vis-à-vis* Spain we know that large amounts of building, infrastructure development and agricultural changes have taken place in Spain while,

apart from selected regions in France land use has been very stable. Similarly we see marked differences in the volume of land change in between old East and West Germany since the fall of the Berlin Wall.

Thus, on one hand, visualization of these differences only reaffirms the importance of considering land use implications when assessing the feasibility or appropriateness of policy. At the same time, knowing the amount of land change says nothing about changes in land use intensity – in how much the land is being manipulated to meet the needs/goals of socio-economic development. This is where the notion of intensity needs to be added to the picture.

The mapping of intensity changes in land use really highlights the magnitude of human activity on land. For instance when we see regions where changes have resulted in high intensifications we know that whatever land that is undergoing changes is being impacted a great deal by changes in levels of socio-economic development. Very clear examples were reiterated in terms of intensive development of the oil, gas and mineral sectors in Norway as well as the land use impact of the tourist economy in coastal and island regions of Spain. At the same time, we were also able to see the profound levels of land use extensification, for instance in Poland due to the lack of investment in the transition of subsistence farming into a competitive agricultural industry. And in that connection also identify regions where former policy measures (and support mechanisms) have been replaced by other resulting in a time slot where moving from one set of constraints to another may have unforeseen and maybe also unwanted consequences in land use patterns.

In an effort to combine the measures of amount of change and intensity, and to flag regions where one, the other, or both phenomenon have taken place the Land change hotspots typology emphasized regions with combined high intensification and area of land change, regions which should, at a minimum, take note of how future land use changes interact with goals of biodiversity, landscape preservation, environmental protection, etc. This in turn would promote increased focus on activities such as brownfield development and infilling rather than continuing land take for urban development. However, such endeavours require coordinated policy approaches if they are to succeed in changing patterns of urban development.

The maps of "hotspots" represent a generalization of land changes which are based on absolute changes in land use. This is advantageous because there is no chance that it "misrepresents" certain land change phenomenon taking place in the regions. At the same time, it lacks in terms of characterizing the underlying processes that are actually the result of these intensifications, extensifications and/or high amounts of overall land change (i.e. the changing social and economic activities that take place as a result of such changes).

As an attempt to account for this void, the intention of the Land use change typology was to trade-out the measure of amount of land change in the hotspots map and replace it with a characterization of changing land uses. Regionalized land use change intensity is therefore combined with the distribution of the most

telling groups of land cover changes (LCF's) in a cluster analysis, and then grouping the results into descriptive Land use change types.

By comparing Figure 3.15 – Hotspots of land change – 1990-2006 – and Figure 3.18 – Land Use Change Typology – 1990-2006 – it is straightforward to see that many of the regions noted as a hotspot of land change are reflected as regions in shades of purple or bright orange – as being regions of at least moderate intensification. In this connection, the main benefit of the land use change typology is that it is able to reflect a limited number of dominant characteristics of land use changes; especially, urbanization from natural areas, intensive urbanization, maintenance of rural functions, agricultural withdrawal, etc. In terms of urbanization for instance, it adds another dimension where population or employment data is often used to reflect the urban development of regions. Complementing this, we can now see a regional dimension to these processes as they take place, literally, on the ground. In this connection, a direction of further work could be to make a closer comparison to land changes resulting in new or maintained urban areas, and to compare this data with regional – or even municipal – population data. This could give an interesting insight into places that are either maintaining or growing their population (labour force) and what the implications re in terms of land take and urbanization.

While the descriptions of the land use change types highlighted a number of very interesting trends – trends which were largely validated in the case studies - the reality is that they represent a further generalization of land change processes. And while it was shown to be beneficial to generalize land change trends it is also potentially misleading; not least due to the fact that any changes deviating from the "average changes" or dominant changes are not well reflected. Most notably, this relates to the "scale effect" where, as mentioned, rural land changes that are more extensive in area than concentrated urban changes are dominant in terms of average regional change. Consequently, the results of the Land use change types can have a tendency to over generalize land changes – and the processes behind those changes – for some region, especially relatively large ones.

Two examples of this were mentioned; in the Skåne region of Southern Sweden (where urban sprawl resulting from the construction of the Oresund Bridge was reflected in the typology because of the dominant agricultural and forest conversions) and to a lesser extent in region containing Madrid. Thus, the Land use change typology's asset of providing a general picture of the characteristics of land changes is also its weakness. It shows that generalizing can be a risky objective; especially in terms of regional patterns of land use where a variety of interacting and independent changes reflect a very complex set of regional processes.

4.

Applying the Land Use Functions framework for spatial assessment of land multifunctionality and impacts of land use change on land performance and efficiency

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4.1. The Land Use Functions Framework: a tool for integrated spatial impact assessment of land use change on sustainability

Sustainable land use implies a balanced consideration of the full range of economic, environmental and social goods and services provided by the land in a certain region / landscape (Wiggering et al., 2006; Pérez-Soba et al., 2008). It also implies a careful consideration of the bio-physical and functional characteristics of the ecosystems underpinning the bundle of ecosystem goods and services that they deliver. In an attempt to operationalize the concept of sustainable development for the case of land use, the concept of land multi-functionality was introduced (Wiggering et al., 2006). Assessing sustainable land use implies therefore to consider simultaneously all relevant functions of the land and the impacts of human activities in the various land sectors (Helming et al., 2008). These include agriculture and forestry as the main traditional land production sectors, nature conservation and ecotourism[1] as mainly land conserving activities, and settlement, transport and energy infrastructure as land consuming activities. All of these sectors and activities compete for land resources, so any change affecting one land use has the potential to induce changes in the others (Plummer, 2009).

The Land Use Functions (LUF's) framework (Pérez-Soba et al., 2008; Paracchini et al., 2011) provides a suitable tool for analysis of the impact that land use developments (partly driven by policies) may have on sustainability, because

[1] Ecotourism is defined as „responsible travel to natural areas that conserves the environment and improves the well-being of local people." (The International Ecotourism Society (TIES), 1990)

it considers simultaneously the three main pillars of sustainability, i.e. economic, environmental and social through an integrated, multifunctional assessment. The LUF's framework analyses the multiple functions linked to the human activities and sectors that use land, which in turn affect stock and quality of natural resources. The analysis is based on a broad range of economic, environmental and social indicators that are used to measure individual impacts on each land function. The multiple individual impacts are finally integrated into an overall impact on each function providing an integrated spatial impact assessment as shown by König et al. (2010) and Reidsma et al. (2011). The LUF's framework consequently responds to the EU policy need for integrated impact assessment and helps to highlight trends and changes in sustainability.

Assessing the land sustainability of European regions by applying the LUF framework mplies:

- To assess quantitatively the degree of multi-functionality of regions by assessing the performance of the land use functions present.
- To assess the impacts of land use change in a comprehensive way and not based on the partial views provided by individual indicators.
- To estimate the impact of land use changes on the economic, environmental and social dimensions, addressing the interface between socio-economic development and the environment, i.e. sustainable development.

This chapter describes the adaptation and implementation of the original LUF's framework methodology for spatial assessment of land multifunctionality and impacts of land use change on land performance and efficiency of European regions.

4.2. Definition of Land Use Functions

Land Use Functions (LUF's) express the goods and services that the use of the land provides to human society, including those economic, ecological and socio-cultural aspects that are susceptible to be changed by human intervention.

For the European regional assessment described in this chapter, six main LUF's are identified considering the following criteria:

- The main land uses in Europe are represented: agriculture and forestry as the main production sectors; nature conservation and ecotourism as land conserving activities; and settlement, transport, other types of tourism and energy infrastructure as urbanized land consuming activities.
- The economic, environmental and societal dimensions have a balanced representation through key issues linked to land use (e.g. employment, pollution).
- The land functions are likely to be affected by policies.

The six functions proposed were reviewed by an expert panel (ESPON seminar on *Evidence on European Land Use*, 2011). The panel found that the six LUF's provided a good compromise between the number of functions and the to-

pics to be covered. Particularly the panel concluded that the six LUF's represented key functions of land use in Europe, could be assessed by available set of indicators at NUTS 2/3 level, and number and names were easy to communicate main messages to policy and decision makers. It was also concluded that many different classification of the functions could be made, if needed, since the approach is flexible. For example, splitting the LUF provision of land-based products into LUF provision of food, LUF provision of timber and LUF provision of biofuels

The LUF's are defined considering their main links to the economic, environmental and social dimensions, and are listed in Table 4.1. It should be noted that each LUF does not refer uniquely to one dimension of sustainability, but has a "prevalent" social, economic or environmental character, acknowledging that the pillars of sustainability are not isolated, but involve numerous cross-linkages. Consequently they are named as mainly economic, environmental and societal because the borders between the three dimensions are not sharp, e.g. provision of work is mainly societal but can be considered as well among the economic functions, provision of housing is considered economical (building areas are strongly linked with economic development), but it can be considered as well as social function.

Table 4.1. The six Land Use Functions in EU-LUPA.

Sustainability dimension	LUF	LUF description	Issues included
Societal	LUF1	Provision of work	Employment provision for all in activities based on natural resources
	LUF2	Provision of Recreation	Recreational and cultural services, including cultural landscapes and green spaces in urban areas
Economical	LUF3	Provision of land-based products	Land-dependent production of food, timber and biofuels
	LUF4	Provision of housing and infrastructure	Building of artificial surfaces: settlements (residential areas, offices, industries, etc.), transport infrastructure (roads, railways, airports and harbours)
Environmental	LUF5	Provision of abiotic resources	Regulation of the supply and quality of air, water and minerals
	LUF6	Provision of biotic resources	Factors affecting the capacity of the land to support biodiversity (genetic diversity of organisms and habitats)

4.3. Methodology

The methodological approach of the LUF concept is described in this chapter. It consists of the following methodological steps:

Step 1: Selection of indicators

The indicators are selected from an extensive survey of harmonized European datasets, considering the following selection criteria:

a) Data availability: the indicators should be available at least for two time steps to measure changes in time, considering the first time step as the reference. In this analysis, the changes in land use are mainly based on changes observed in CORINE Land Cover, and therefore the time period selected is 2000-2006.

b) Data quality: the quality of the data should be checked avoiding datasets with large data gaps or poor quality.

c) Spatial resolution: in principle preference is given to indicators available at a detailed administrative level. It was agreed to use the NUTS 2/3 level (a mixture of NUTS 2 and NUTS 3 to achieve a balanced size in the administrative regions; Renetzeder et al, 2008), as most optimal resolution regarding data availability; it is always possible to upscale data to a less detailed spatial resolution.

d) Proper balance between the economic, environmental and societal dimensions: the number of indicators should be approximately the same for each dimension to keep a balanced approach.

e) Ability to assess functional changes in the area of study: for example, in a region with large natural protected areas the set of environmental indicators should reflect main trends regarding key environmental issues such as water, soil, air and biodiversity.

f) Redundancy or correlation should be avoided: indicators describing trends about the sa`me issue or being statistically correlated will not be considered. For example, habitat eutrophication is directly caused by deposition of atmospheric NH_3 and therefore habitat eutrophication and atmospheric NH_3 concentration are redundant.

g) Spatial coverage: the indicators should be available for all EU-27 Member States.

Step 2: Definition of the links between indicators and the LUF's

The specific links between the selected indicators and the LUF's is defined by a group of experts using a generic table similar to that shown in Figure 4.1, which lists and quantifies the contribution of each indicator to each LUF, and justifies the scores.

Indicator code	Indicator name	Score	Justification for score
..	..	..	..
..	..	..	..
..	..	..	..

Figure 4.1. Indicators showing the change in performance in LUF's.

The generic relation between each indicator and each LUF is measured as a score. It is defined individually because one indicator can have at the same time a positive relationship with one LUF while a negative relationship with another LUF. For example, the relation between the indicator 'urban fabric coverage' and the LUF1 'Provision of Work', is interpreted as a positive score since the larger the area of buildings, the higher the potential nr of jobs in the construction sector of the region (higher performance of LUF1). On the contrary, the link between 'urban fabric coverage' and the LUF6 'Provision of Biotic Resources' is interpreted as a negative score because the larger the soil sealing, the lower the potential amount of biotic resources.

The scores range from -1 to +1 as follows:

1 = the indicator value is linked to a negative (-) or positive (+) potential performance of the LUF. In the example described above, 'urban fabric coverage' is linked by the value +1 to LUF1, and by the value -1 to LUF6. The indicator 'nights spent in touristic accommodations' is linked by the value +1 to LUF2 'Provision of Recreation', because the higher the number of nights spent in touristic accommodations, the larger the potential recreation activities in the region. The indicator 'area harvested' is linked by the value -1 to LUF5 'Provision of abiotic resources' because the larger the area harvested, the lower the potential provision of (abiotic) water and minerals resources.

0 = irrelevant, i.e. the relationship between the indicator and the LUF does not allow one to infer on the consequences that a change in the indicator value could have on the LUF. This happens when a direct link is not known between the indicator and the LUF. For example, in principle the indicator 'atmospheric NH_3 emission' is irrelevant for LUF1 'Provision of work'.

Step 3: Assessment of the specific importance of each indicator for the economic, environmental and social performance of the region

The regional dimension of the assessment results from the recognition that not all indicators may be relevant for all regions. For example, the indicator 'area harvested' is unlikely to be relevant in a region with small agricultural area. In effect, this step provides the regional dimension to the framework by evaluating for each region considered in the analysis, the potential importance that each indicator may have on each of the economic, environmental and social dimensions. It considers the variety of situations that exist within EU27 by weighting of individual indicators within each of the regions considered. It combines information as to whether (1) the land use change analysed actually does affect the region, (2) if it does, are we likely to see impact in the land use functions of the region and finally, (3) if there is impact, does it affect the three dimensions of sustainability in the region.

It is well accepted that changes in indicators – that is a quantitative measurements of a specific value of change in the economy, environment or society – may be of a different degree of importance in relation to our efforts to assess the changes in phenomena (such as land use). In other words, it means that some indicators are more important for the phenomena we are concerned about than others. Therefore, weighting of different indicators is a normal procedure in Environmental Assessment and Strategic Environmental Assessment, and indeed finds its place in EU Impact Assessment. However, agreeing on the weighting

is challenging. It can be imposed 'top-down' by policy makers/administrators and their advisory scientists, or generated 'bottom-up' by stakeholders. Ideally, one might have different weighting systems derived from different sources such as expert ('Delphi') panels, stakeholder valuation in participatory workshops, internet valuation, etc. and present them in final outcomes to assess the risk. In this exercise we have chosen to limit ourselves to expert panels.

The description of the decision rules used by the experts is transparently done in individual fact-sheets, which include the 'importance' weighting showing how significant an issue (measured by the indicator) is in that region. It is an expert-based value judgment on what impact it would have on sustainability in the region if that indicator was to have an unacceptable value based on the current knowledge. The rule base determines the potential impact of land use change on an indicator for a particular region, and should be guided by supporting references describing the core bio-geographical (e.g. climate, altitude, relief, land use) and socio-economic (e.g. GDP, population, unemployment) characteristics of each region. For example, forest fire risk is deemed of low importance in a region with a small forest area, and a low population density, because the impact of a forest fire will be low. Conversely, nitrogen and phosphorus inputs are considered important in regions where agriculture dominates land use, and where the level of eutrophication is already high. The detailed description should not be exhaustive and therefore for some indicators other sources explicitly concerning the impact of the indicator have been used. For example, some indicators, particularly the economic ones, are considered of equal importance in all regions. Care should be taken to minimize co-correlation of factors determining the rule base and those from which the indicator values themselves were derived.

In this step the scores take values between 1 and 3 as follows: (1) not important at all, or of very low importance for the region, (2) of some importance, (3) of great importance. Indicators may show multiple potential impacts across LUF's, therefore the rule-base needs to be accommodated to potential impacts on a number of different sectors. The rules are defined such that importance scores of 1 are only assigned where it is clear that there is no current importance and that this is not likely to become important in the future, in order to preserve the validity of the assessment framework to future change. The rule base could be independently validated by a group of external experts in a workshop. The panel of experts can be selected according to criteria from recent practice of impact assessments. The regional importance scores should be summarized in a table as shown in Figure 4.2, while full description of the rule bases and the scientific justification should be given separately (example shown in step 4).

Region code	Region name	ENV 01	ENV 02	ENV 03	ECO 01	ECO 02	ECO 03	SOC 01	SOC 02
..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..

Figure 4.2. Example table to illustrate how the regional importance scores (1 to 3) are indicated for each selected indicator in the regions of analysis.

Step 4: Normalization and equalizing of indicators values

One of the requirements for processing multiple indicators within an aggregation framework is that all indicators are transformed into the same scale with common units (Nardo et al., 2005). Thus all indicators must be normalized, preferably to a continuous numerical scale, in order to allow mathematical procedures such as linear-additive aggregation to be performed. The aggregation framework followed in this assessment is based on the one described by Paracchini et al. (2011), which considered to normalize the values towards a nominal scale of 0 (low performance) to 10 (high performance).

The equation used for the normalization of the indicators is:

$$I_{NORM} = \frac{x - \min}{\max - \min} * 10$$

where x is the value of the indicator under a given situation (e.g. the specific region studied), and min and max are the ends of the normalization range, corresponding to minimum and maximum of the indicator itself.

Even though normalization is frequently applied within an aggregation framework to combine different indicators, it does not provide an optimal stretching of the data range. Figure 4.3 shows an example of the histogram distribution of the percentage of soil sealing in a region. As only a few regions are covered with an extreme low or high percentage of soil sealing they pull the normalization value to one side of the histogram. The result is that the majority of the cases are classified only in one or two classes and all the existing differentiation disappears. The final consequence is that, when aggregating several indicators to show the performance of one LUF, the lack of differentiation in the values of one of these indicators will strongly push towards a homogeneous result.

One way to avoid such a homogeneous result is to stretch the individual indicators before aggregating. A commonly accepted method for visualization purposes is to perform a so called histogram equalization. One example of histogram equalization can be found in Figure 4.3. In principle the objective of this method is to reclassify the indicator in such a way, that a linear trend arises in the cumulated frequency histogram.

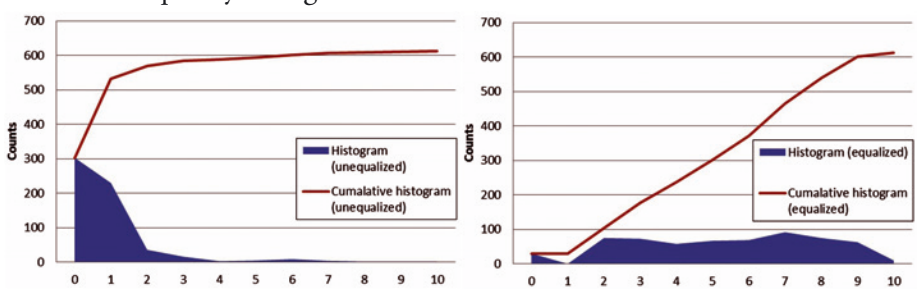


Figure 4.3. Example showing the effect of histogram equalization, for the normalized soil sealing information (percentage of CLC 111 + 112 + 121 +122 +123 + 124 + 125 within the NUTS 2/3 regions).

In case one works with multi-annual data, as we do in this European assessment for the years 2000 and 2006, one should be aware that the normalization and equalization are carried out on the multi-annual data set, instead of repeating this exercise for each year separately.

Step 5: Integrated assessment of the impact of land use change on regional multifunctionality

The final step is the integrated assessment in order to derive a final functionality score for each LUF. The integrated weighting of the normalized values of all indicators contributing to a LUF, provides a comprehensive description of changes measured by the indicators, which show the overall impact (stimulating, hindering or none) on the LUF performance. The integrated weighing is described below in the aggregation scheme, adapted from Paracchini et al. (2011).

The aggregation scheme

Aggregation can be performed in compensatory or non-compensatory frames. In the first case the weights have the meaning of trade-offs (Jeffreys, 2004), therefore a decrease in a LUF value is considered comparable to an increase in one or more other LUF values. Due to the complexity and multiple dimensions of the impacts to be assessed, it was decided to leave the analysis of trade-offs to the end user, since it would be impossible to assess ex-ante if conflicts between all possible targets exist. Therefore, a solution that has some character of non-compenzation was sought. The basic aggregation framework is presented in Figure 4.4.

In such a hierarchical scheme the six LUF's are grouped in pairs according to the three dimensions of sustainability, and each indicator is individually assigned to one or several LUF's. The value of the weight attached to each LUF is decided a-priori and LUF's are considered to be equally weighted (Munda, 2004). The indicator weights are then derived by dividing the LUF weight by the number of indicators concurring to it. The method therefore remains compensatory within a LUF, but not among the LUF's. The end-user of the system, i.e. the regional stakeholders, are the ones who make the decisions on the possibility of accepting trade-offs between LUF's. For example, they decide if an increase of LUF1 work provision can compensate a decrease in biodiversity (LUF6 provision of biotic).

In practice, the requirements of the system are complex. The LUF's do not refer uniquely to a dimension of sustainability, but have a 'prevalent' social, economic or environmental character, acknowledging that the pillars of sustainability are not isolated, but involve numerous cross-linkages, as shown in Figure 4.4.

In this aggregation framework, three additional characteristics apply, as described in Paracchini et al. (2011):

- Each indicator can be related to one or more LUF's (as shown in Figure 4.4)
- The indicator link to a LUF can be positive or negative (see step 2)
- Each indicator may perform differently according to the geographical/economic, environmental, social context in which it is measured (see step 3)

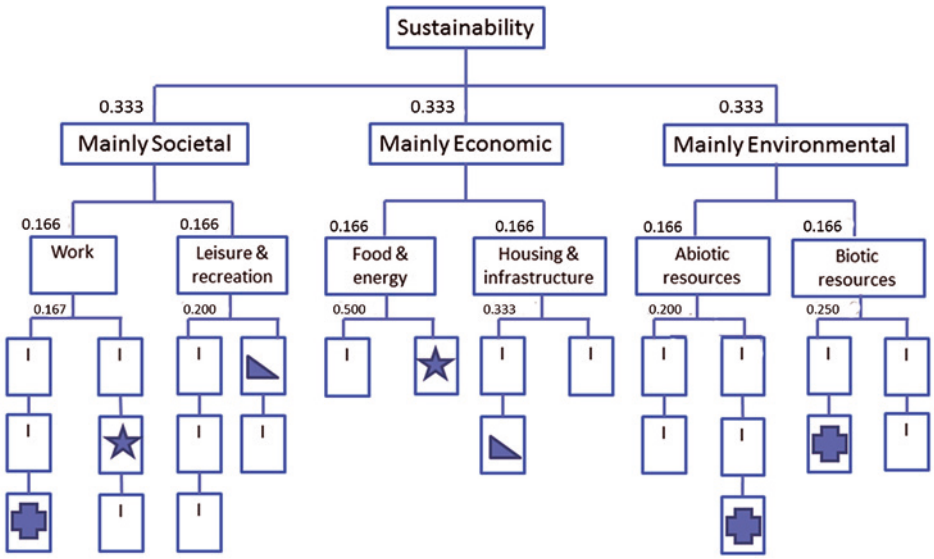


Figure 4.4. Basic aggregation scheme, after Paracchini et al. (2011). The symbols represent individual indicators contributing to more than one LUF.

The weighting

The system uses three weighting components to achieve this multi-dimensional, regional assessment, and is organized in a way that the aggregated values of indicators produce a final LUF score on the same 0 – 10 scale.

In case data are missing, the corresponding weights are excluded from the scheme. If this would not be done, then the sum of the weights would be smaller than 1, resulting in a lower score. The calculation method is automatized and corrects the weighting whenever data are missing based on the principle that the sum of the weights must always be 1.

The three weights used are as follows:

w1 – Number and type of indicators contributing to each LUF

Figure 4.4 shows that aggregation of indicators to LUF's is performed on a compensatory basis, in which the contribution of each indicator is weighted according to the number of indicators concurring to a LUF, the indicator inherent importance (addressing issues of redundancy between indicators) and the balance of indicators across the three sustainability pillars. This is the first of two weighting factors: w1, and is calculated as follows:

w1 = Intrinsic indicator weight x pillar balance weight x 1/ nLUF

where nLUF is the number of indicators concurring to the LUF.

Intrinsic weights should be shown as in the example shown in Table 4.4. The importance of some individual indicators may be down-weighted to account for issues of redundancy. For example, nitrogen and phosphorus surplus represent

both the impact of the agricultural sector on water quality. However, the spatial pattern varies across Europe, so rather than selecting just one indicator and fail to adequately capture this impact, it can be decided to maintain both, but to down-weight them equivalent to one indicator. The second component to w1 takes into account the differences in the number of economic, social and environmental indicators to achieve a balanced representation between the three pillars of sustainability. These two components are combined to a total weight of one. In the LUF framework, weight 1 is adjusted separately for each LUF to take into account the number of indicators contributing to that LUF (nLUF), ensuring LUF calculations are evenly balanced through the framework.

w2 – Strength and sign of indicator impact on LUF performance

Expert panels of internal experts (i.e. researchers working in the project) and external experts assign values to the link between each indicator and the LUF's. Such weights are attributed in close relation to the indicators' ranges. Weight 2 (w2)describes the impact on sustainability, i.e. whether it has a positive or a negative impact on that LUF. Since these indicator weights can show positive or negative relations, great attention must be paid to the meaning attached to minima and maxima per each indicator in the normalization frame. As explained above the same indicator can have a positive relation to one LUF and a negative one to a different LUF, and this must be reflected in the direction the scale min-max is assigned to indicators in each LUF during the normalization process (i.e. high GDP may be good for LUF provision of work and bad for LUF provision of biotic resources, therefore the maxima are attached to high GDP values in the first case, and to low GDP values in the second).

This is the second of two weighting factors: w2, taking discrete values from -1 to +1.

w3 – Regional importance of the indicator

Weight 3 (w3) reflects the importance of each indicator at a regional level. Once more a panel of experts need to define a set of indicator-specific rules to determine the importance of an indicator in separate regions. For example, area harvested is deemed of low importance in a region with a small agricultural area. Some indicators, particularly the economic ones, are considered of equal importance in all regions. Care needs to be taken to minimise co-correlation of factors determining the rule base and those from which the indicator values themselves were derived. This is the third of three weighting factors: w3, taking discrete values from 1 (not relevant) to 3 (highly relevant).

This third weight was only calculated for the Netherlands and it is not presented in this chapter.

4.4. Application of the LUF's methodology at pan-European level

The LUF methodology described in the previous section is applied at pan European level using NUTS 2/3 regions as spatial units. The specific regional weight

3 was not applied in this case due to the impossibility to determine regional weights for each NUTS 2/3 region within the framework of the work. The results are analyzed at the end of this chapter.

Step 1: Selection of indicators

Table 4.2. List of 25 selected indicators, with their principal link to the three main dimensions of sustainability, e.g. economic, environmental and societal.

Indicator Number	Dimension	Indicator
01	ECO	Multimodal potential accessibility normalized
07	ECO	Gross Domestic Product (Purchasing Power Standard per person)
08	ECO	Gross value added at basic prices – Agriculture and fishing (EURO per person)
09	ECO	Gross value added at basic prices – Total (EURO per person)
11	ECO	Industrial and commercial areas (Land cover)
16	ECO	Nights spent in tourist accommodations (nr/ha)
24	ECO	Urban fabric (Land cover)
02	ENV	Area harvested
03	ENV	Artificial non-agricultural vegetated areas (Land cover)
04	ENV	Status of bathing water (qualitative)
06	ENV	Forest and semi-natural areas (Land cover)
10	ENV	Green Urban Areas (Land cover)
12	ENV	Natural Recreation (Land cover)
13	ENV	NH_3 emission (kg N/ha)
14	ENV	Navigable rivers and canals (m/km^2)
17	ENV	N-surplus (kg N/ha)
19	ENV	Natural protected areas – CDDA and Natura 2000
20	ENV	P-surplus (kg P/ha)
21	ENV	Sport and Recreation facilities (Land cover)
25	ENV	NO_3 concentration of leaching water from agriculture (mg NO_3/litre)
05	SOC	Pre-primary education – Total
15	SOC	Net migration - arrivals-departures (nr/km^2)
18	SOC	Population density (nr/km)
22	SOC	Monuments and other tourist sights (index)
23	SOC	Unemployment (nr/km^2)

The indicators were preliminary selected following the criteria specified in section 3. The NUTS 2/3 dataset (mixture of NUTS 2 and NUTS 3 regions developed to enhance the homogeneity in the size of the administrative regions, Renetzeder et al. (2008) was selected as optimal spatial resolution considering the data availability. The selected indicators are presented in Table 4.2.

The final selection of indicators was based on the analysis of their statistical correlation and data quality. The statistical correlations are analysed per LUF using a „pairwise.complete.obs" method, which is based on multi-annual data. Those indicators that show a correlation above 0.8 were considered highly correlated and therefore only one was selected. For example, nitrogen surplus and phosphorus surplus were highly correlated and only the phosphorus surplus was finally selected. As a rule, indicators with the highest quality of the dataset had priority in the selection. In addition, a data quality check was done for all the indicators, which resulted in the dismissal of the indicator 'Natural protected areas – CDDA and Natura 2000' because the database of 2000 was incomplete. As a result of the correlation analysis and data quality check, some indicators were rejected per LUF as shown in Table 4.3.

Table 4.3. Indicators rejected per LUF as result of the correlation analysis and quality data check.

LUF	Indicators rejected
LUF1	Pre-primary education – Total
	Population density (nr/km)
	Natural protected areas – CDDA and Natura 2000
LUF2	Forest and semi-natural areas
	Natural protected areas – CDDA and Natura 2000
LUF3	Land cover – Artificial non-agricultural vegetated areas
	Green Urban Areas
	Land cover – Industrial and commercial areas
	N-surplus (kg N/ha)
	Natural protected areas – CDDA and Natura 2000
LUF4	Land cover – Industrial and commercial areas
	Nights spent in tourist accommodations (nr/ha)
	Population density (nr/km)
	Natural protected areas – CDDA and Natura 2000
LUF5	NH_3 emission (kg N/ha)
	N-surplus (kg N/ha)
	Natural protected areas – CDDA and Natura 2000
LUF6	Green Urban Areas
	N-surplus (kg N/ha)
	Natural protected areas – CDDA and Natura 2000

Step 2: Definition of the links between indicators and the LUF's

The specific links between the finally selected indicators and the LUF's were defined by a group of scientific experts in Alterra (the Netherlands) and reviewed by experts of the Autonomous University of Barcelona (Spain). They are presented in Table 4.4.

Table 4.4. Summary of cross-linkages between the finally selected indicators and the six LUF's (for definition of LUF's, see chapter 2).

Indicator nr	Dimension	Indicator	LUF1	LUF2	LUF3	LUF4	LUF5	LUF6
0	ECO	Multimodal potential accessibility normalized	1	1		1		-1
1	ENV	Area harvested			1		-1	-1
3	ENV	Status of quality of bathing water		1			1	
4	SOC	Pre-primary education				1		
5	ENV	Forest and semi-natural areas (Land cover)			1		1	1
6	ECO	Gross Domestic Product (Purchasing Power Standard per person)				1		
7	ECO	Gross value added at basic prices - Agriculture and fishing (EURO per person)			1			
8	ECO	Gross value added at basic prices - Total (EURO per person)	1	1				
9	ENV	Green Urban Areas (km^2) (Land cover)		1				
10	ECO	Industrial and commercial areas (km^2) (Land cover)	1					
11	ENV	Natural Recreation (km^2) (Land cover)		1				1
13	ENV	Navigable rivers and canals (m/km^2)		1			1	1
14	SOC	Net migration - arrivals-departures (nr/km^2)	1			1		
15	ECO	Nights spent in tourist accommodations (nr/ha)	1	1				
17	SOC	Population density (nr/km)					-1	
19	ENV	P-surplus (kg P/ha)			1		-1	-1
20	ENV	Sport and Recreation facilities (km^2) (Land cover)		1				
21	SOC	Monuments and other tourist sights (index)	1	1				
22	SOC	Unemployment (nr/km^2)	-1					
23	ECO	Urban fabric (km^2) (Land cover)				1		-1

Step 3: Assessment of the importance of each indicator for the sustainability of the region

Due to the large number of NUTS 2/3 regions and the limitations of this study, the assessment of the regional importance was not done at pan-European level.

Step 4: Normalization and equalizing of indicators values

The normalization was done following the method described in section 3. The calculations were automatized in excel.

Step 5: Integrated assessment of the land use functionality

The resulting aggregation scheme showing the links between the selected indicators and the LUF's is shown in Figure 4.5.

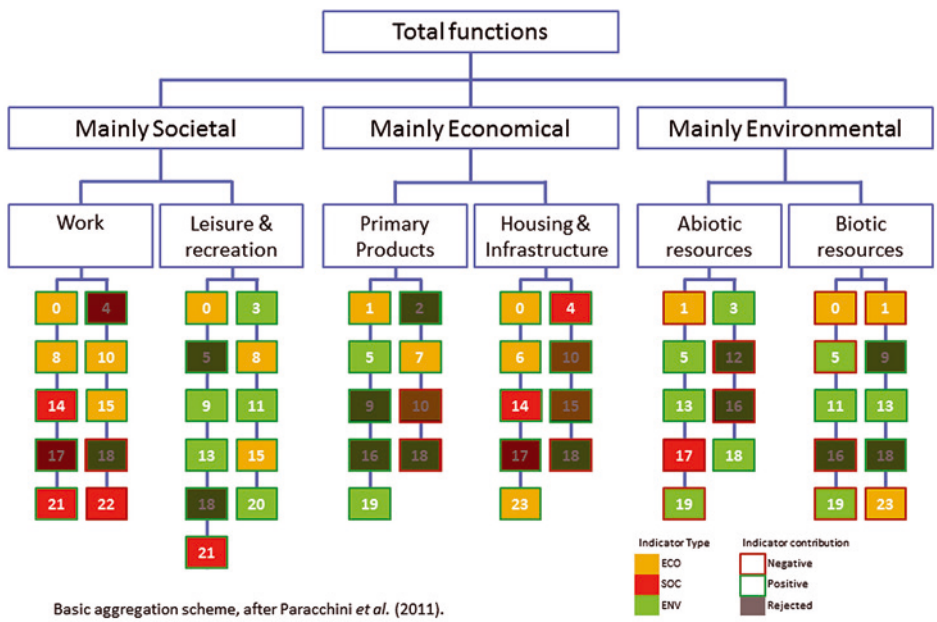


Figure 4.5. Basic aggregation scheme, after Paracchini et al. (2011). The colours indicate the economic, social and environmental dimensions. The numbers indicate the code of the indicators. The outlines define the type of link between the indicator and the functions (weight 2), i.e. red is a negative link and green is a positive link. The grey shadow shows the indicators that were finally rejected due to statistical correlation or data quality problems.

Weight 1 was calculated as described in section 3 and the results are shown in Table 4.5.

Table 4.5. Example showing how components combine to form Weight 1. The first component is the intrinsic indicator weight (to account for issues of redundancy), The second component considers differences in number of economic, social and environmental indicators to achieve balanced representation between the three dimensions. These two components are combined to a total weight of one.

Indicator code	Indicator	Intrinsic indicator weight (A)	LUF balanced weight (B)	Product (A) x (B)	Balanced Weight 1
0	Multimodal potential accessibility normalized	1	0.14	0.14	0.14
6	Gross Domestic Product (Purchasing Power Standard per person)	1	0.14	0.14	0.14
7	Gross value added at basic prices - Agriculture and fishing (EURO per person)	1	0.14	0.14	0.14
8	Gross value added at basic prices - Total (EURO per person)	1	0.14	0.14	0.14
10	Industrial and commercial areas (km^2) (Land cover)	1	0.14	0.14	0.14
15	Nights spent in tourist accommodations (nr/ha)	1	0.14	0.14	0.14
23	Urban fabric (km^2 (Land cover)	1	0.14	0.14	0.14
	No. ECO indicators	7			1
1	Area harvested	1	0.14	0.14	0.14
3	Status of quality of bathing water	1	0.14	0.14	0.14
5	Forest and semi-natural areas (Land cover)	1	0.14	0.14	0.14
9	Green Urban Areas (km^2) (Land cover)	1	0.14	0.14	0.14
11	Natural Recreation (km^2) (Land cover)	1	0.14	0.14	0.14
13	Navigable rivers and canals (m/km^2)	1	0.14	0.14	0.14
19	P-surplus (kg P/ha)	1	0.14	0.14	0.14
	No. ENV indicators	7			1
4	Pre-primary education	1	0.17	0.17	0.17
14	Net migration - arrivals-departures (nr/km^2)	1	0.17	0.17	0.17
17	Population density (nr/km)	1	0.17	0.17	0.17
20	Sport and Recreation facilities (km^2) (Land cover)	1	0.17	0.17	0.17
21	Monuments and other tourist sights (index)	1	0.17	0.17	0.17
22	Unemployment (nr/km^2)	1	0.17	0.17	0.17
	No. SOC indicators	6			1

Results

When mapping the results of the analysis, it was considered that:

The sum of all normalized indicators (with a nominal scale from 0 to 10) weights must add to 1. The final LUF result will also be a nominal scale ranging from 0 to 10. However, as a nominal scale to describe performance of the functions can be unclear, the end result was converted into the following three classes; 1 = little functional performance (score 0 to 3); 2 moderate functional performance (score 3 to 6); 3 high functional performance (score 6 to 10).

The results of the two different time steps are combined in a two digit number, in which the first digit expresses the functional performance in the year 2000, and the second digit the functional performance in the year 2006. Combining these two digits results in nine different classes, with three classes showing a functional performance increase, three classes show a decrease and three classes indicate that changes did not occur (Figure 4.6).

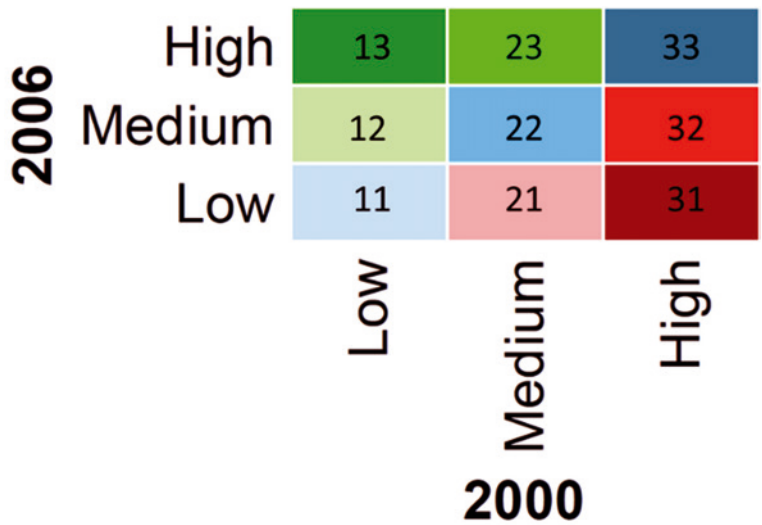


Figure 4.6. Description of legend used in the mapping of LUF performance changes between 2000 and 2006. Blue indicates no change, red indicates decrease and green indicates increase. The intensity of the colours shows the level of the LUF performance, from light colour (low performance) to deep colour (high performance).

As a result of the implementation maps were developed for:

- The economic, environmental and social dimensions (aggregated results of the contributing LUF's) presented in Figures 4.7 to 4.9.
- The six LUF's (aggregation of the selected indicators following the LUF methodology) ; shown in Figures 4.10 to 4.13.
- Each indicator contributing to the LUF's (not included in this chapter)

The spatial assessment of the changes in land use functionality between 2000 and 2006 starts with a general overview of the performance of economic, environmental and social dimensions. As it can be seen in Figures 4.7 to 4.9 the performance of the three dimensions remained quite stable (i.e. dominance of the blue colours). Few changes are observed, mainly in the economic and environmental aspects, and these changes are moderated – never from high to low or low to high. They do not follow apparently any geographical specific pattern. The social performance is high in the Blue Banana corridor. Interestingly, the regions where changes in economic performance are found do not coincide with those regions showing changes in environmental or social performance. This indicates that the three dimensions are not following the same development patterns. The economic aspects show a decrease in performance in Southern Finland, Northern Denmark, North France, Cataluña (North-eastern Spain) and central Italy, and increases in southern Norway and Levante (eastern Spain).

The assessment of the changes in the six LUF's provides a more detailed insight at the functional levels (Fig. 4.10-4.13). The analysis of the LUF's maps show that:

Extreme changes do not occur and the overall pattern shows relative stability during the six years studied. Overall Scandinavia shows the highest stability, while central and southern Europe are more.

The two mainly economic LUF's (LUF1 Provision of work, and LUF2 Recreation) in Figure 4.10a and 4.10b show a high and stable performance in the Blue Banana corridor, as it could be expected, although some negative changes in LUF1 are observed in the fringes, e.g. in the Netherlands and East Germany, Eastern France and Barcelona. Positive changes are scattered except in Scandinavia and the Baltic countries. Other countries showing positive development are eastern Turkey, western Spain and central Europe.

LUF2 Recreation shows a more general trend to increase its performance (Fig. 4.10b). In general, coastal areas and the Canarias islands improve. Romania and Bulgaria increase from low to medium, showing developments in the tourist sector in the previous years to their entrance in the EU (2007).

In contrast with the economic LUF's, LUF3 Provision of food, timber and biofuels shows negative developments in several regions, especially in the Mediterranean countries, which could be associated to land abandonment and decrease in area harvested (mainly due to conversion of rural areas into urban). In contrast, there are positive changes in Scotland and central Europe. It is interesting to see the different geographical patterns in Sweden, with a high and stable performance in the North (associated to forestry production), and a negative performance in the south (linked to agricultural production).

LUF4 Housing and infrastructure shows a high stable performance in the Blue Banana, similarly to the economic LUF's, indicating significant urban and infrastructure developments in the European Megalopolis (Fig. 4.11). Coastal areas in the Mediterranean show as well a high and stable performance and even an increase in some regions. Increases are also observed in southern Spain, southern Italy and eastern Germany, as well in main cities in central Europe (Budapest, Bratislava and surroundings). Decrease is found in few rural areas of Romania, Poland, South Sweden and Lleida (Spain).

LUF5 abiotic resources shows scattered changes as it describes broad environmental issues linked to air, water and soil quality (Fig. 4.12). Therefore variations are difficult to explain without assessing the changes in the specific indicators affectingthe LUF.

LUF6 biotic resources shows significant improvement in central Spain and north-western France. On the contrary, some regions of the Dutch 'randstad' (industrial and metropolitan conurbation occupying west-central Netherlands) where significant infrastructure and urban development has taken place show a negative development. The same negative trend (Fig. 4.13) appears as well in the southern Alps including the densely populated Po valley.

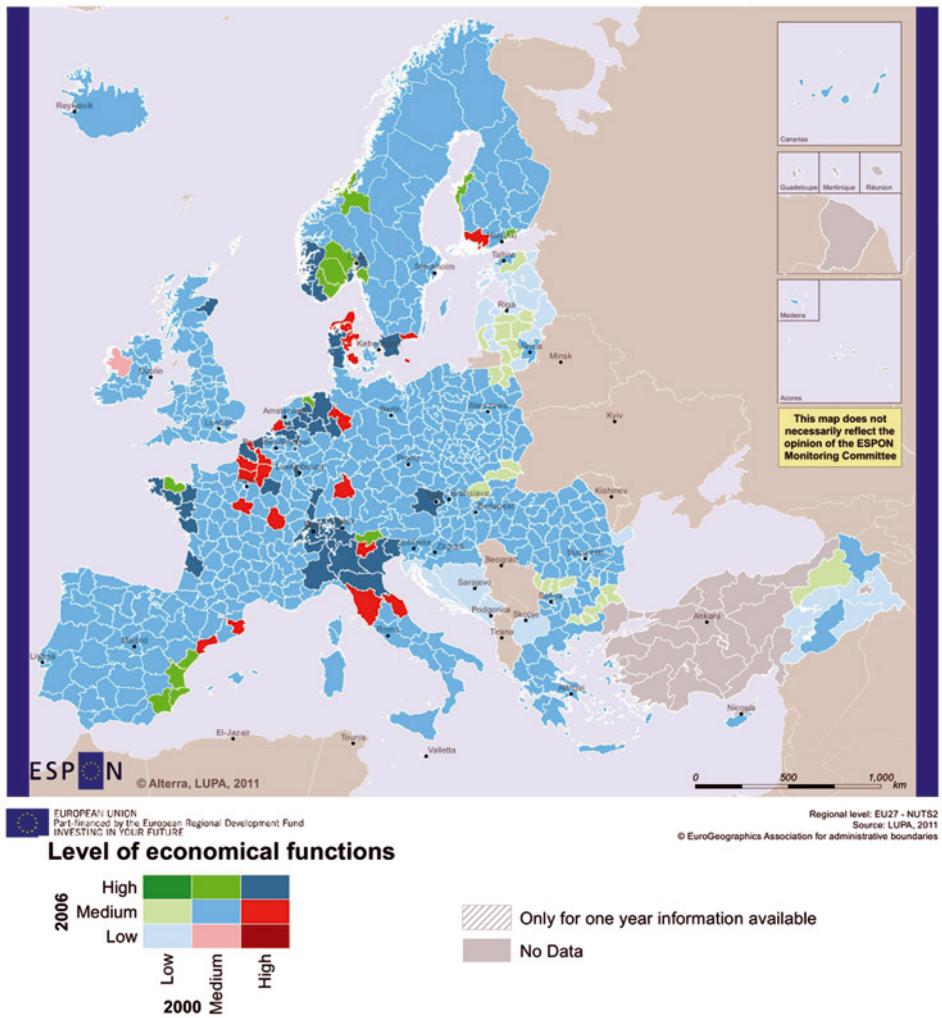


Figure 4.7. Changes in the economic dimensions in the period 2000-2006, based on aggregated changes observed in Land Use Functions.

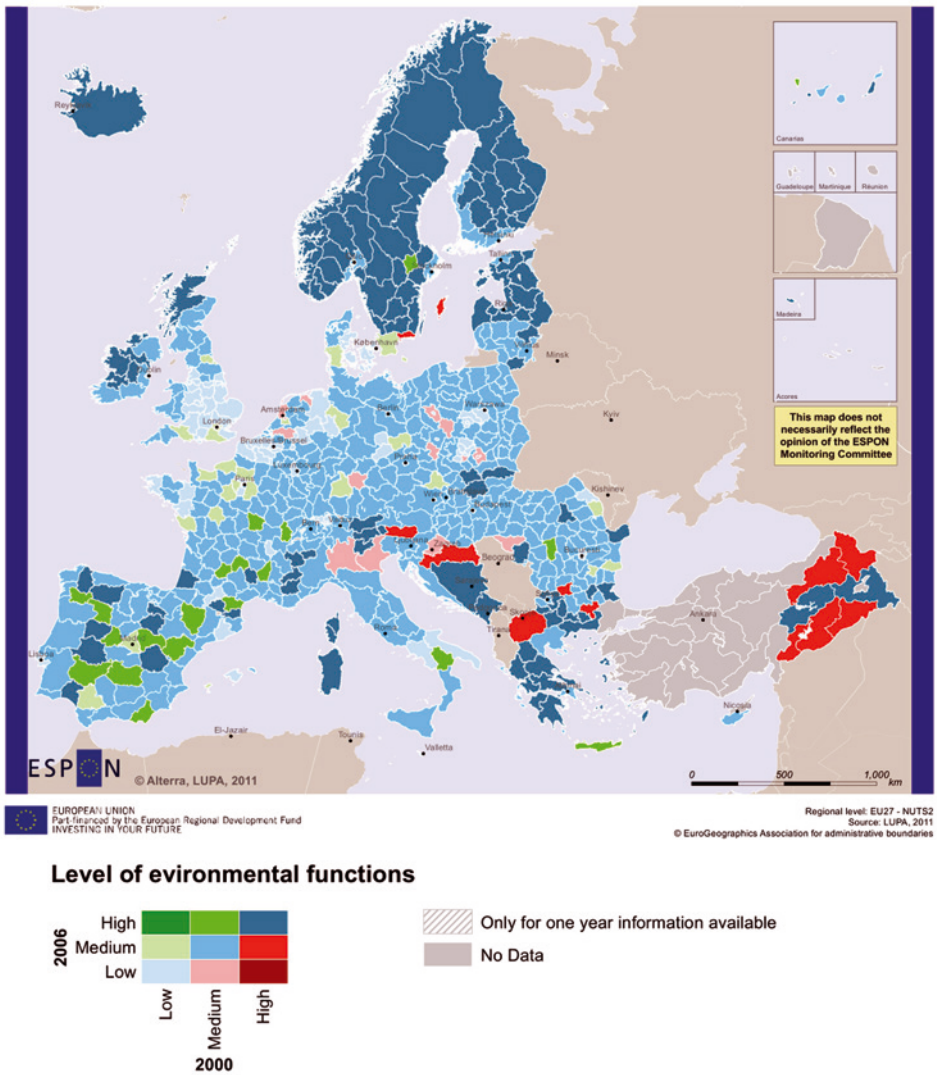


Figure 4.8. Changes in the environmental dimensions in the period 2000-2006, based on aggregated changes observed in Land Use Functions.

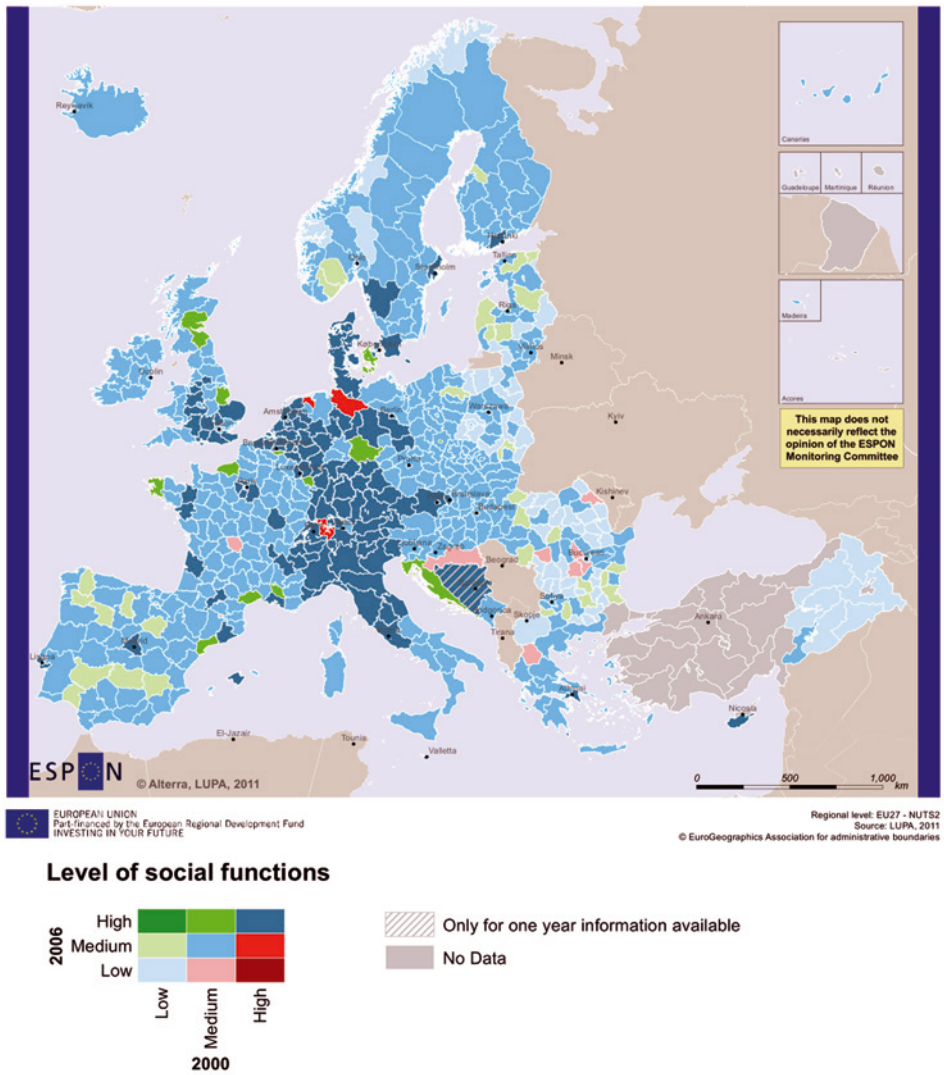


Figure 4.9. Changes in the social dimensions in the period 2000-2006, based on aggregated changes observed in Land Use Functions.

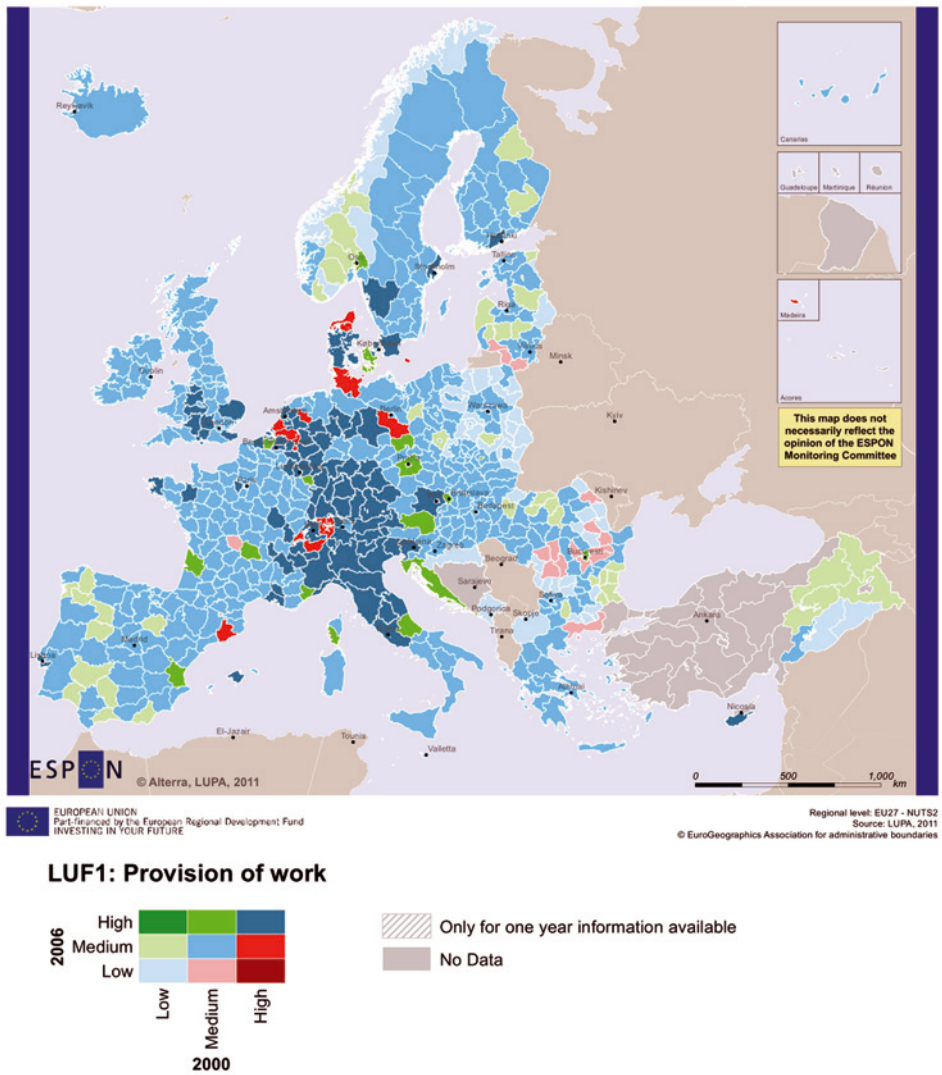


Figure 4.10a. Changes in the performance of LUF1 Provision of work for the period 2000-2006.

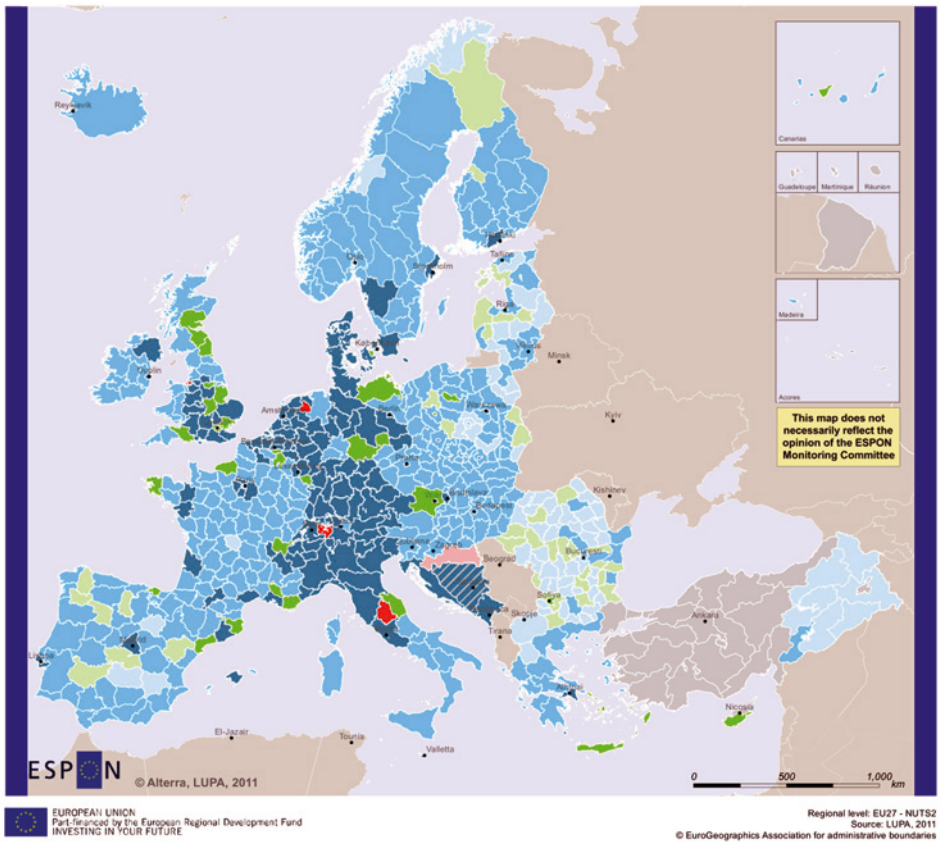


Figure 4.10b. Changes in the performance of LUF2 Provision of leisure and recreation for the period 2000-2006.

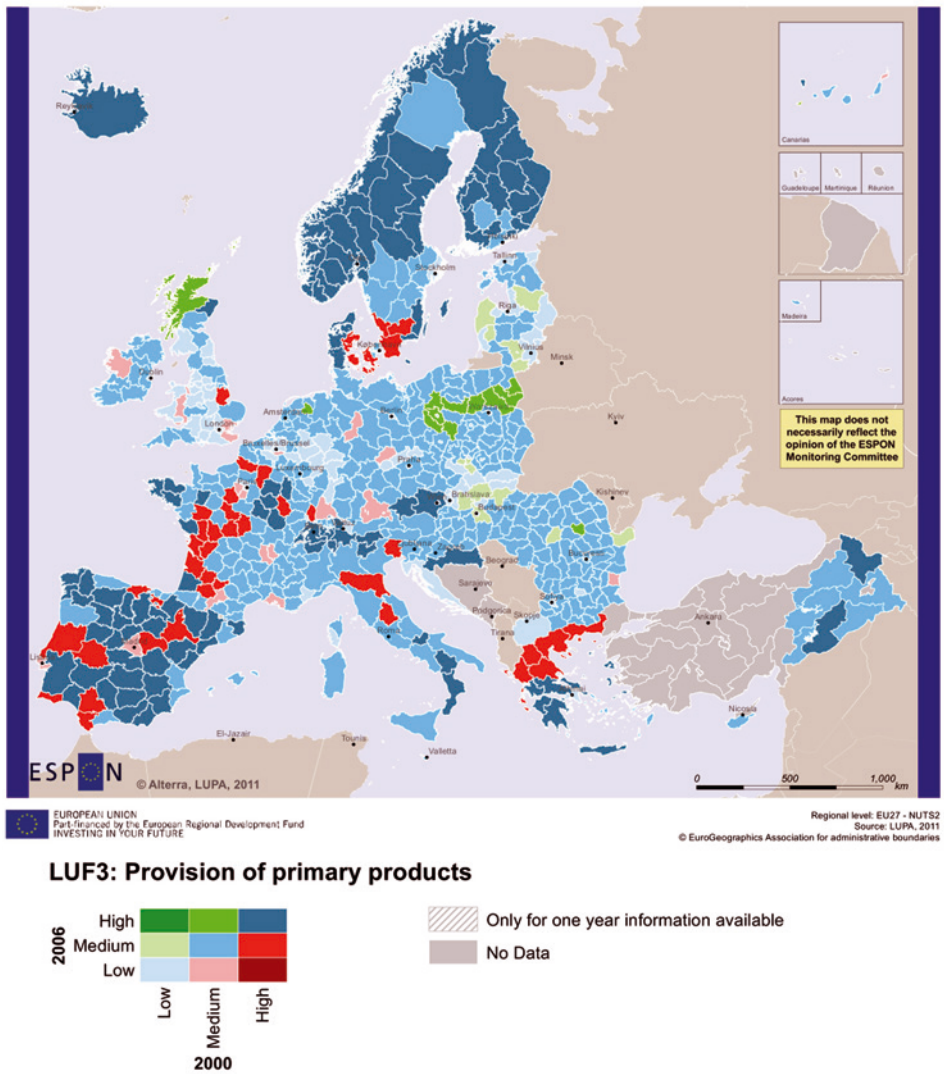


Figure 4.10c. Changes in the performance of LUF3 Provision of primary products for the period 2000-2006.

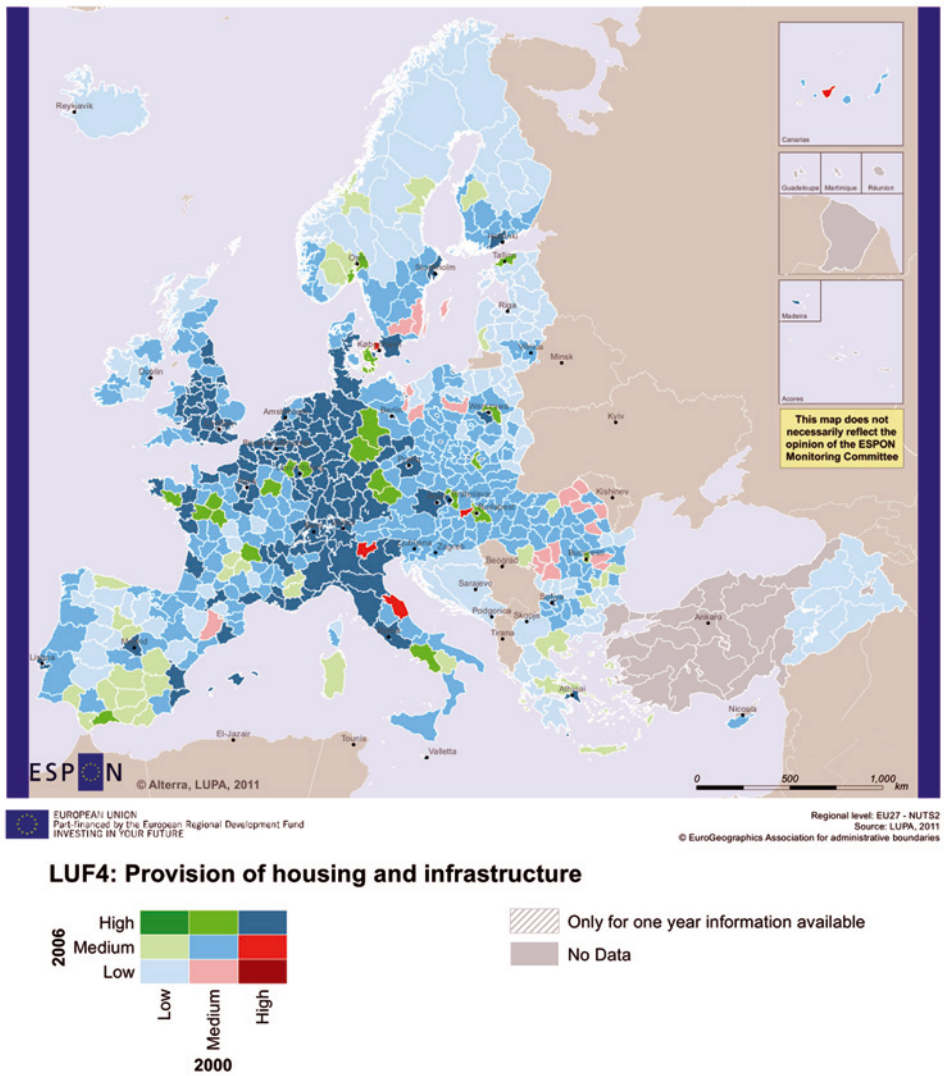


Figure 4.11. Changes in the performance of LUF4 Provision of housing and infrastructure for the period 2000-2006.

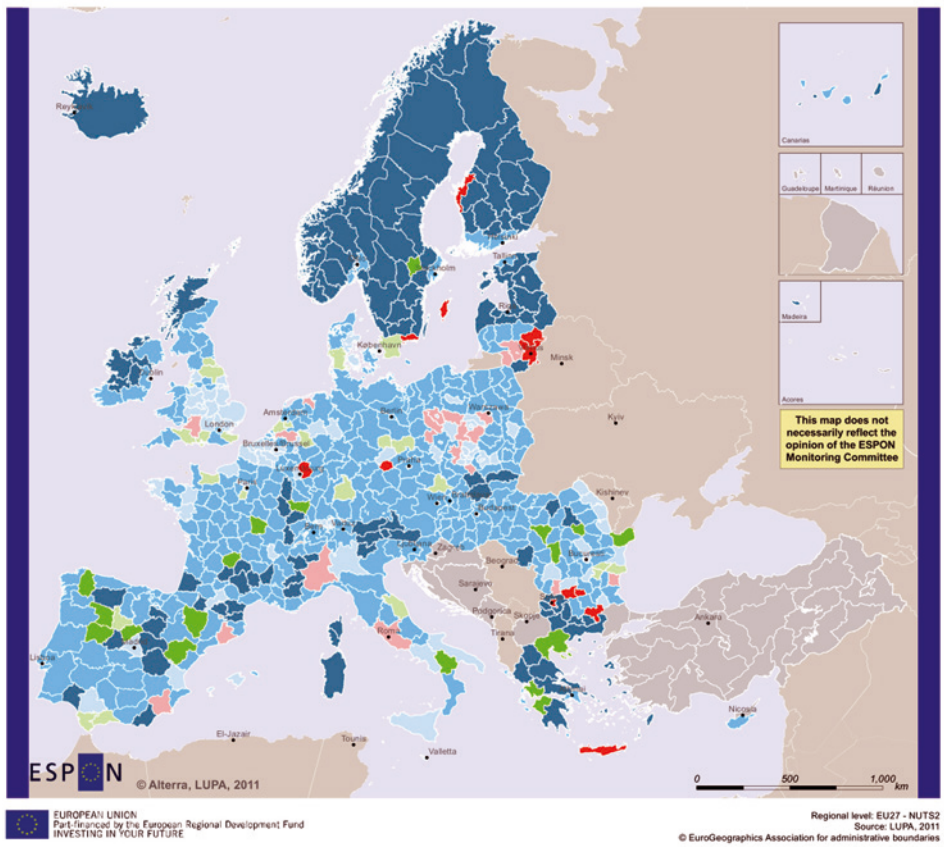


Figure 4.12. Changes in the performance of LUF5 Provision of abiotic resources for the period 2000-2006.

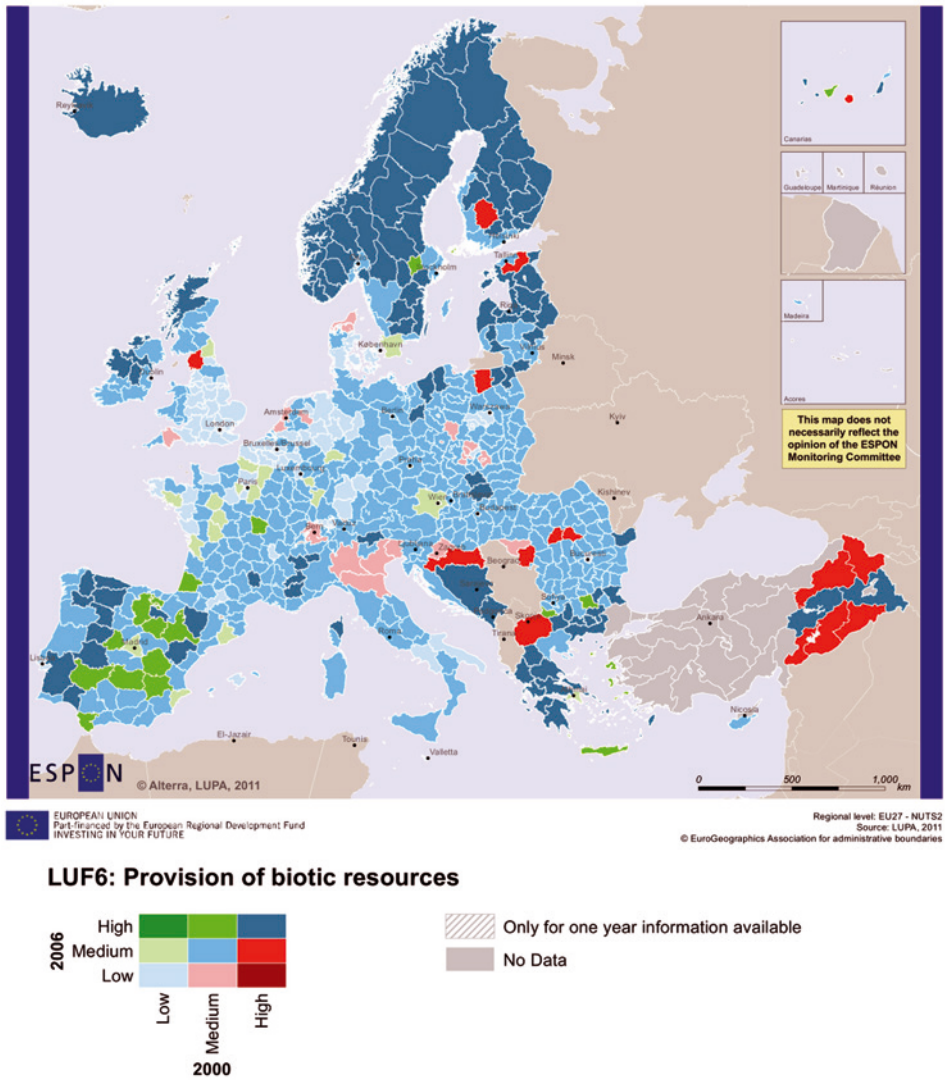


Figure 4.13. Changes in the performance of LUF6 Provision of biotic resources for the period 2000-2006.

4.5. Land Use Performance and Land Use Efficiency

In this section the concept of Land Use Functions is further applied to define Land Use Performance and Land Use Efficiency. By assessing the individual performance and efficiency of the six LUF's, a deeper insight is reached in the depiction of the multi-functionality of a region.

4.5.1. Land Use Performance

Land Use performance is defined as the degree in which the land that is used for a specific function complies with a related policy target. The policy goals should be clearly defined and could be simple (e.g. job provision, air quality, soil quality) or combined (e.g. job-to-housing ratio). In addition policy goals should allow comparisons to quantifiable measures/indicators belonging to the list of indicators selected to define the Land Use Functions. The policy goals should be ideally available at national or regional level. However a comprehensive analysis of European policy documents showed that it was not feasible to use them as reference to calculate the Land Use (LU) performance. In fact, only few policy targets were found that were quantifiable and could be therefore linked to the values of the LUF's indicators. Considering that policy goals were not be directly available, it was decided to use the EU or national averages or other statistical measures as reference for the analysis.

Examples

1. In order to show how the calculations could be done if quantifiable policy targets and corresponding indicators were available at NUTS 2/3 level.

The LU performance was calculated as regards the Nitrate Directive. The Nitrate Directive requires MS to monitor surface waters and groundwater for nitrate pollution against a maximum limit of 50 mg nitrate/l (Directive 91/676/EEC on pollution caused by nitrates from agricultural sources). '...The Directive seeks to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is designed both to safeguard drinking water supplies and to prevent wider ecological damage in the form of the eutrophication of freshwater and marine waters generally...'. This policy target clearly refers to the two environmental LUF's (LUF5 Provision of abiotic resources and LUF6 Provision of biotic resources). One of the indicators considered underpinning these functions is the 'nitrogen surplus', for which values are available at NUTS 3 level. The 'nitrogen surplus' values were calculated as nitrate concentration of leaching water from agriculture for the years 2000, as calculated by the model MITERRA Europe (Velthof et al., 2009).

Two options were considered:

Option 1: Showing the level of compliance above and below the policy target.

- If nitrate concentration in the NUTS 3 region is > 50 mg Nitrate/l (policy target) (which is considered as 100%), then the LUF5 and LUF6 performances are negative and it is expressed as a proportion below the 100%.
- If nitrate concentration is < 50 mg Nitrate/l, then the LUF5 and LUF6 performances are positive as it is expressed as a proportion above the 100%.

Option 2: Showing only the level of compliance when the values are above the policy target and considering all values below the threshold as 100% compliance.

The results are shown in Figure 4.14 and 4.15, respectively for Options 1 and 2. The results in Figure 4.14 and 4.15 show that regions in eastern and central Spain, Bretagne in France, south of the Netherlands, Belgium, some regions in the western part of Germany, Finland and some regions in Poland do not comply with the nitrate directive and therefore their LUF5 and LUF6 environmental land use performance regarding the agricultural land use is negative.

2. Example of Land Use Performance calculation when policy targets are not available or suitable for the calculation.

The limited number of policy targets related to land use made necessary to develop other approach for the calculation of the LU performance. This approach calculated the LU performance by considering the individual performance of each indicator having as reference the European average, as it is often used, and the performance of the indicators was aggregated per LUF to calculate the LUF's performance in the same way as described in section 3.

As example of the calculation of the LU performance using as reference the EU average, we used again as indicator the Nitrogen surplus. The same assessment was made but considering the distance of the regional nitrate values to the European average, in the case that no policy target would be available. In the same way as before, Figure 4.16 shows the distances above and below the European average, and Figure 4.17 only the distances above the European average.

The results in Figure 4.16 and 4.17 show that in case no policy target would be available for the nitrogen surplus and then the distance to the European average will be considered as estimation of the Land use performance, the results would be quite different since the European average is below the threshold of 50 mg nitrate/ l. Consequently, more regions would show a low environmental land use performance concerning agricultural land use, with values above the European nitrate concentration average.

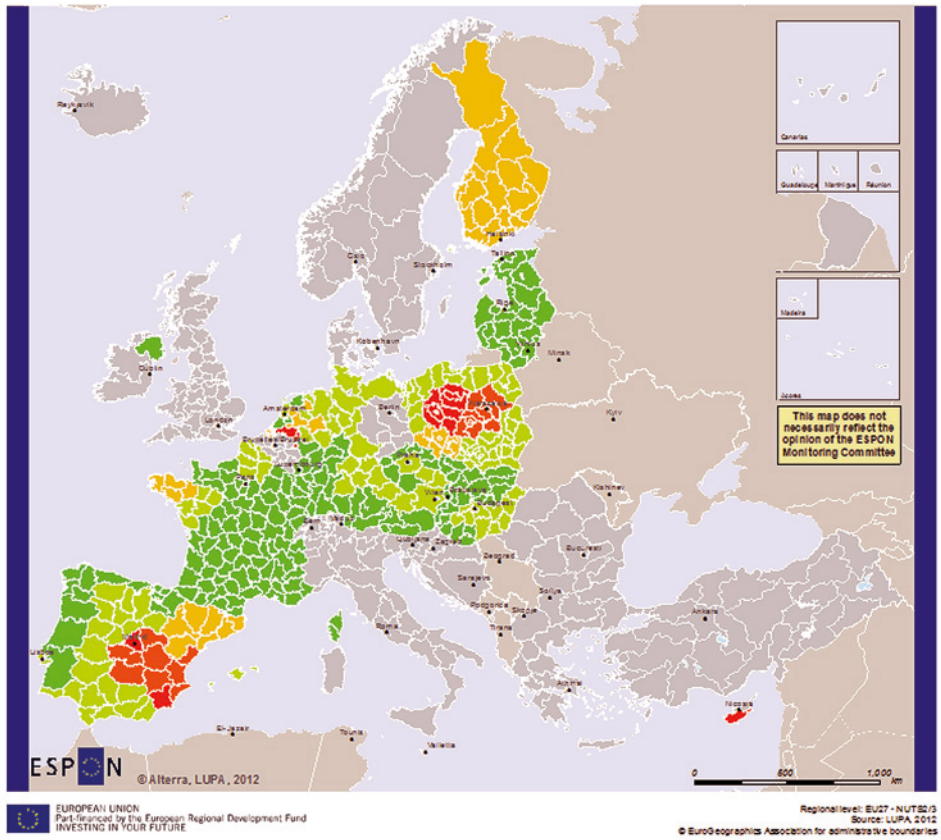


Figure 4.14. Land Use Performance of the agricultural land use regarding Nitrate Directive showing the level of compliance above and below the policy target.

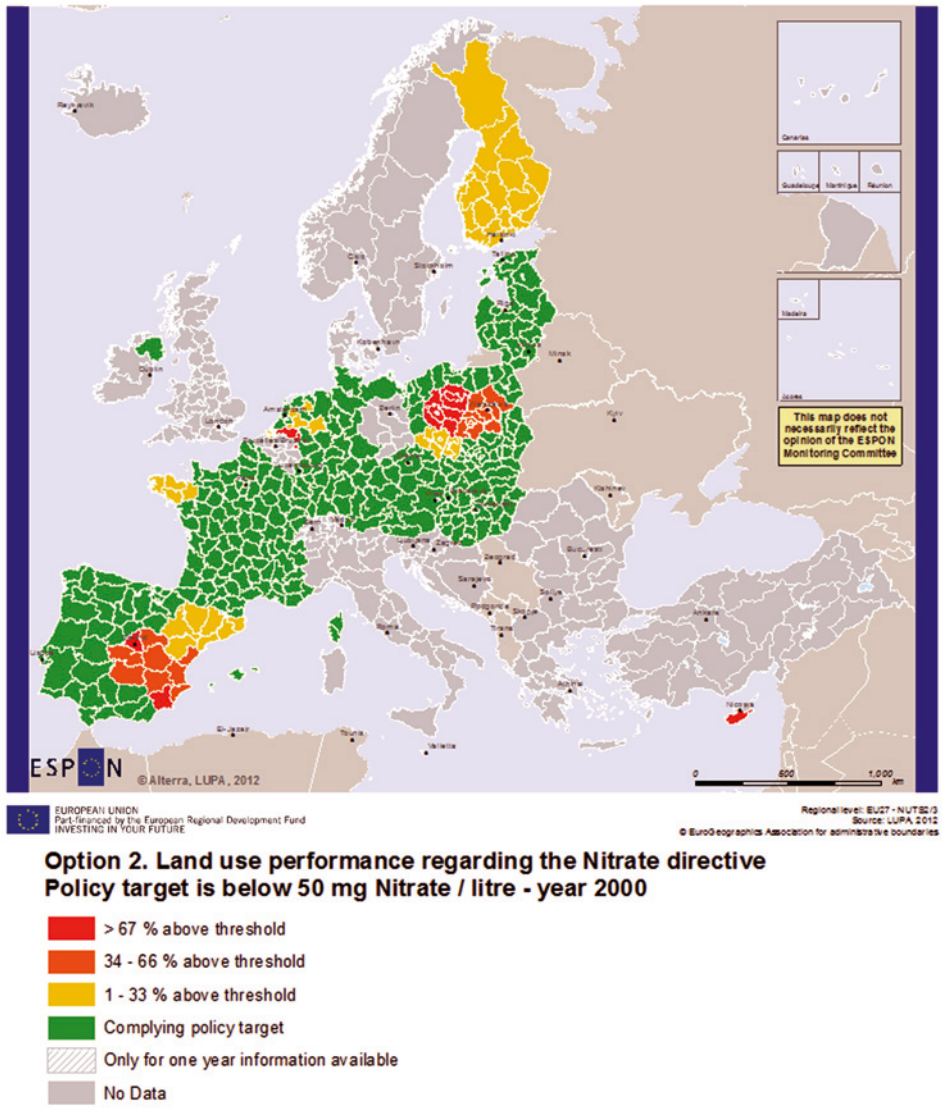


Figure 4.15. Land Use Performance of the agricultural land use regarding Nitrate Directive showing the level of compliance only above the policy target.

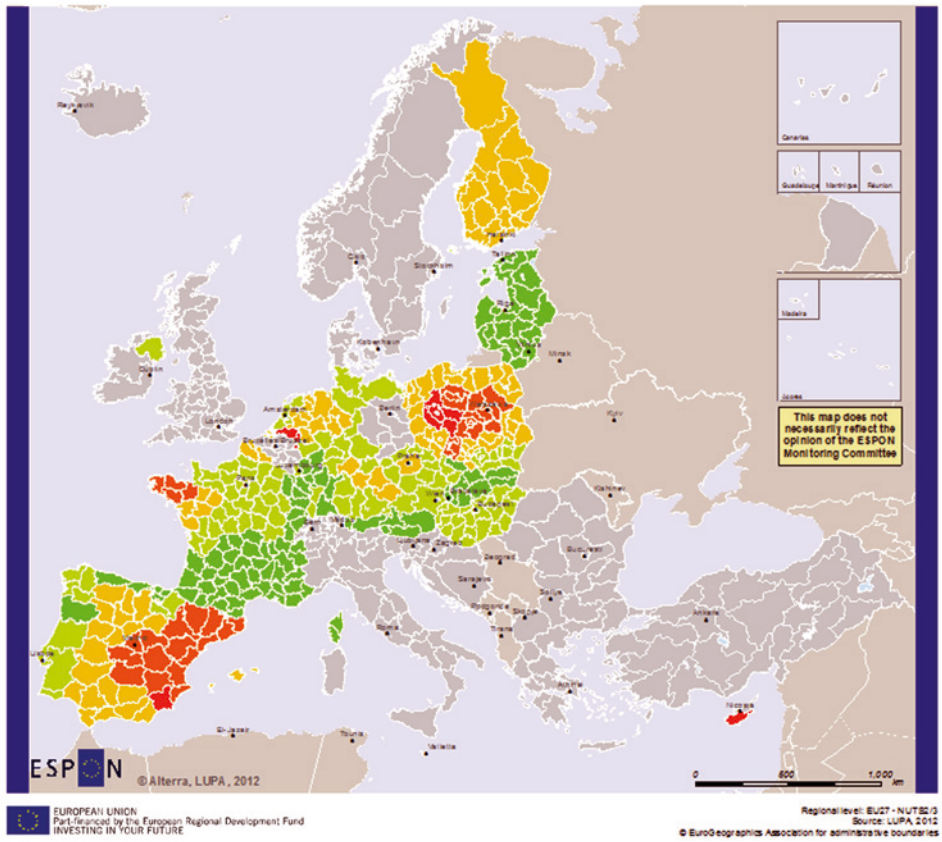


Figure 4.16. Land Use Performance of the agricultural land use regarding the European average showing the distances above and below the average.

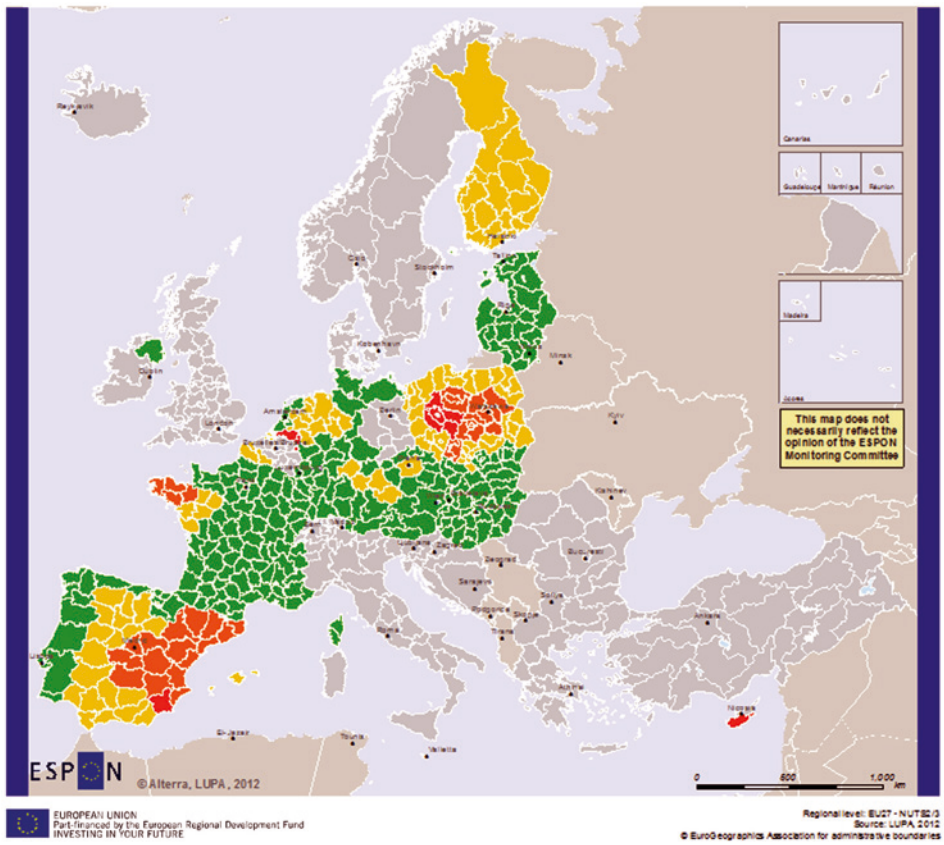


Figure 4.17. Land Use Performance of the agricultural land use regarding the European average showing the distances above the average.

In addition to the maps, the Land Use Performance results were visualized as well using spider diagrams, which show the normalized scores for the indicators or the Land Use Functions, compared to the normalized value of the European average. The normalization by range is given a nominal scale of 0 to 10.

Spider diagrams were produced for all NUTS 2/3 regions. As the figures below show, the spider diagrams seem to be an useful tool to visualise at once all the indicators or the LUF's for a single region, displaying their distance to the EU average. Being able to analyse simultaneously the spider diagrams of the indicators and the LUF's, also helps to understand the role that the indicators play in underpinning the values of the LUF's. The spider diagrams show as well the large differences between the NUTS 2/3 regions and highlight their main functional specificities Figures 4.18-4.22.

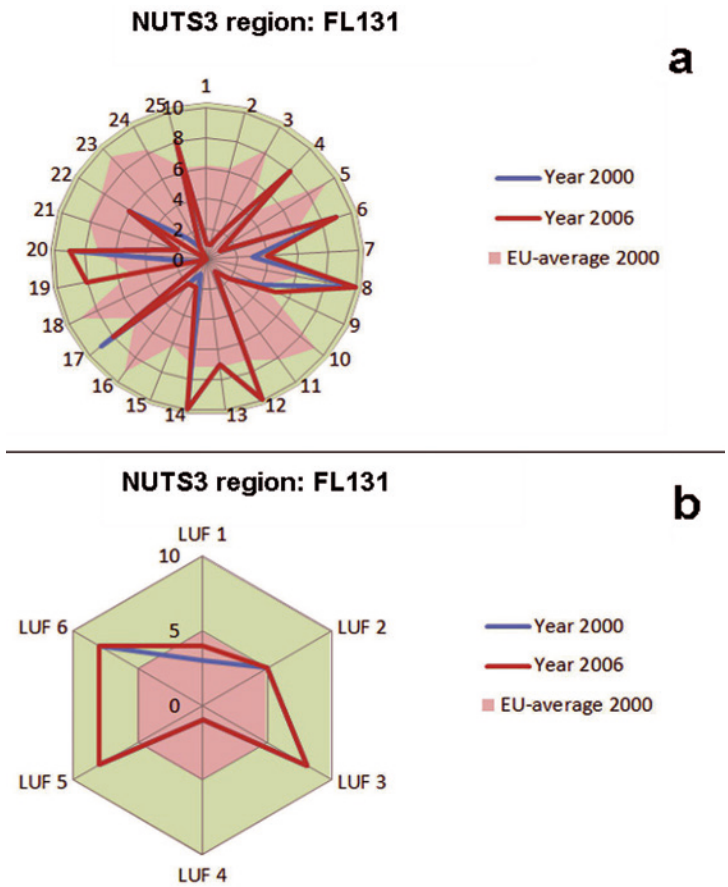


Figure 4.18. Spider diagrams showing the results of (a) the 25 individual indicators and (b) LUF's for NUTS 3 region FL131 – Etelä-Savo. The names of the 25 indicators are provided in Table 4.2.

Ëtela-Savo (Southern Savonia) is a region in the south-east of Finland. It is located in the heart of the Finnish lake district. It has only two major towns in the region, the rest being mainly rural or remote areas (shown by the low values of LUF4 and high values of LUF5 and LUF6). Its key economic sectors are services (67%) and manufacturing (24%), with a minor role of the primary sector (9.2%). Because of the climate, agricultural development is limited to maintaining self-sufficiency in basic products. Forestry, an important export earner, provides a secondary occupation for the rural population (shown by high values above EU average of LUF3). It has a high unemployment rate (12%) (shown by low values of LUF1).

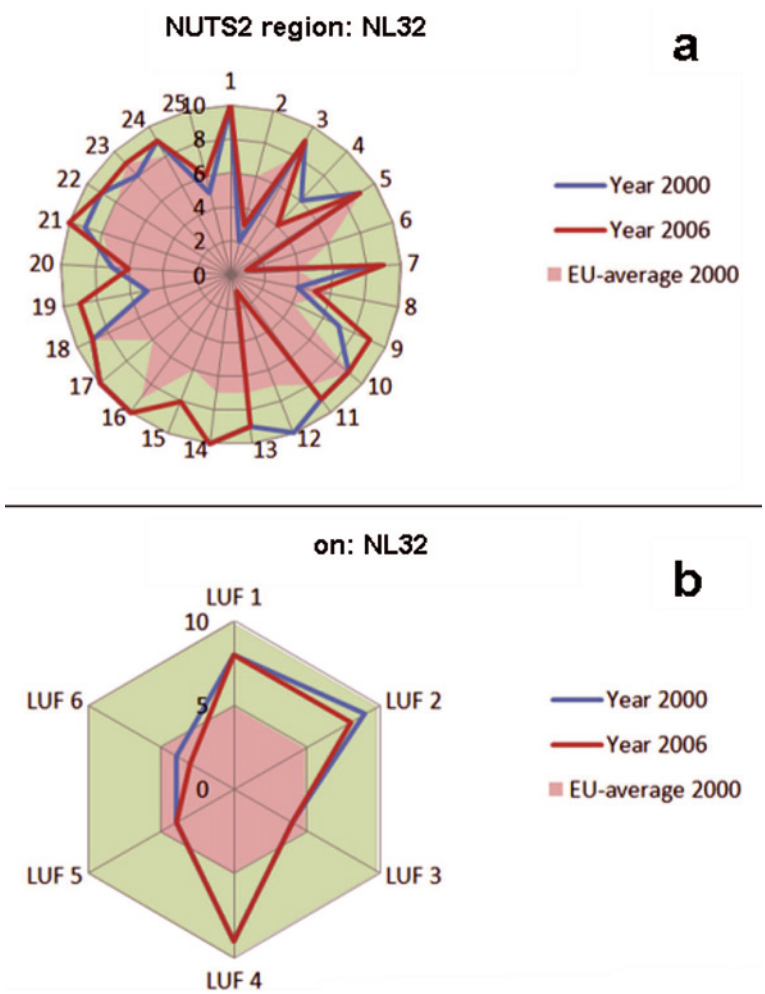


Figure 4.19. Spider diagrams showing the results of (a) the 25 individual indicators and (b) LUF's for NUTS 2 region NL32 Noord-Holland. The names of the 25 indicators are provided in Table 4.2.

Noord-Holland is a province situated close to the North Sea in the northwest part of the Netherlands. Noord-Holland is the country's second most densely populated province, with high level of urbanization (as shown by the very high values of LUF4 compared to the EU average). It is as well one of the most attractive touristic areas as it is shown by the also very high values of LUF2.

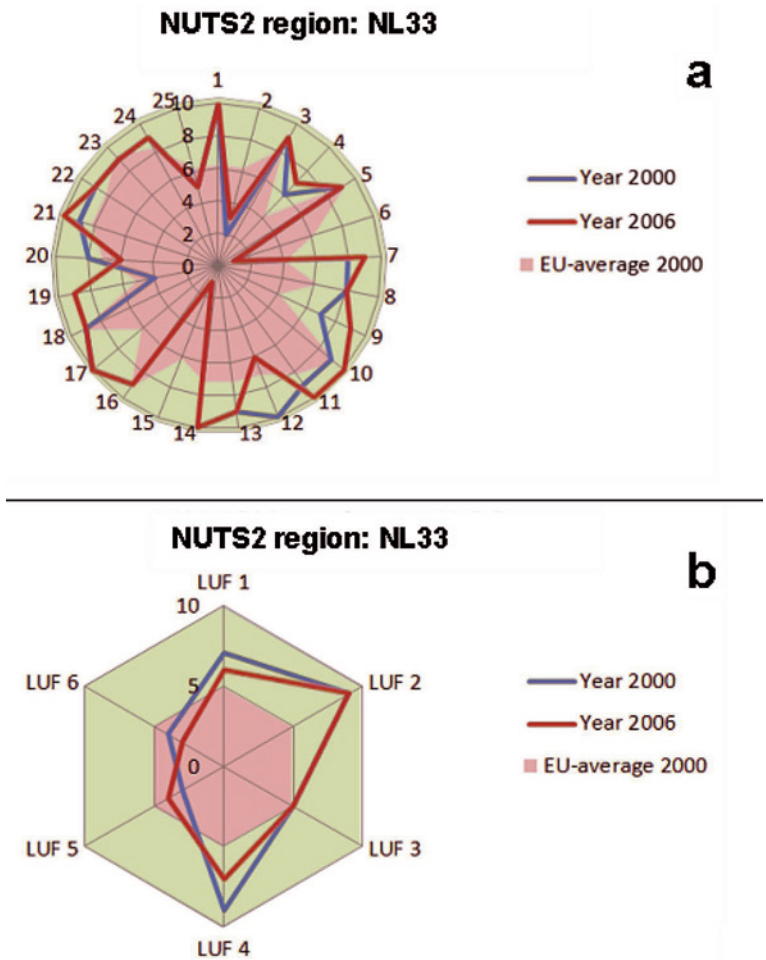


Figure 4.20. Spider diagrams showing the results of (a) the 25 individual indicators and (b) LUF's for NUTS 2 region NL33 Zuid-Holland. The names of the 25 indicators are provided in Table 4.2.

Zuid-Holland is a province situated also along the North Sea in the western part of the Netherlands. Zuid-Holland is one of the most densely populated and industrialized areas in the world (as it is shown by LUF4), and is the province with the highest population density in the Netherlands. Zuid-Holland is the coun-

try's most important province in terms of economy, agriculture and the provision of services (as it is indicated by the very high scores of LUF1 and LUF4). It is a hive of activity, criss-crossed by a busy network of roads, railways and waterways. Rotterdam with its mainport is Zuid-Holland's largest city. The provincial capital is The Hague, which is the seat of national government and the Queen's official place of residence. Outside its urban heart, Zuid-Holland offers spacious tranquillity, sprawling countryside, rivers, polders, lakes, dunes and endless sandy beaches (high level of LUF2). Despite being neighbour provinces in the same country, it is interesting to see the differences between the two Dutch provinces regarding agricultural production (LUF3) – higher in Zuid-Holland, and the two environmental LUF's.

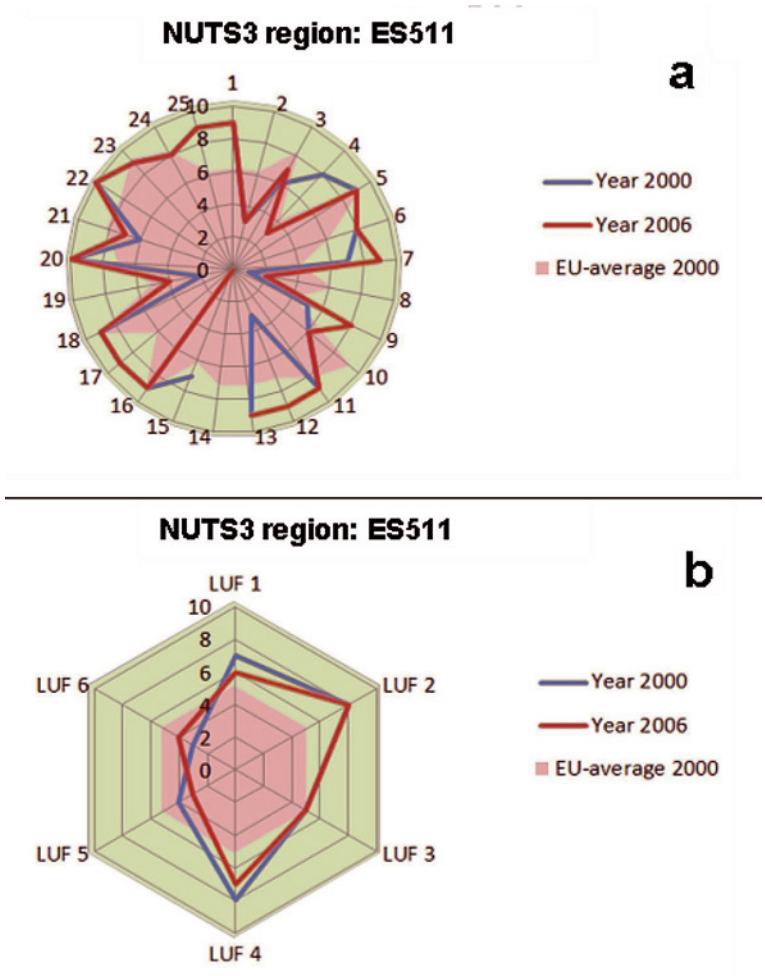


Figure 4.21. Spider diagrams showing the results of (a) the 25 individual indicators and (b) LUF's for NUTS 3 ES511 Barcelona. The names of the 25 indicators are provided in Table 4.2.

The province Barcelona is located in eastern Spain on the Mediterranean coast. It is one of the most touristic provinces in Spain with its capital Barcelona one of the most visited cities in the world (high LUF2). The whole province is highly populated and very urbanized (high values of LUF4) which has significant impacts on the environmental resources (low values of LUF5 and LUF6).

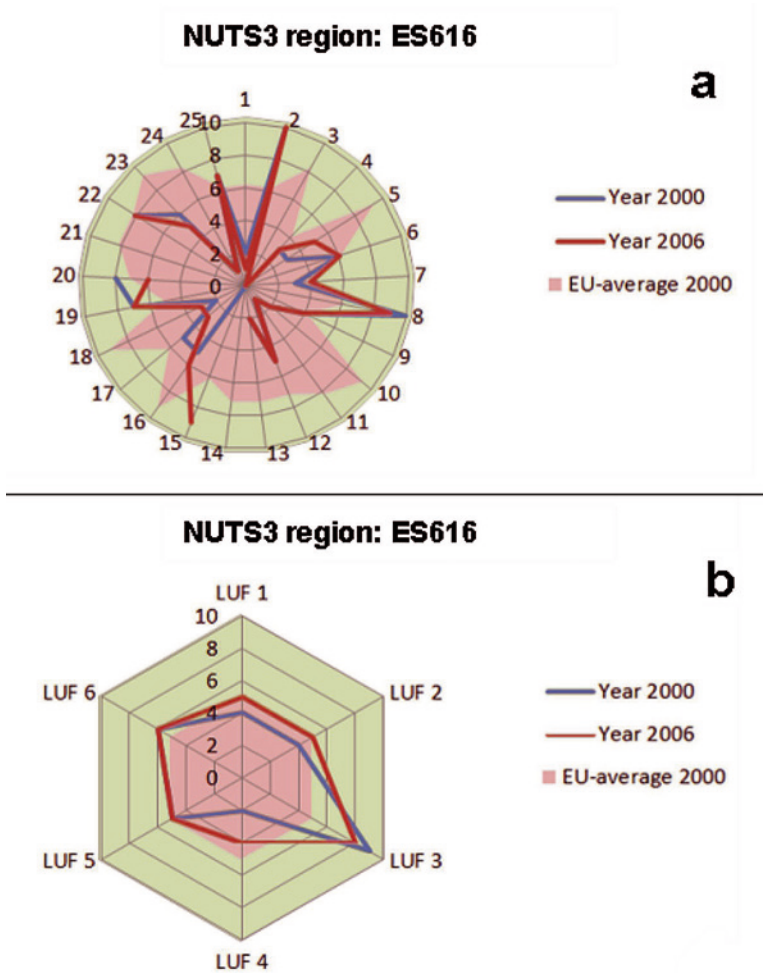


Figure 4.22. Spider diagrams showing the results of (a) the 25 individual indicators and (b) LUF's for NUTS 3 ES616 Jaén. The names of the 25 indicators are provided in Table 4.2.

Jaén is a province of southern Spain, in the eastern part of the autonomous community of Andalusia. Jaén consists of mainly rural and remote areas with few cities. It is one of the larger producer of olive oil in the world. The results show indeed the main relevance of the LUF3 for land-based production, which is far above the EU average, and the slight increase in this LUF between 2000 and 2006, which could be explained by the influence of the CAP. At present, olive oil production is heavily subsidized by the CAP. This policy has led to intensification and increased output. On the other hand, it has helped to reduce the land abandonments in marginal regions.

4.5.2. Land Use Efficiency

The definition of Land Use efficiency is a complex issue. Efficiency has a wide variation in meaning for different disciplines. In general terms, efficiency describes the extent to which time or effort is well used for the intended task or purpose. In the case of land use science, this definition could be translated as the extent to which land is well used for the intended function considered.

The term "efficient" is very much confused and misused with the term "effective". In general, efficiency is a measurable concept, quantitatively determined by the ratio of output to input. "Effectiveness", is a non-quantitative concept, mainly concerned with achieving objectives. In our approach, effectiveness is clearly related with the Land use performance definition, i.e. achieving policy objectives.

How to measure land use efficiency quantitatively? Efficiency can be expressed as a a percentage of what ideally could be expected, hence with 100% as ideal case. This does not always apply, not even in all cases where efficiency can be assigned a numerical value, as it is in this case. Therefore we use a slightly broader model of efficiency, i.e. efficiency corresponds to the following ratio:

Land Use efficiency = Output of some valuable resource/revenue produced by the use of the land /Input of land used

In the context of this EU assessment, LU efficiency is defined considering the central concept of multi-functionality, i.e. Land Use Functions. Therefore the LU efficiency ratio is calculated for each of the six Land Use Functions. For example, in LUF1 Provision of Work, the main output is the nr of jobs, and the LU efficiency will be defined as the nr of jobs per sector related to the use of the land for that specific sector. The definition of efficiency is therefore linked to the specific functionality of the land used and does not always correspond to a percentage when the resource/revenue produced and the areal (amount of land) used are not compatible units, or if they are transformed into products. For example, in the analysis of the efficiency for the LUF3 Provision of food, the Output may be the revenues obtained by the production of food, timber and bioenergy, while the Input is the amount of land used as input.

The definition of the Output and Input to calculate Land Use Efficiency ratio for each Land Use Function are described in Table 4.6.

Table 4.6. Definition of the Land Use Efficiency Output and Input for each Land Use Function. CLC nr refers to the second level of Corine Land Cover classes. CLC 11 = urban fabric; CLC 14 = Artificial non-agricultural vegetated areas; CLC 21 = Arable land; CLC 22 = Permanent crops and CLC 24 = Heterogeneous agricultural areas.

LUF	Output	Input	Definition
Provision of work	Nr of jobs per sector	Area used by each sector	Based on NACE data on jobs per sector; considering two categories: (i) the agricultural sector and (ii) all the other sectors: Nr of agri-jobs/km² agriculture (CLC 21 + 22 + 24) Nr of jobs outside agriculture/km² built-up area (CLC 11)
Provision of Recreation	Nr of tourists (proxi: Nights spent in tourist accommodations)	Urban areas	Nr of nights spend in tourist accommodations/km² urban areas (CLC 11 + 14)
Provision of food and bioenergy (only for agricultural production)	Area harvested	Agricultural area	Area harvested (km²)/agricultural area (CLC 21 + 22 + 24)
Provision of housing and transport and transport infrastructure	Population nr	Built-up area or roads longitude	For housing: Population nr/km² built-up area (CLC 11) For transport infrastructure: Population nr/ km roads
Provision of abiotic resources	All the soil that is not sealed is consider as potential source of abiotic resources	Area of the region	Un-sealed area (km²)/Total area region (km²)
Provision of biotic resources	Area covered by N2000 and CDDA in 2006	Area of the region	Protected area (km²)/Total area (km²)

The maps in the eight following figures visualise the Land Use Efficiency for the six LUF's, as defined above.

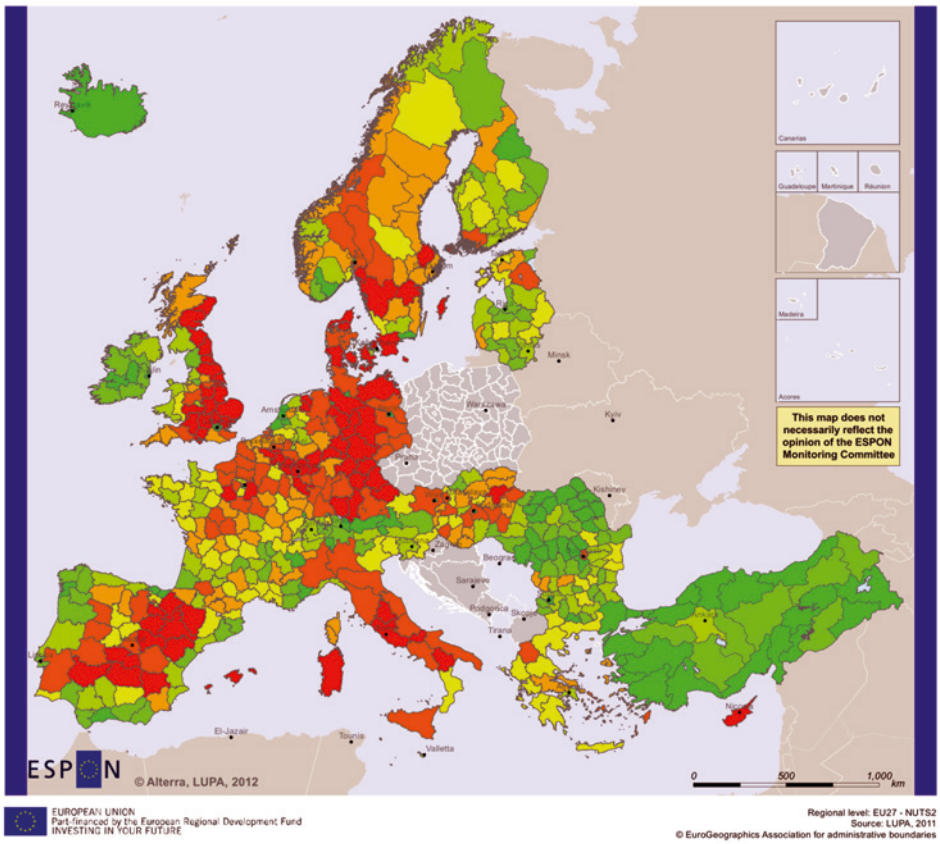


Figure 4.23. Land Use Efficiency regarding to (1) Provision of work based on agricultural land use.

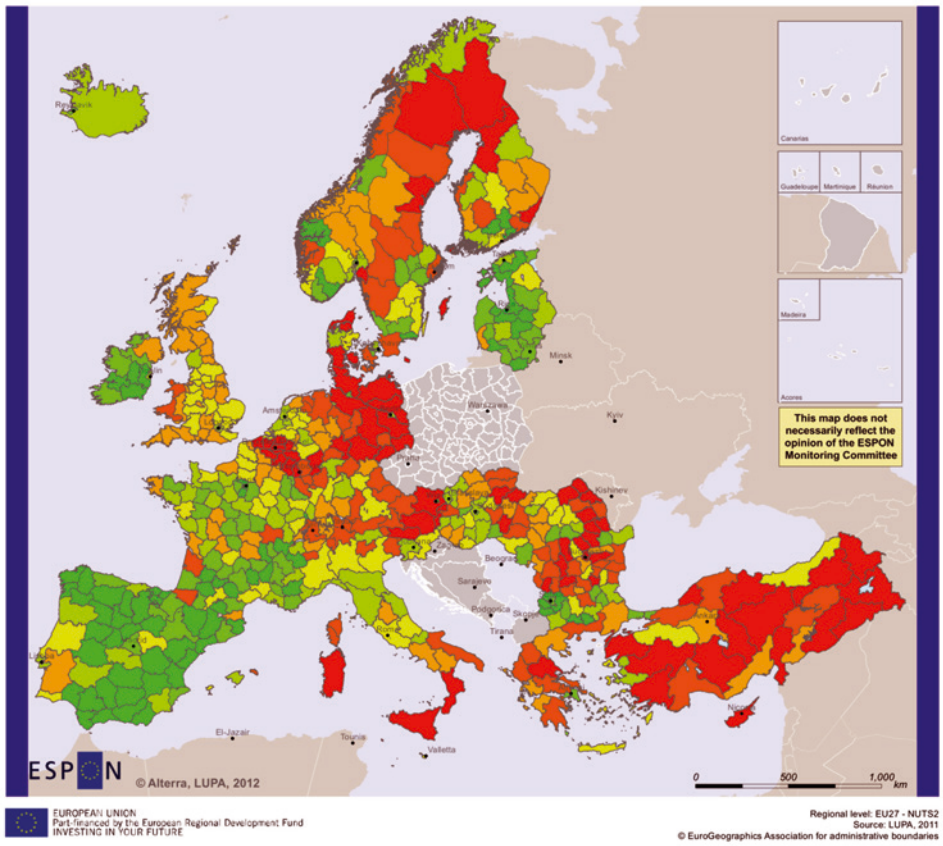


Figure 4.24. Land Use Efficiency regarding to (2) Provision of work based on other activities than agriculture.

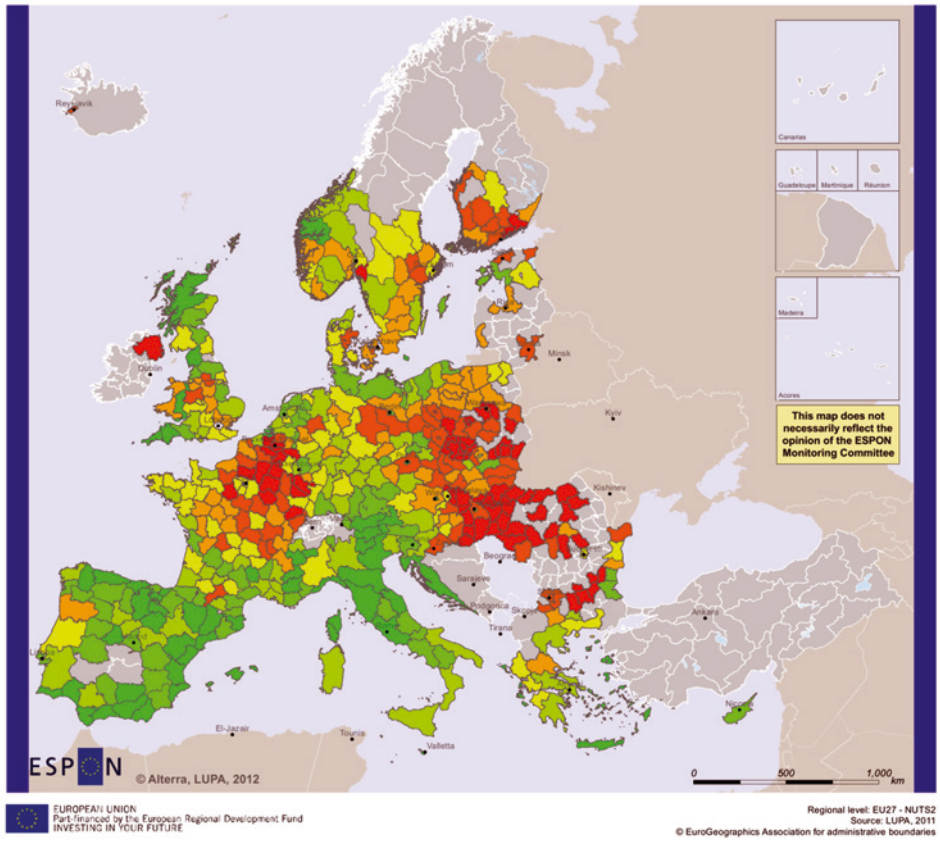
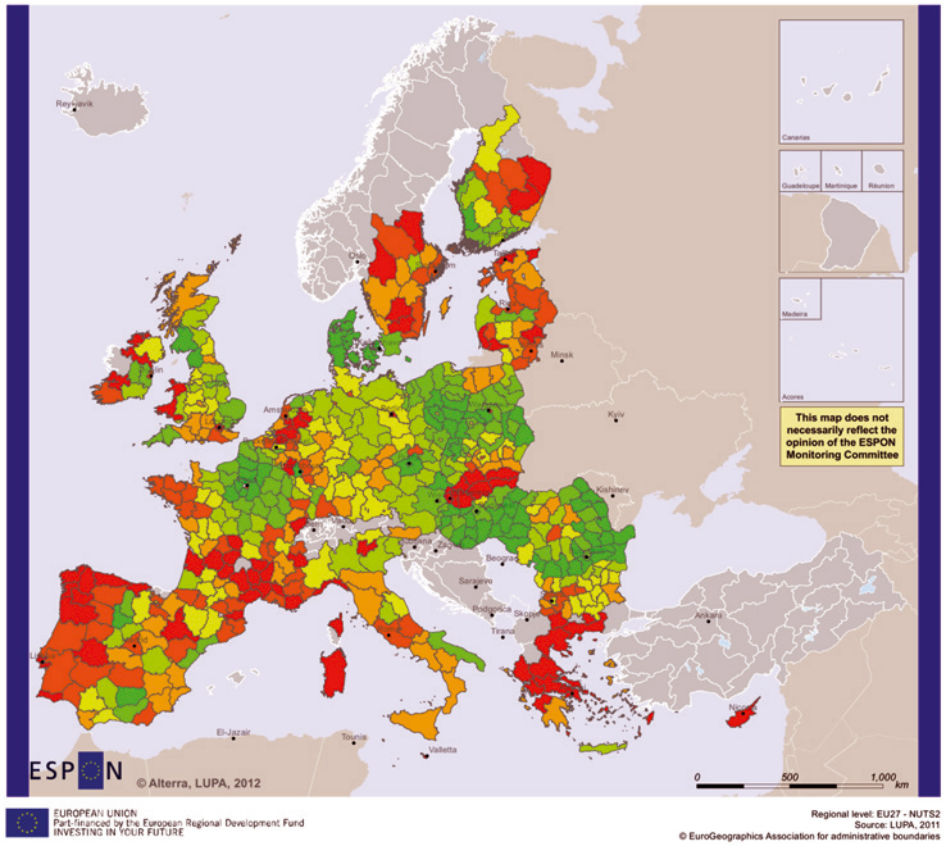


Figure 4.25. Land Use Efficiency regarding to (3) Provision of Recreation.



4. Land-use efficiency regarding Food and Energy (km2 harvested / km2 agriculture CLC 21 + 22 + 24)

- 0.000002 - 0.000021
- 0.000022 - 0.000033
- 0.000034 - 0.000040
- 0.000041 - 0.000046
- 0.000047 - 0.000053
- 0.000054 - 0.000062
- 0.000063 - 0.000328
- No Data

Figure 4.26. Land Use Efficiency regarding to (4) Provision of food and bioenergy.

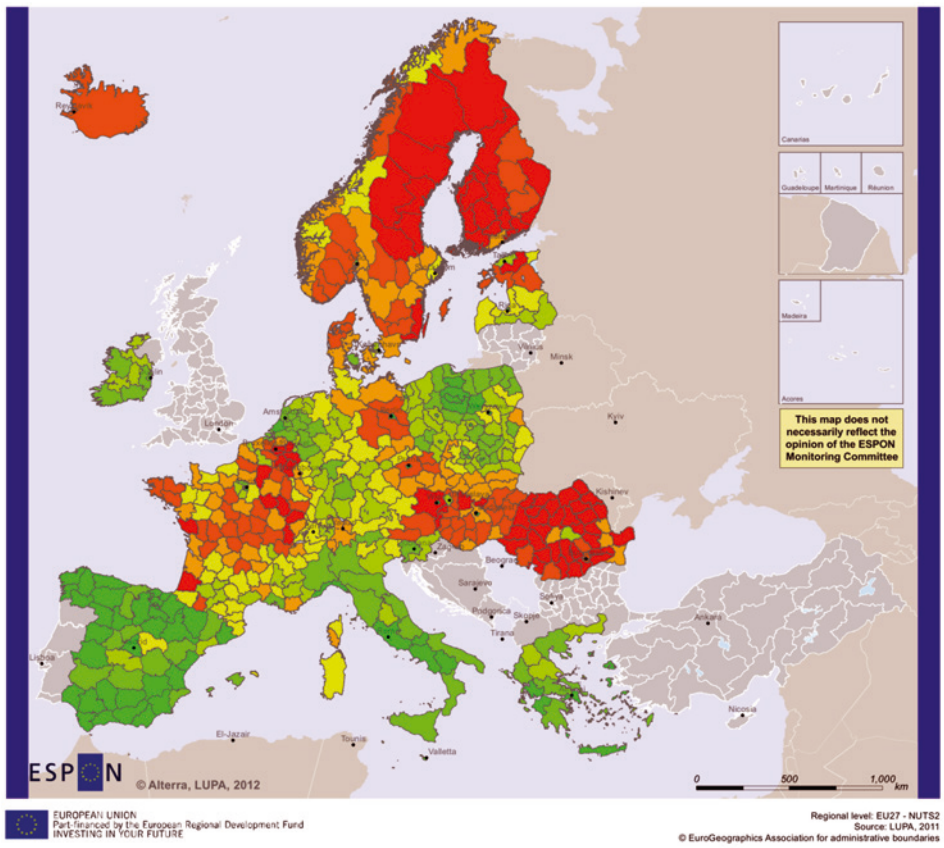


Figure 4.27. Land Use Efficiency regarding to (5) Provision of housing.

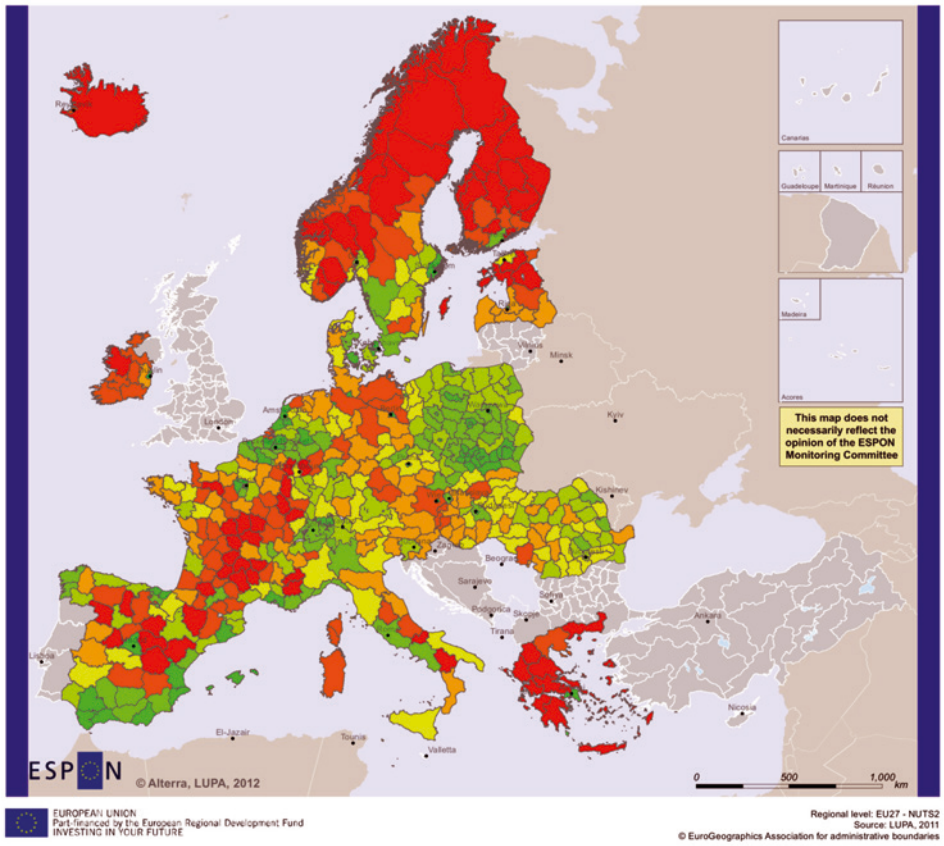


Figure 4.28. Land Use Efficiency regarding to (6) Provision of transport infrastructure.

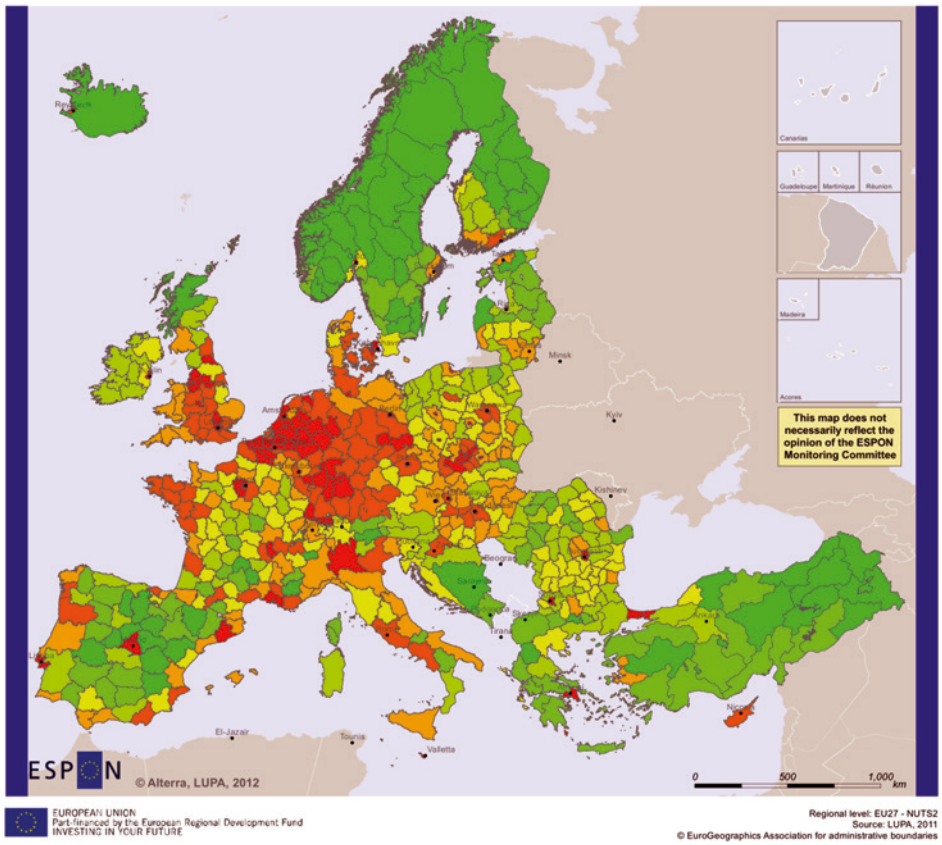
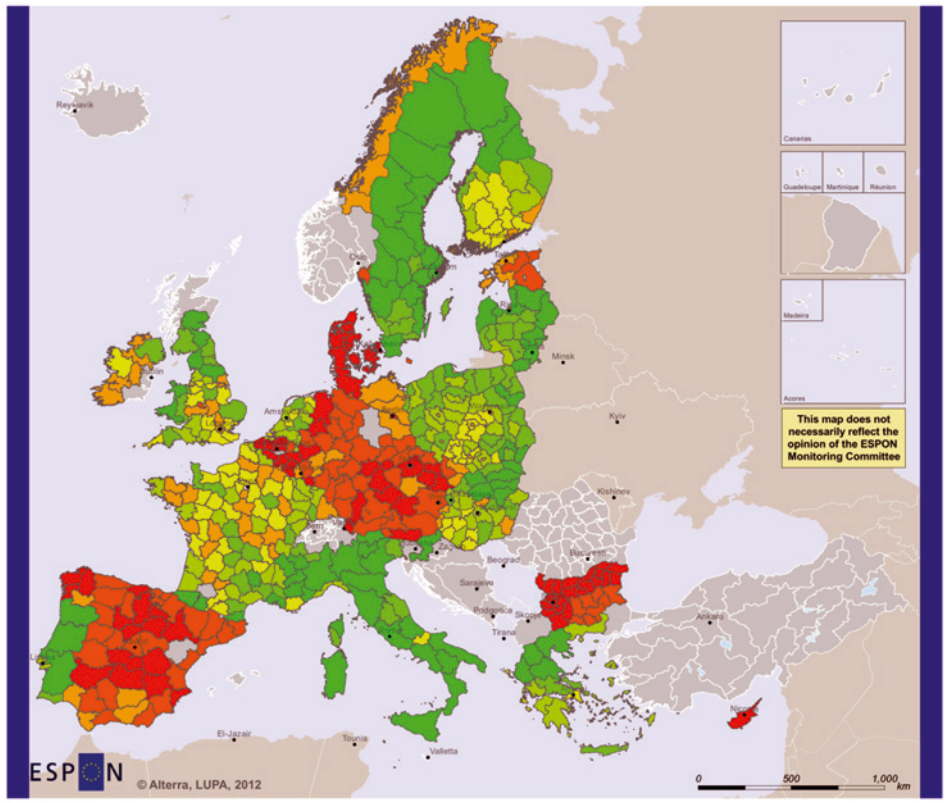


Figure 4.29. Land Use Efficiency regarding to (7) Potential Provision of abiotic resources.



8. Land-use efficiency regarding Provision of Biotic Resources (Protected area km2 / Total area km2)

- 0.000001 - 0.000006
- 0.000007 - 0.000015
- 0.000016 - 0.002374
- 0.002375 - 0.011638
- 0.011639 - 0.027026
- 0.027027 - 0.063669
- 0.063670 - 2.538507
- No Data

Figure 4.30. Land Use Efficiency regarding to (8) Provision of biotic resources.

The approach to assess Land Use Efficiency is in principle quite coarse. However, it helps to show how relatively efficient works out multi-functionality in every region. For example, the land of a region can be used very efficiently to provide food, while at the same time being 'inefficient' in providing housing and abiotic resources (e.g. some North provinces of the Netherlands). The LU Efficiency approach also helps to find out the degree of current use regarding the maximum (e.g. provision of food and bioenergy) or the potential use (e.g. in provision of abiotic resources).

4.6. Conclusions

This chapter describes an adaptation of the LUF conceptual framework to assess the impact of LU changes between 2000 and 2006 on the multifunctionality of EU27 regions. The results indicate that the application of the LUF's methodology is feasible. Finally, the application of the LUF's concept to assess the Land Use Performance and Land Use Efficiency seems an useful approach to get deeper insight in the complexity of the multi-functionality of the land in the European regions.

It can be concluded that the three main objectives defined for the LUF's framework, as defined in chapter1, have been achieved. Specifically:

- The degree of multi-functionality of regions has been assessed quantitatively for the period 2000-2006 by applying the LUF methodology to the 635 NUTS 2/3 regions of EU27. The LUF multi-criteria analysis calculates a functionality score for each of the six land use functions, by integrating weighing of the normalized values of a set of meaningful indicators contributing to each LUF. The six functionality scores measure the functional performance of a region, i.e. the degree of multi-functionality.
- The impacts of land use change have been assessed in a comprehensive way by applying the LUF methodology to calculate the changes in the performance of six land use functions. The LUF performance integrates the changes in the underpinning indicators and therefore provides a comprehensive assessment and not based on the partial views provided by individual indicators.
- The impact of land use changes on the economic, social and environmental dimensions, are assessed by linking the results of the changes in the performance of the six LUF's to the changes in the three sustainability dimensions. The LUF methodology defines the LUF's considering main links to the economic, environmental and social dimensions (see section 2), noting that 'the LUF's do not refer uniquely to a dimension of sustainability, but have a "prevalent" social, economic or environmental character, acknowledging that the pillars of sustainability are not isolated, but involve numerous cross-linkages. In this way sustainable development, when considered as the interface between socio-economic development and the environment, is addressed. For example,

the performance of the LUF 'housing and infrastructure' (associated with socio-economic development) is not only underpinned by socio-economic indicators but as well by soil sealing and the percentage of green areas close to residential areas, representing the environment.

Regarding the implementation of the LUF's methodology and its further use as tool to support regional policy assessments (ex-ante and ex-post), it can be concluded:

- The Land Use Functions (LUF's) provide a useful approach by focusing on a fixed set of cross-cutting issues linked to the mains sectors involved in the use of the land, including the economic, environmental and societal dimensions. Therefore LUF's may be relevant for the design of policies addressing the interface between socio-economic development and the environment, i.e. sustainable development.
- These issues are in line with several EU policies that affect directly or indirectly the use of the land, e.g. employment, agriculture, resource efficiency, transport, urban areas, biodiversity, etc. The LUF methodology could turn into a workable tool for policymakers at different spatial scales ranging from European, national to sub-national level.
- LUF's provide an integrated assessment of the economic, environmental and social aspects of the land used, providing a good basis for trade-off analysis between the different main land functions.
- The two environmental LUF's and their respective indicators are linked to non-marketed environmental services (e.g. "Status of quality of bathing water", "natural Recreation") and help showing how areas contribute to the overall well-being of Europe. The potential link to policy targets, as shown in the project, can help to indicate how may such ecosystem services be at risk, and how can policies take these aspects into account considering the interaction with marketed goods and services.
- LUF's and the indicators used to build them can be used to estimate land use performance using different references. Firstly, LU performance when compared to specific policy targets. And secondly, LU performance of a specific region when compared to others (EU, national and sub-national level).
- The six LUF's identified offer a consistent and broad basis to approach the complex concept of LU efficiency. For example, it allows identifying regions that may be very efficient in terms of agricultural production whereas inefficient in maintaining natural resources.
- The LUF's approach may help to approach a multi-level governance by identifying diverse patterns and trends, not only within each LUF category but among the full set of categories as well, on the basis of NUTS 2/3 data and case studies. The LUF's help to identify common issues (both concerning performance and efficiency) that support the finding of similar solutions. There-

fore the LUF's approach is also useful as a basis for pan-European dialogue, insofar as territories with the same LUF's profile are relatively more prone to develop cooperation.

- The LUF's approach demonstrates that the designation of territorial policies needs to be integrated, considering the heterogeneity and dynamics of, and trade-offs between, the economic, environmental and social profiles within each type of areas. At the same time, the LUF's categories can be a useful tool to deal with the individuality of territories, insofar as they make it possible to categorise states and processes in a consistent way across the European regions.
- The LUF's methodology has been consistently applied at NUTS 2/3 level, based on a shared set of indicators available at pan European level. Unfortunately some key indicators were not available for all regions or their quality did not suffice to be used. This lack of relevant indicators represents a major constrain in the implementation of the methodology, as it has been explained in the report and pleas for further work on gathering new data at higher spatial resolution by the appropriate European institutions (e.g. Eurostat, EEA, JRC). The methodology is flexible and can be applied at all spatial levels (European, national and sub-national).

Regarding the implementation of the LUF's concept to the Land Use performance and LU efficiency can be concluded:

- Visualization of the LU performance results with maps and spider diagrams brings complementary information. The maps show the spatial distribution of the calculated values and help to identify hot spots, however it is difficult to get the full picture (i.e. addition of all the LUF's and indicator maps) for one region. The spider diagrams provide this by visualising at once all the indicators or the LUF's for a single region, displaying their distance to the EU average. Being able to analyse simultaneously the spider diagrams of the indicators and the LUF's, also helps to understand the role that the indicators play in underpinning the values of the LUF's. The spider diagrams show as well the large differences between the Nuts 2/3 regions and highlight their main functional specificities.
- The approach to assess LU efficiency is in principle quite coarse. However, it helps to show how relatively efficient works out multi-functionality in each region. For example, the land of a region can be used very efficiently to provide food, while at the same time being inefficient in providing housing and abiotic resources (e.g. some North provinces of the Netherlands). The LU Efficiency approach also helps to find out the degree of current use regarding the maximum (e.g. provision of food and bioenergy) or the potential use (e.g. in provision of abiotic resources).

5.

Land Use Change and Land Use Functions – Case Studies

Jerzy Bański, Konrad Czapiewski, Mariola Ferenc, Marcin Mazur

5.1. Objective and methodology

There is a large variety of European regions that represent different systems of land use management, each with its own drivers of land use patterns. They represent a variety of types located in geographical space. Land use also has differing regional dynamics according to changes in social, economic and environmental development. The EEA claims that the type of land use change varies among different types of regions. "Urban areas and related infrastructure are the fastest growing land consumers, mainly at the expense of productive agricultural land. Rural landscapes are changing due to the intensification of agricultural activity, land abandonment and forest exploitation. Coastal and mountain areas are undergoing profound spatial reorganizations to accommodate intensive tourism and leisure activities."

The rationale behind using case studies as a component of the scientific method is to identify, conceptualise and theorise drivers and dynamic processes which are stimulated by specific land use changes on the macro and micro level. The cases shall differ in their features, e.g. the endogenous potential of the region (physical, human and social capital), its environmental, socio-economic and geographical assets.

Case studies are seen as essential elements, conducive to providing better insight and confirming some of the main findings, taking advantage of additional expertise with strong local/regional knowledge. Finally the major objective of the case studies in EU-LUPA was to:

- Verify and confirm the proposed typology and identified processes and challenges.
- Identify land use functions and undertake a "multifunctionality" assessment
- Identify factors and drivers (natural and socio-economic) of land use changes and land use dynamics in detail in different types of areas.
- Provide an answer about mechanisms and trends (processes) of land use changes on a local scale.

– Identify challenges in those areas and define policy recommendations to cope with those challenges based on stakeholders' opinion

Four regions were indicated as case studies:

1. Øresund – as cross-border region with highly differentiated land use structure (from urban core, semi-urban to arable), high multifunctionality and several clusters of land cover changes in the period 2000-2006.
2. Eurocity Basque Bayonne-San Sebastián – a cross-border region with a high share of urban areas and relatively high number of changed clusters in the period 2000-2006 (mainly agricultural), multifunctional.
3. Chełmsko-Zamojski – located on the periphery (EU border), mostly agricultural, monofunctional, with a low number of changed clusters.
4. Jeleniogórski – located in the Polish-German-Czech borderlands multifunctional, in economic transition.

Figure 5.1. Regions for case studies.

In the first step, the case studies were focused on creating a statistical profile for each region, specifically identifying the main current socio-economic processes and actors with a possible impact on land management and changes in land cover.

Secondly, the changes in land use and land cover structure were characterized, along with their respective dynamics. In each region, the major effect of the land use change (deforestation, desertification, soil degradation, impact on biodiversity, urban sprawl, floods etc.) and the dynamics of these changes were identified.

Regional development strategies and other regional and state documents were analyzed according to land use policies and influences on land use changes. Other sources with influences on land use changes were also surveyed, e.g. interviews with local authorities and other important players were conducted.

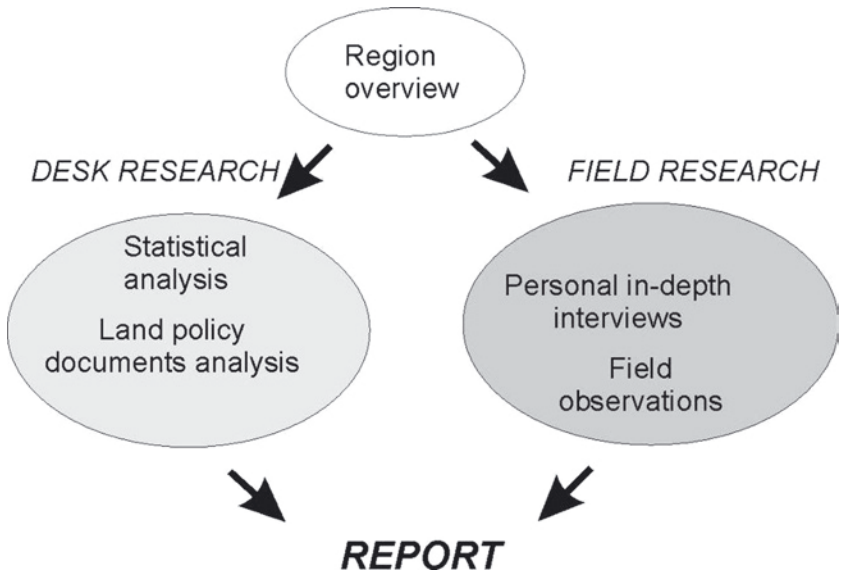


Figure 5.2. Basic scheme of case study research.

Finally, on the basis of the analysis described above, we were able to validate a number of proposed typologies and formulate chosen policy recommendations (on the basis of stakeholders' opinion).

5.2. Øresund Region

The Øresund region is located on two strands of the Strait of Sund - both in Denmark and Sweden. The boundaries of the Øresund region have undergone changes in recent years. With administrative changes affecting Denmark as well as Sweden, the area of the region has increased. From 1 January 2007 the administrative division of Denmark breaks the country up into 5 regions, which replaced the previous division consisting of 13 provinces (*Amts*). As part of administrative reform, the number of municipalities was reduced from 270 to 98. In Sweden, in 1997, the counties of Kristianstad and Malmöhus merged to form

Skåne County (*Scania*). Through changes in the Øresund, the region expanded its area more than twofold. It currently covers the region of Skåne on the Swedish side of the strait, the capital region of Denmark, and the Zealand region (the islands *Sjælland, Lolland, Falster, Møn* and *Bornholm*) on the Danish side. With 3.7 million inhabitants, the Øresund region is the largest and most densely populated metropolitan region of the Nordic countries.

The Øresund Bridge that has linked Copenhagen and Malmö since 2000 is a comprehensive motorway network that connects the North of Scandinavia with Denmark and Western Europe.

This bridge also extends the regional railroad that formalizes a loop between the Danish and Swedish coasts. On the other hand, the various waterways that facilitate communication among numerous cities of the Bay extend to the Baltic Sea and the Atlantic Ocean via the North Sea, thus expanding the possibilities with the coastal countries concerned. The most obvious and ongoing process in this area is urban sprawl.

The Øresund region is very interesting in the aspect of land use typologies interacting with urban sprawl, and consequently also with multifunctional activities such as the following that are taking place on an ongoing basis:

- Protected areas, both on the islands of the region and on the Swedish mainland.
- Agriculture, with Southern Sweden being the most intensive producing area of that country.
- A large number of renewable energy producers, both individual and park-based windmills, on both land and sea.
- In addition, a high production of biomass for biogas, power and generation of heating for the district. Especially on the Swedish side there are interactions and conflicts between agriculture and biomass production.
- High mobility between the Swedish and Danish sides, and with the bridge being the most important commuting route, especially from the Swedish side. In 2010 approximately 20,000 people a day commuted across the sound – six times more cross-border commuters compared to the year 2000.
- Coastal communities, where tourism and second homes from both sides are playing a significant role.

The region is an excellent illustration of the urban sprawl problem and since the bridge was erected the implications of urbanization from one country (the Danish side) on the land use patterns in another country (the Swedish side) have become recognizable and palpable.

Table 5.1. Statistical survey and characteristic of Øresund region.

Øresund Region									
Location within Europe	Nordic		Western		East-Central			Mediter-ranen	
	X								
Type of location	Core			Transitional			Peripherral		
	X								
	Cross-border			Coastal			Mountain		
	X			X					
Size	Inhabitants (nb.)	Density (nb./ km^2)		Surface (km^2)		Pop. growth rate, 1990-2010 (increase/decrease/stabile)			
	3,600,000	170		21,203		increase			
Quali-tative descrip-tion	Cross-border region with important impact on land use of the bridge between Sweden and Denmark. The focus would be on the Swedish side where most changes have been registered. The Øresund region is very interesting in the aspect of land use typologies with urban sprawl interaction, and consequently also with multifunctional activities as the following are taking place: – Protected areas both on islands in the region, and on the Swedish mainland, – Agriculture, with South Sweden being the most intensive producing areas in Sweden, – A large number of renewable energy producers both individual and park based windmills, on both land and sea, – In addition a high production of biomass for biogas, power and district heating generation. Especially on the Swedish side there are interactions and conflicts between agriculture and biomass production, – High mobility between the Swedish and the Danish side, and with the bridge being the most important commuting tool, especially from the Swedish side, – Coastal communities where tourism and second homes from both sides are playing an important role. The region is an excellent illustration of the urban sprawl problem and since the bridge was erected the implications of urbanization from one country (the Danish side) on the land use patterns in another country (on the Swedish side) is obvious.									
Land use structure (%)	Artificial surface		Agricultural land		Forested land			Water bodies	
			38% (2009 – NUTS 2)		22% (2009 – NUTS 2)				
Dominant land use changes 1990-2006 (see Nordregio said nb. 23)	Developed land area has increased at the expense of agricultural land								
Description of land use changes (other important information)	Increase of built-up area Change land on wetland areas and forests								
Socio-economic level	GDP per head		Index of unemploy-ment		Share of high educated inhab.		Degree of urbanization (densely/intermed./ thinly)		
	49,000 Euro		3% (2009)		30%		densely		
Regional functions (2 – highly represented; 1 – represented; 0 – lack)	Agricul-ture	Forestry	Tourism and recreation	Settlement (Build up)	Industry	Others (admini-strative, education, etc.)			
	2	1	1	2	2	1			

Other qualitative description of region	This region is already part of Nordregio's research agenda, so accessing data, interviews etc. would be quite easy. In relation to the aims of the case studies, this region will contribute by: – Verify and confirm proposed typology and identified processes and challenges – Identify land use functions and undertake a "multifunctionality" assessment, – Identify factors and drivers (natural and socio-economic) of land use changes and land use dynamics in detail in different types of areas, – Give answer about mechanisms and trends (processes) of land use changes at local scale. Identify challenges in those areas and defining policy recommendations to cope with those challenges on the basis of stakeholders opinion

5.2.1. Structure and functional diversity of land

Surface and structure of land use

The region has a total area of 21,203 km^2, of which 11,369 km^2 is on the Swedish side and 9,834 km^2 is on the Danish side. It is very diversified: a high population density region comprising Copenhagen and Malmö, forested areas in the North and East of Scania, agricultural land in Southern Scania and Zealand. Additionally the entire region has a highly developed coastline, along which a varied cluster of infrastructure evolved, including a residential area, touristic and recreational zones, a small business centre, and windmill farms producing renewable energy.

Kostrowicki observed that the Northern region is mostly characterized by market-oriented agriculture with livestock breeding, which progressively declines with the distance from the settlement that is the hub of traditional agriculture (Lee, 1991, p. 40).

Agriculture has a large impact on the specificity of land use in Denmark. Land under arable use accounts for 90% of the utilized agricultural area in Denmark (Kostrowicki, 1991, p. 2). On the Danish side of Øresund region agriculture is the most significant form of land use. In the past, traditional agriculture dominated, but recent years have seen the advent of organic agriculture. A new trend is also to convert agricultural land into industrial areas with highly developed transport infrastructure (like in the Køpe area).

Merging information about land use in Denmark and Sweden is difficult due to the different approaches to the primary statistics. The structure of land use in the Øresund region is decidedly different between Denmark and Sweden. On a national level, in Denmark there are more agricultural lands that are being exploited (58%) and less forested areas (11%). In Sweden the situation is reversed: more than 58% of land consists of forest cover, and just 7% is used as agricultural land. The Øresund region consists of three sub-regions: Hovestaden (the capital region of Denmark), Sjælland (Zealand) and the Scania region (in Eurostat statistics the most similar region in terms of area is Sydsverige). Each of the three regions is distinct in its peculiarities: the Copenhagen area has

the highest rate of "Other" kinds of land, which is mainly urbanized land. In the two remaining regions, this indicator registers the significantly lower proportion of ¼ of the total land area. The Zealand region utilizes 63% of its agricultural area and merely 1/10 of this region is covered by forest. The region of Scania has the highest share of wooded land (42% of area) and a high proportion of agricultural land.

The region is a combination of mono-centric development (Copenhagen, Malmö) with some multicentre elements (Roskilde, Købe, Søro).

In the 21st century, the land use changes were not as significant in case of the urban area of Great Copenhagen. Most changes occurred in rural areas, which transitioned into urban ones. The changes in urban areas were not observed in recent years, as they mostly took place in the 1970s and 1980s. Nowadays only the fifth zone is still developing with respect to uses for its area. The vast majority of urban land was established on former agricultural land. Between 2000 and 2006 the urban land-take was much higher than between 1990 and 2000 – about 340 ha per year in second period compared to the previous 50 ha per year (Zasada et. al., 2011). Almost no urban land is transferred back to other uses. Once the land becomes urban – it remains urban.

In 1972 the zoning system in Denmark divided the land into urban, rural and recreational zones. This approach was in use until the turn of the century. It protected rural areas, reserving them exclusively for agricultural production, the one compromise being the development of communication networks.

Every year, the number of residents in the Danish and Swedish countryside is increasing. Nordic people are highly aware of healthy and safe styles of living, and they perceive contact with nature as a medicine for "lifestyle illnesses". For this reason, preservation of values connected with the natural environment is so essential for the citizens of the Nordic countries.

It was not simple to reconcile the aspirations of both residents and investors, but the Nordic people managed to achieve it. Most overwhelming was the rigid adherence to the rules concerning planning and thinking about the future, not the current time and potential benefits.

It was noted that the city of Copenhagen evolves on a circular plan: the first round entails the expansion of infrastructure and consequently the "gaps" in between are managed. According to the formulated "Finger Plan", which was used as a basis to fill the emerging space, both in the city and the outskirts, green spaces were put to use. Small areas, located in or near the city, were mainly used by residents for short trips, while large surfaces of green areas on the outskirts were visited during the longer vacation. While organizing the undeveloped space, a conflict between natural and urbanized areas was visible: the pressure put on recreational and agricultural area was intensified.

Between 1985 and 2004 agriculture in Denmark underwent several seminal changes. The agricultural land area decreased or was stable in almost all the Danish side of Øresund. The greatest changes are to be noticed in corn farming land areas: in 1985, this type of agriculture was critical due to the abundance and lar-

ge number of animal farms. With the accession of an another wave of EU Member States, these farms have been moving out to less developed countries – Poland, for instance. The size of farmlands dedicated to corn has hence decreased. EU policy supports big farms; thus, the average farm size still increases in almost all of Denmark. It is only in a few municipalities that farms of insignificant size remain. This situation exists exclusively in the neighborhood of Copenhagen and in the North of the Copenhagen region, because of a specific lifestyle and recreational farming.

Land cover specificity

Land cover is the physical material directly on the surface of the earth. Corine Land Cover for the Øresund region reflects the biophysical state of the land. In this region the urban area plays the main role, followed by forest and arable land. Detailed land use in the region is shown in Figure 5.3. The core of the region is the Copenhagen area, which is the single most urbanized part of the Nordic countries.

The lands occupied by industry, commerce and transport are closely associated with urban areas. The highest percentage of them is concentrated in the immediate vicinity of Copenhagen. In Figure 5.3 there is a noticeable green ring surrounding the city, approximately 15 km from the center. Most arable lands are situated within 20-30 km from the city; further increases in distance register an average proportion of arable lands higher than 50% of the area. With added distance from the center of Copenhagen, forest area gradually increases. About 70 km from Copenhagen, the forest cover exceeds 40% of the area. This effect is mainly associated with dense forestation of Skåne.

Current and potential multiple uses of land

The current state of land use is strongly diversified throughout the region. A common example of multifunctional land use is the fusion of agricultural production with the recreational functions of a horseback riding area and the energy-producing potential of a wind power station. Furthermore, active environmental protection in a national park favours multifunctional land use, like landscape protection joined with, among others, agricultural and forestry production or recreational activities. The coastal residential area joins the prevailing housing function with recreation, tourism, energy production and small businesses, which do not require a large area. Many smaller farms near the Copenhagen agglomeration are organic due to a big demand for healthy food in the region. Multifunctional land use has become very effective in the economic sense as well.

The number of functions is expected to continue increasing, probably as a result of economic circumstances. The popularity of and demand for organic farming in the vicinity of Copenhagen and future possibilities of moving large-scale market-oriented farms to other countries with lower land prices and less restrictive environmental protection laws will be helpful in introducing multifunctionality into rural areas as well.

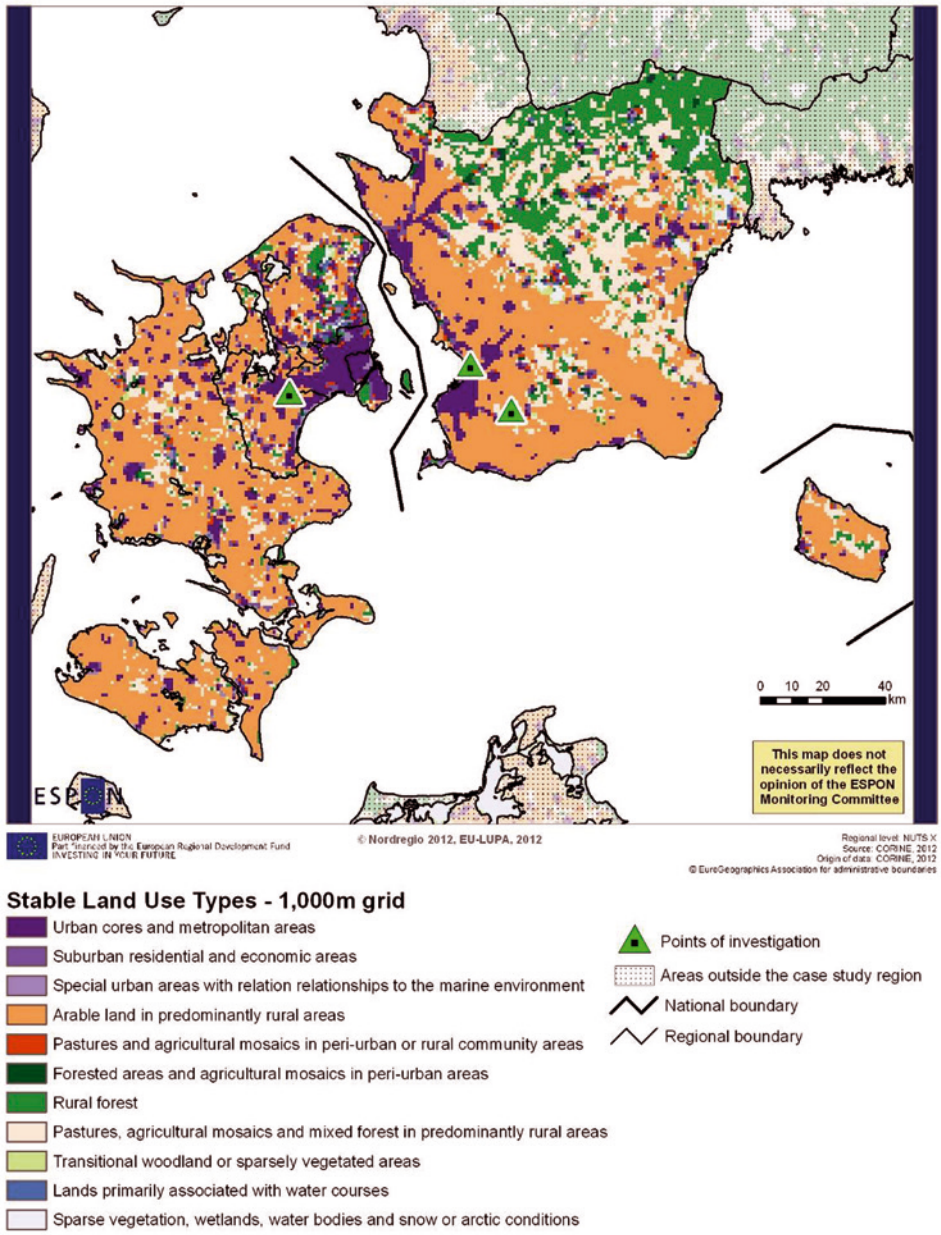


Figure 5.3. Stable elements of Land Cover (1990-2006).
Source: Nordregio based on Corine Land Cover.

The function of agriculture will change to a source of high-quality food production, not limited to only an economic activity. Moreover, organic farming is easy to combine with leisure activities and the development of rural tourism, which is economically promising and useful as well. Indeed, this trend is currently being empirically observed.

The next strong driver of future multifunctionality will be the demand to join agriculture and environmental protection with energy production, which will become more expensive. This is why introducing wind power stations in new areas and combining it with the other functions of land use will become necessary. Approximately 25% of Danish electricity is produced by windmills. Current benchmarks for government policy are to double energy production from renewable energy sources during the next 20 years. However, this will have a negative impact on multifunctional land use, because the windmills limit recreational or residential functions and disturb environmental protection in the surroundings. This has led policymakers to embrace an ongoing process of pulling windmills back to the sea surface, but in the future this may prove insufficient.

Another aspect is the change of agricultural land cover caused by energy production demands. Even currently biomass plants are becoming more important as an energy source, especially the willow. Such land cover means nominally an increase in multifunctionality as it adds energy production to the traditional rural functions, but due to the growing density it entails, as well as the dubious contribution it has to the landscape, it limits the introducing on other functions. Less problematic for the landscape and multifunctionality is the cultivation of rapeseed for bio-fuel.

We can expect a dynamic development of the high-tech industry and research centres in rural areas as well. This will eventually become necessary due to both better conditions for such activities compared to the city centre and the comparably favorable land prices. Organic farming helps rural municipalities to attract such enterprises.

5.2.2. Analysis of land use changes

Dynamics and directions of land cover change

Different trends of land use change are observed in the three sub-regions. These are:

a) Terrains adjacent or close to Copenhagen and Malmö are associated with the importance of the services, industry, housing and transport land use functions. This zone is extended along main traffic routes and along coastal lines, in accordance with the famous 5 fingers plan of Copenhagen agglomeration.
b) Agricultural and recreational – Central, Southern and Western Zealand.
c) Most of the Swedish part of the Øresund region registers strong activity in the areas of forestry and recreation, with a consequently lesser importance of agriculture.

The dynamics and direction of land use changes depend mostly on belonging to the one of these zones. However, general trends of land use changes can be also observed.

The Øresund region recognizes a permanent decrease of arable land area in each of its parts. Due to the strong influence of Copenhagen and Malmö on the land prices during the last 20 years, agricultural lands are retreating further away from the agglomeration. Attractiveness of terrains adjacent to the long coastal line of the region as an area for second houses is an important factor contributing to the perceived arable land decrease.

Nevertheless, the rural character of agricultural areas is relatively efficiently protected by the law, regulations and spatial planning. Changes concern the functional structure for the benefit of functions more exposed to leisure time services. These changes do not concern landscape in any significant manner. Therefore, the falling proportion of available agricultural land in the farming areas is much slower.

In spite of good accessibility of the region's outskirts to its strong and multifunctional development core, the falling proportion of agricultural land in the agricultural areas is relatively slow and is related, for the most part, to arable land. An important factor of rural landscape preservation is a tradition of strict spatial planning. The national policy of Sweden can also have a significant impact on this situation due to the strategic importance of Southern Sweden for Swedish agriculture, where utilized agricultural land takes only 7.5% (arable land 6.4%) of the total area of the country. Significant increases in the share of fodder plants in the structure can be observed and the parallel decrease in the share of permanent grasslands can be explained by the intensification of husbandry, especially pig breeding in the region. The retreating of agriculture from permanent grasslands is observed mainly in the surrounding areas of Copenhagen, where strong pressure on less favorable agricultural land is much higher. Permanent transformation of less valuable agricultural land into non-agricultural forms of land use in Denmark and Sweden has also caused a general decline in the number of fallow lands and green manures areas.

In the Øresund region a dynamic increase of forest area is also worthy of being analyzed. However, this process is not observed in all of Denmark. In Sweden as a whole, afforestation is not as significant compared to the Skåne region. The intensity of this process is strictly related to the transition of rural areas into multifunctional land use in the last years, especially for recreational purposes. This is mostly driven by the needs of the inhabitants of developing agglomerations. Such areas are usually multifunctional because, for instance, they provide a source of wood or a residential area apart from their primary mentioned functions.

Table 5.2. Identification of the factors and drivers of land use change according to type of land in the Øresund Region.

Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Factors ++ most important, + less important	Identified processes
Arable land	E	++	+ From 1972 – zoning system in Denmark (agriculture, leisure, urban) protected agriculture area (one compromise: communication network) + EU support big farms	Moving animals' farms to less develop countries. Transform agriculture to ecological, organic. On Danish side arable land decreases, in Sweden side it is stable because Skane is the only agricultural region in whole country
Pastures with annual/permanent crops	E	+	+ Trend to transform land from agriculture to sport and recreation functions	Decrease area in Capital Region of Denmark and Skane, but increase in other part of Zealand
Forests	S	+	+ Forest is more and more popular for recreation services	Internal changes
Marshes, coastal areas and inland waters	S	+	++ In the case of coastal areas strongly developed residential function in the past, now protection of access to coast for recreational purposes	Strongly developed zone of summer houses along sea coast during many decades. Now landscape conflict with needs of wind power plant on the sea and spatial conflict about needs of access to sea coast and recreation, which is a barrier for further residential zone enlarging and intensifying
	E	+	+ In the case of inland waters environmental protection	Environmental protection of water reservoirs and their surroundings and recreational purposes are the often reasons of economic activities abandon. Now function of environmental protection and recreation dominates in these cases
Core urban areas	S	+	+ Migration of young people into city centers and older (with families) to suburbs	Internal changes

Type of land	Change E – extensi-fication, S – stabili-zation, I – intensi-fication	Dynamics +++ high, ++ medium, + small	Factors ++ most important, + less important	Identified processes
Core urban areas	S	+	+ Migration of young people into city centers and older (with families) to suburbs	Internal changes
Urban areas in transition	I	++	++ Suburbanization, improving quality of life, ++ Transformation of regional economy appearing as dispersion of industry, warehouses and research activities	Urban sprawl according spatial plans (controlled by law). Transformation of regional industry and economy appearing in deconcentration of high-tech economy and R&D sector activities connected with demanding of clean environment, improving conditions of work and spatial accessibility, lowering costs and decreasing role of agglomeration profits
Urban areas in arable land	I	+	++ Suburbanization, improving quality of life	Urban sprawl according spatial plans (controlled by law)
Urban areas in pastures with annual and permanent crops	I	++	+ Investment in sport and recreation areas	Investment in golf clubs, leisure areas, horseback riding paths, etc.
Urban areas in forested areas	I	+	+ Investment in recreation areas, horse path,	Investment in leisure areas, horseback riding paths, etc.
Urban in marshes, coastal areas and inland waters	I	++	++ Nice landscape, high land value	Business centers, wind power plant

Table 5.3. Analysis of land use changes in the investigated areas in the Øresund Region according to type of land.

Name of investigated area	Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Land Cover Flows	Factors ++ most important, + less important	Remarks
1. Hedeland – Sprawl of economic sites and infrastructures	Urban areas in intensive transition	I	+++	Sprawl of economic sites and infrastructures	++ Very good localization close to the city with specified spatial plan	Old grave and clay mine, which was transformed into very diverse recreation zone
2. Lomma – Natural Grassland	Natural Grassland	E	+++	Agricultural internal conversions	+ High value of nature + protection because of threat from motorway and new investment	Nature reserve protecting wildlife of small pond. A couple of new economic investments in the surrounding
3. Forest near Svedala	Forest	S	+	Forest creation and management	+ Cut down because of trees disease	Horseback riding paths and old golf club in the area. Transformation of forest slightly east from indicated point

Actors and drivers of the changes

The observed change in land use structure in recent years is influenced not only by the agricultural and economic situation, but also by the strong pressure of new investments pertaining to the development of the agglomeration. The significance of the rural landscape becomes more salient, as it is protected by some municipalities and national law regulations. This protection has come to the forefront of the changes under discussion. Among the others, the immigration regulations in Denmark bear mention, as these are very restrictive in comparison to Sweden.

The demand for new housing areas are among the chief needs that need to be addressed in both cases. Their basis lies within Copenhagen and Malmö's immediate vicinity, and ties into labour market opportunities. In localities that are farther out, the purposes of housing pressure are gradually being sacrificed in favour of landscape, preserving the traditional rural and coastal landscape. These areas are most valuable. However, the rural landscape was well protected during the past decades by Copenhagen's general plan of development, called the "five fingers plan". The plan assumed new investments along the coastal line and the main transport corridors. Intertwining with an flanking these corridors are there are agricultural areas. The most effective administrational barrier to protect them is to restrict or fordibd new settlement building in rural areas. Despite this, agriculture is retreating gradually further from Copenhagen and Malmö to Jutland and to the new EU-member states under the existing economic pressure.

Apart from the preservation of rural landscape by law and increasing the value of plots intended for housing, another growing power is the knowledge industry and research activities, which are moving to rural areas to work in more natural landscapes and clean conditions. They are interested in preserving such conditions in rural areas and have sufficient arguments as the sector develops. An example of such localization of an institution in rural areas is the new Nokia technological centre near Copenhagen.

Changes in agricultural land use rely on intensification pressure, especially in pork production. In the rural areas, especially relatively close to Copenhagen and Malmö, the important support of the protection of landscape from the intensification of agricultural production has an economic basis. It relies on an increase in the value of properties situated in traditional rural landscapes. That is why multi-functionality of such areas is introduced effectively. The functional changes of land use in rural areas are far stronger than changes in land cover structure. However they might be gradually contributing to the reduction of the land area available for agriculture.

Scenarios and potential conflicts

As opposed to traditional industry, the high-tech sector is developing very fast. It often demands clean environmental conditions, e.g. computer-related operations, medical and surgical equipment production, social science, consultancy regarding machinery or optical instruments, and photographic equipment.

The scenario of future development focused on the high-tech manufacturing industry and service production is most likely, which can be supported by 2.6% of Danish and 3.9% of Øresund region GDP deducted to the R&D expenses (by OECD, 2007).

The process described above will be probably followed by the further retreating of agriculture from the centre of the Øresund region and possibly moving some of the large, intensive farms featuring animal production to other countries. These will be forced to adapt by changing circumstances and the growing needs of an unpolluted environment for the development of high-tech activities and life in the region. To prevent this, shifting gradual shift from agriculture to the leisure activities function of land use in rural areas will take place. A different situation will take place in the areas of the Øresund region, farther away from development core. They can change land use in connection with the needs of the cultivation of energetic plants. Shifting from intensive pork production to the production of bioenergy can be the most important direction of land use changes in agricultural areas.

A less likely, but possible scenario to be taken into consideration is that the agriculture in Denmark and Sweden, like in all of Western Europe, will be forced by the international situation to face the calamity of excessive demand for insufficient supply. In this pessimistic scenario, agriculture will return to the intensification of food production, which will be unfavourable to the landscape and land use structure in the Øresund region. This scenario can mostly influence land use changes in Swedish part of Øresund region, which is of great importance for the Swedish agriculture.

The most important contemporary and most likely future spatial conflict is related to the intensification of pork production, which has an impact on the preservation of the traditional rural landscape of the region and is lowering the land prices in the municipality. This conflict is related especially to the trends observed in Danish agriculture. It can be resolved by moving part of the Danish farms responsible for intensive pork production to the new EU Member States in the future. The discrepancies in agricultural land prices are conducive to this, so this process will probably take effect only after buying the land by foreigners is allowed in the new member states.

There is no real threat of conflicts related to the development of the new transport or industrial areas. In the framework of new transport investments, huge external corridors are planned rather than new routes through the region. The only possible strategic future transport investment in the region is the new bridge between Denmark and Sweden. The possible two new outlets from the region to the exterior are the tunnel under the Fehrman Belt straits from Zealand to Germany (planned for 2018) and a direct bridge between Zealand and the Jutland Peninsula in the vicinity of Aarhus in the more distant future. Such new transport areas can appear in the capital region to handle a growing number of daily commuters. New industrial areas will be rather rare as well, because the number of employees in the manufacturing industry – including construction – is

decreasing. This sector accounted for approximately 15% of the total employment in the capital region, 22% in the Zealand region and 23% in Skåne (Øresund Trends 2010). Even if the manufacturing industry were to shrink in all three areas, the reduction would be the greatest in the capital region. In all three areas, business services and wholesale and retail trade are outstanding.

5.2.3. Conclusion

The major land use change in the Øresund region during the last 25 years was the increase in recreational and residential areas. This was an effect of urban sprawl, suburbanization, increased construction of summer houses as a result of improvements in standards of living and the transformation of rural areas into spaces for leisure activities with a lesser agricultural production function. The general framework of regional spatial plans, especially in the capital region, was relatively effective in protecting the environmental (green) corridors, but were less successful with respect to the preservation of the traditional rural landscape of Danish rural areas. However, due to urban sprawl and pressure from the agglomeration, agricultural activity was gradually retreating to more peripheral areas and to Jutland.

Simultaneously, the transition of industry to high-tech branches occurred, which today yields fruit in the form of a clean environment and well-organized landscape in the surroundings of the agglomeration. With respect to investments in transport infrastructure, the development of railway and bicycle transport networks is currently a priority. Investments in roads are and will be taking place in the Copenhagen suburbs.

The demands of energy production are another new driving force of land use changes within the region. The spatial conflict of wind turbines with other functions is a barrier in introducing them into the rural landscape, but given the expected future increase in energy prices, it seems to be a necessary step, in addition to a broader introduction of plants cultivated for energy production purposes, like the willow *(salix)*.

The 1990s and 2000s were a period of transition for the Øresund region from traditional forms of agriculture, industry and transport to a state more responsive to and in line with modern challenges. This reflects in contemporary changes in land use, and this process will probably accelerate due to inertia following the spike in demand that has characterized recent years.

The conclusion of the case study are generally in line with land use change typology and land use functions analysis. However, in the case of Øresund it needs to be stressed that the NUTS units taken into consideration are on different levels of spatial generalization. E.g. in the Swedish part of the region, the most economically and functionally important changes are taking place in a small part of the total area, mainly near the coast. This might cause some misunderstandings in the interpretation of the effects of the typology of land use changes.

Field studies seem to be a proper method of verifying the typology, although conclusions and observations should be selected according to the scale of the typology itself. Thus, the general assessment of the typology is rather positive, because specific and the most extreme land use changes have been proven to be factual during the investigation. The handful of mistakes that were detected should be treated rather as difficulties of the typology verification method, not a defect of the typology itself.

Nevertheless, one extremely important conclusion considering typology and its general assumption needs to be stressed. All investigations are taking into consideration land use changes in the spatial dimension, expressed as an area of land use changes, even if they are described by functional change. In some cases, this could be misleading, as the importance of functional changes in land use cannot be measured by the physical area affected by the changes.

5.3. Eurocity Basque Bayonne-San Sebastián Region

The main focus of this case study is the Basque Bayonne-Donostia-San Sebastián Eurocity in the wider context of the Basque Country Region in northern Spain.

This cross-border conurbation extends from Bayonne (France) to Donostia -San Sebastián (Spain) along 50 km of the Atlantic front of the Pyrenees, on both banks of the River Bidassoa, the mouth of which marks the border between France and Spain. The main towns in this coastal cross-border conurbation of 600,000 inhabitants are those of the Bayonne-Anglet-Biarritz Conurbation community on the French side and Donostia-San Sebastián on the Spanish side.

In order to better understand the land use dynamics occurring in this area it is important to have a wider territorial perspective. That is why we have analysed the area in the context of the Basque Country Region (NUTS 2) in northern Spain, and also the French Department of Atlantiques Pyrénées (Department 64) in the Region of Aquitania.

The Basque Country Region, also called Euskadi, is a NUTS 2 Autonomous Community located in northern Spain (7,234 km² and 2,169,038 inhabitants) consisting of three provinces, specifically designated as ”historical territories”:

- Áraba (capital: Vitoria-Gasteiz)
- Biscay (capital: Bilbao)
- Gipuzkoa (capital: Donostia-San Sebastián)

Summarizing the general characterization of the analysed region, we can point out some of the elements which will influence land use and the changes in land use functions:

1. High density of population. The Basque Country is one of the most densely populated areas in Spain, but for the last 20-30 years stagnation in population growth has been noted. This is a corollary of stable natural population growth and low levels of migration from other areas of Spain and other countries.
2. Diversified settlement system between coastal area and interior. Concentration of population in three capital cities (Bilbao, San Sebastian and Vitoria), some development of the towns in the coastal and transport corridors and relatively uninhabited inland areas of the region.
3. Relatively sustainable development of a coastal zone. Because of the relief (rocky areas with some bays and estuaries), settlement cannot be so intensive as on the Mediterranean Coast. This is why the changes are not so rapid and so intensive. The expansion of tourism in the Basque Country has never been as intensive and massive as on the Mediterranean Coast and on the Spanish islands. Instead, it was much more selective, restricted to some well situated and well educated visitors (modern-day examples are numerous and notable – for instance, the Film Festival in San Sebastian or San Sebastian as the Cultural Capital of Europe in 2016).
4. Relatively favourable socio-economic condition of the region – the level of unemployment is lower than the national average, the wages are higher and the general level of development is also above the national average.
5. Rapid industrialization processes in the 1950s, 1960s and 1970s. Industrial activity is still an important element in the regional economy. However, nowadays, a revitalization of some industrial areas can be observed, adapting these areas to the services, residential or public developments, as well as establishing open spaces. Highly intensive development of transport infrastructure – railway, motorways, harbours and airport in Bilbao.
6. Development of the main cities – projects that facilitate the development of social infrastructure, creation of towns with special regard to aesthetic considerations (destruction of some roads, industrial buildings, etc.), promoting public transport, creating big towns much more compact and complex.
7. Diversified relief determines, to some extent, the development of certain socio-economic and infrastructural elements – i.e., settlements, linear elements of infrastructure, land use.
8. Attention paid to improvement of environment quality – by way of social programmes and strategies – e.g. promoting public transport, improving the quality of air.
9. One highly important element in the rational planning of land use and land use functions are legal regulations in the Basque Country. The set of legislative documents – such as strategies, plans, GIS tools – and the hierarchical planning system provide superior and effective instruments for complex and rational spatial planning. The spatial and sectoral strategies, and the ways of implementing and monitoring these, are an important tool that is useful in the harmonious and well-planned development of the region.

Table 5.4. Statistical survey and characteristic of Eurocity Basque Bayonne - San Sebastián.

Eurocity Basque Bayonne - San Sebastián					
Location within Europe	Nordic	Western	East-Central	Mediter-ranen	
				X	
Type of location	Core	Transitional	Peripherral		
	Cross-border	Coastal	Mountain		
	X	X			
Size	Inhabi-tants (nb.)	Density (nb./ km²)	Surface (km²)	Pop. growth rate, 1990-2010 (increase/decrease/stabile)	
	650,000	about 810	800	unknown	
Qualitative description	The Basque Eurocity of Bayonne-San Sebastián is located on both sides of the dividing line that was historically formed by the Bidasoa River. „The Bayonne-San Sebastián Basque Eurocity" straddles the French-Spanish border on the Atlantic side of the Pyrenees, extending along the 50 km urban corridor that separates Bayonne and San Sebastián. It is the natural access route between the Iberian Penninsula and Western and Central Europe..." – At the heart of the Atlantic Arc between Bilbao and Bordeaux – At the western end of the French-Spanish border – On the Atlantic façade of the Pyrenees Both territories share a common Basque cultural heritage and throughout history have lived together through periods governed by mutual goodwill and the desire to promote reciprocal needs and interests, and, as has occurred in other border areas, also through periods of confrontation and estrangement. In effect, the special circumstances of the twentieth century made the Franco-Spanish border very strong**.**				
Land use structure (%)	Artificial surface	Agricultural land	Forested land	Water bodies	
		23% (2006 - NUTS 2)	41% (2006 - NUTS 2)		
Description of land use changes (other important information)	Visible pressure on land use change by the infrastructure				
Socio-economic level	GDP per head	Index of unemployment	Share of high educated inhab.	Degree of urbanization (densely/intermed./ thinly)	
	25,000 Euro	10,7% (2009)	36,8% (2009 - NUTS 2)	intermed.	
Regional functions (2 – highly represented; 1 – represented; 0 – lack)	Agriculture	Forestry	Tourism and recreation	Settlement (Build up)	Industry	Others (admini-strative, education, etc.)
	2	1	2 (France)	1	2 (Spain)	0
Other qualitative description of region	The desire to live without frontiers and to co-operate across borders, means that sharing differences and diversity produces a new metropolitan reality that adds a new element to the features defining the identity that each of us already has. New squares, avenues, universities, beaches, promenades... will spring up out of the sum of those that already exist. Here are just two examples: the Eurocity will have a large square, the Main Square of the Eurocity, which will be the sum of the squares that already exist in our cities today. Our University won't have a single campus, but the university campus of the Eurocity will be the sum of the campuses that we already have. The same will happen with the beach, the coast, culture.				

5.3.1. Structure and functional diversity of land

Surface and structure of land use

The surface and structure of land use is strictly connected with the topography of the region. The physical structure of land in this region is highly diverse. From the north the region is bordered by the Bay of Biscay – the coastline is 225 km long, including 104 km of beaches. The southern part of the region is occupied, for the most part, by a high plateau called the Araba plains. Between the coastline and the plateau, the terrain is highly diverse. Three types of land use dominate in the Basque Country: forests, special protection areas and agriculture with farmland. Forest dominates in Araba: this form of land use covers 31.5% of region's surface and 34% of green areas in the region. Special protection areas cover 22.7% of the territory, encompassing one or more kinds of protection. Agricultural land, which represents 10-11% of all lands in the Basque Country (Eurostat, 2012), is located mainly on the bottoms of valleys and in plain areas.

The kind of agriculture depends on the terrain. Arable land dominates in Araba, where although the altitude is high, but variation and roughness of the terrain are relatively small. In the other two provinces, scrub grassland and pasture areas dominate.

The hierarchy of the Basque Country is organized around central cities. Industrial centers and rural villages play fundamental, pre-defined roles. Euskadi has evolved into a City-Region in which the boundaries of the urban centers, functions and activities spread over territory in an ever-widening arc. The San Sebastian-Bayonne corridor is a highly urbanized coastline. More than 600,000 people live in large cities on both sides of the border. One of the main factors that have determined the development of the conurbation was its strategic location on the main road that has historically connected the Iberian Peninsula with the rest of Europe, and continues to do so. Every day 9,000 trucks pass through, here.

Developed land in the Basque Country occupies 8% of the whole area, but in Bizkaia (Biscay, Vizcaya) it comprises 10% and in Araba – 6% of the entire territory. The urbanized land can be classified as residential land, land for public use (infrastructure, parks) and land for business. These three kinds of land use are equally represented in the Basque territories.

Land cover specificity

Based on the Corine Land Cover, the picture of the region under study is not unequivocal. Based on the map (Fig. 5.4), forest areas dominate in the region of the Basque Autonomous Country and Navarra. In the Atlantique Pyrénées, the majority of the area is classified as pastures with annual or permanent crops. In this part of the region, topography favours allocation of grassland.

Most of the areas of Navarra and Araba are occupied by arable land. The main factor that determines the situation is the topography of the region: specifically, height differences are low. The climate is of high significance: a subtropical sea, the southern part of the region entering the dryness of the continental climate. In relative terms, the climate is harsh – especially in the northern part. Southern areas require irrigation. Agriculture developed primarily in the river valleys and in irrigated areas. On the gentle slopes and valleys wheat, corn, grapes, sunflowers, olive trees and vegetable and fruit orchards are grown. In the north of the region there are large areas of forest.

Urban areas are found along the coast and in valleys. Together with the development of urbanization the region was connected to a communication/transportation network. Thus, the areas located along the transport lines have become attractive to investors.

Current and potential multiple uses of land

The Basque Country is characterized by a relatively big differentiation of the relief. These diversity in vertical elevation affects the possibilities of development of specific functions in particular areas. The most characteristic feature of functional differentiation is the fact that due to the traditional division into three provinces, there are three equal (in the administrative sense) cities – Bilbao, San Sebastian and Vitoria-Gasteiz. Each of these cities has a different area economic specialization, but all of them attempt to be a compact urban settlement – with all possible services of general interest, development of R&D centres, development of tourism and modern transport infrastructure. From the economic point of view the most important town in the region is Bilbao and its agglomeration. It is worth noting that within these towns there is an ongoing process of revitalization – the old industrial districts are transformed into the public spaces (parks, museums, etc.) and housing or industry functions take the place of the old functions. Thus the functional differentiation of the cities is decreasing, and, nowadays, a domination of the housing and service functions can be noticed.

Around the three major cities (especially Bilbao and San Sebastian), neighboring towns are developing at a rapid pace. This is made possible by the very well-developed transport infrastructure, with huge possibilities of travel offered by public transport. The very good connections (via motorways or fast two-lane roads and the railway system) make for efficient travel time to the core sites of development in the region from many locations. The development of the settlements is especially evident on the west-east axis via motorway E5. That area is replete not only with settlements boasting well-developed housing functions, but there is also a dynamic expansion of logistics, industry, manufacturing, transport, shipping, technological parks, harbours (in Bilbao and Pasaia) as well as other functions. Due to the privilege of a very convenient and accessible location (motorway, airport and two important harbours), a single belt of over 150 km around motorway E5 is not only the most densely populated, but also the fastest-developing zone in the Basque Country, being one of the most developed areas in Spain as well as in Europe.

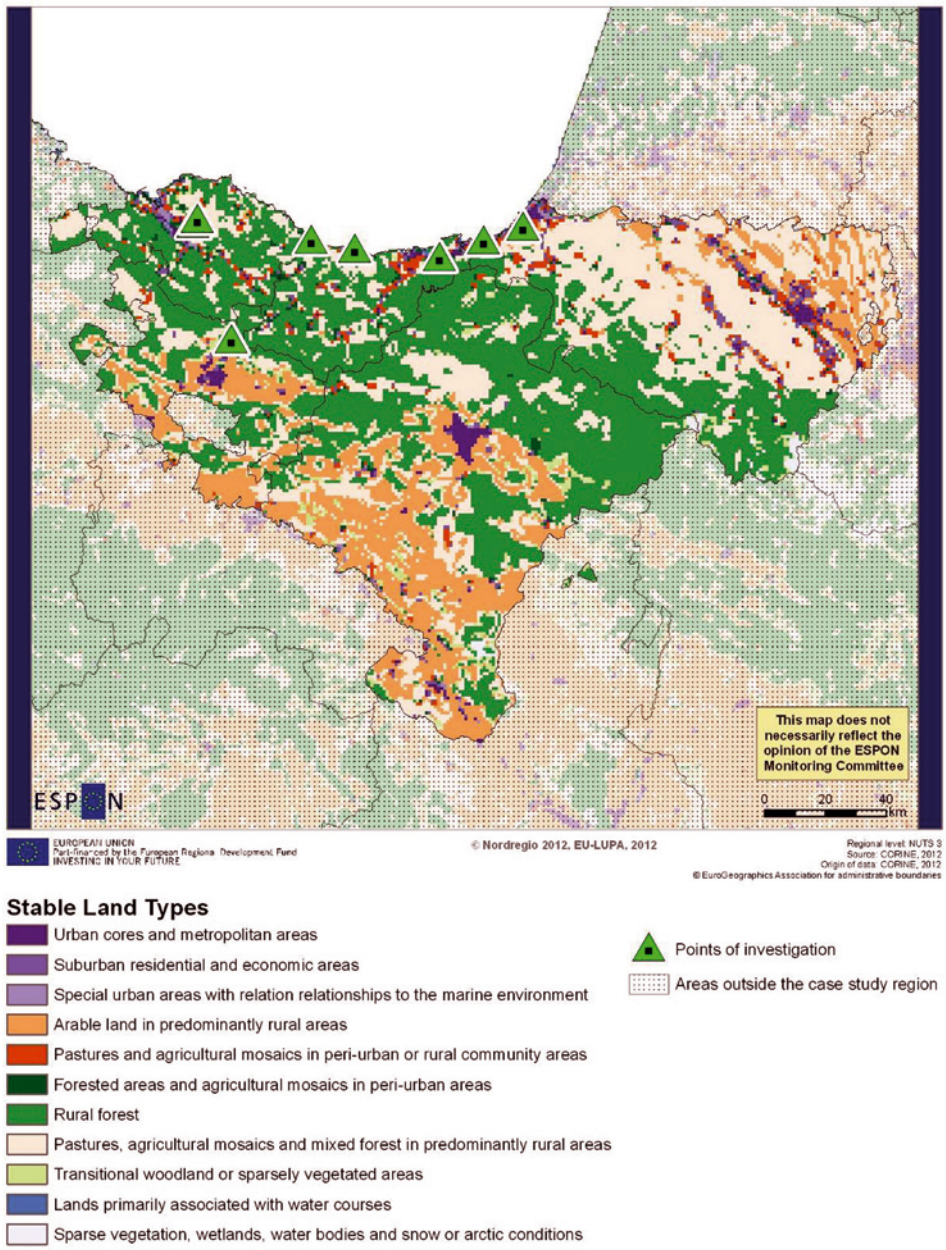


Figure 5.4. Stable Elements of Land Cover (1990-2006).
Source: Nordregio, based on Corine Land Cover.

Next, there is the belt of towns that are located mostly in the estuaries of the rivers by the ocean. These towns are relatively small – the largest one (except for the San Sebastian agglomeration) is Bermeo, with around 17 thousand inhabitants (and, interestingly, a stable population since the 1970s). The development of these settlements is limited by the relief – in most cases they are located in the bays, which are surrounded by rocky cliffs. This is why they cannot develop, grow and expand; they are geologically constrained. Also, an important factor in the development of these towns is the premise and philosophy behind the development of tourism. These settlements have not developed the massive tourism functions typical of the Mediterranean coast. Due to colder summers, the development of tourism is less intensive and rather more selective and exclusive.

The rest of the region is sparsely populated – especially the southern part of the region (mainly Araba). The biggest land surfaces of the regions are covered by forest (pine and eucalyptus). There are also rocky hills in the central part of the region (especially Sierra de Gorbea). Also, some parts of the region (in particular, the southern territory of Araba) are utilized as agricultural land. Detailed descriptions of the agricultural areas were provided in the previous parts of this report.

In the future, we can expect to observe further concentration of the population in the major cities of the region, and concurrent depopulation of the small towns or peripherally located settlements. Owing to this, the stronger development of the main cities should become patent – accompanied with more intensive usage of the land around them, and further revitalization processes of the ex-industrial districts. General future trend will therefore be associated with intensive development of many co-existing functions in the centres and transport corridors, and the expansion of human activity in the less populated areas. Again, in the future, spatial and sectoral planning will be rapidly gaining importance in the Basque Country. Given the natural conditions of the region, the planning should be carried out in a proper way, because some activities do not have an alternative location in which they could be realized.

Also, in the future, the closer cooperation between the three main Basque cities (Bilbao, San Sebastian and Vitoria) can be predicted – under the Euskal city concept (the Basque Y transport system) – as can cooperation with the Bayonne agglomeration in France – under the Eurocity concept. These stronger ties will also influence, to a certain extent, the multifunctionality of the particular areas. Thanks to cooperation, some higher functions will be distributed to particular places (some cities), and others, instead of building and developing the same institutions and functions on their territories, will be using them in the neighboring cities. Thanks to such cooperation and increased specialization of the towns, the process of development of multiple functions is expected to be somewhat reduced.

5.3.2. Analysis of land use changes

Dynamics and directions of land use and land cover changes

The population of the Basque Country has increased by about 20,000 people over the last 20 years. There is strong internal migration: people living in peripheral, forested and mountainous areas are moving to cities and to the coastal area. This phenomenon is driven by the labour market in the north of the region. San Sebastian was previously a health resort with a mild climate. As time went by, the aristocracy began to build houses and the city became popular, trendy and expensive. Bilbao in the 1960s was an industrial city, but after the outbreak of the oil crisis in the beginning of the 1970s, local authorities had to change their strategy of development. They opted for a high-tech industry and tourism, with a particular focus on modern art. There were some changes in the landscape of the region: heavy industry was replaced by modern technology, based on the rapid development of transport and accessibility thereto.

In the Basque Country, the urbanization process is highly visible. Urban municipalities of between 40,000 and 100,000 inhabitants have been losing their population at a rate of about 0.4% per year. On the other hand, in rural municipalities that are located close to the big city, the population has been on the rise (by about 15% in the last decade). A lot of new houses in the rural areas are holiday cottage houses (second homes for people from cities) (EuskalHiria_Net…, 2007). A number of functions are concentrated in the capitals of provinces, which offer growth opportunities for infrastructure and employment opportunities for those who build and use it – the result of this is a process of brain drain. Parallel to the development of the cities' centres, an expansion of metropolitan areas has taken place. There has been a significant change in space: old industrial and port buildings have disappeared, replaced by high-tech companies. In Vitoria-Gasteiz, the local community has addressed urgent problems and actively started works to restore the historical centre. In San Sebastian, various initiatives have been launched, such as the creation of a network of museums, concentration on the proposed expansion of tourism, knowledge-intensive activities, or the renewal of the Bay of Pasaia.

Coastal areas are becoming increasingly popular. However, the trend is different than in the south and west of Spain, which is dominated by sandy beaches. In other coastal regions in Spain, tourism plays a dominant role. Hotel complexes, restaurants are being built and services for tourists are being developed. In the area of the Basque Country, coastal tourism is geared mainly towards the domestic tourists, who in this area are building their second homes (seaside cottages). Most of them are people from the same region.

Table 5.5. Identification of the factors and drivers of land use change according to type of land in the Eurocity Basque-San Sebastian Region.

Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Factors ++ most important, + less important	Identified processes
Arable land	E	++	+ Urbanization process, ageing of population, style of life	Urbanization, withdrawal of farming, transformation of agriculture to more ecological
Pastures with annual/ permanent crops	S	+	++ Terrain (hills and mountain areas)	Stable area of pastures, but just in mountain region
Forests	E	++	+ Forest are mostly private areas	A lot of planta-tions of trees, which can be cut down in every moment – destroy of environment (soil, water, landscape)
Core urban areas	I	+	+ Depopulation, style of life +Transition from heavy industry to high-tech	old industrial buildings, the port disappeared – there appeared high-tech companies
Urban areas in transition	I	++	++Suburbanization, improving quality of life +Style of life +Research and business activities	Urban sprawl controlled by spatial plans
Urban areas in arable land	I	++	+ Improve quality of life, ++Good localization, near cities and transport corridors, + Specific day schedule of Spanish people (They have a long lunch break in the middle of the day, so they want to live near their work)	Urban sprawl, transport corridors, rural tourism
Urban in marshes, coastal areas and inland waters	I	++	++ Natural process of suburbanization +Nice landscape, good infrastructure	New investments: second houses, urban sprawl

Table 5.6. Analysis of land use changes in the Eurocity Basque-San Sebastian Region investigated areas according to type of land.

Name of investigated area	Type of land	Change E– extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Land Cover Flows	Factors ++ most important, + less important	Remarks
1. Lanbarren Industrial Zone	Urban areas in arable land	I	+++	Sprawl of economic sites and infrastructures	++ Very good location – near the motorway and harbour, increase of international exchange	Very good location of that new logistic park
2. Urban sprawl In Kalitxo	Urban areas in arable land	I	++	Urban residential sprawl	++ Location in a very favourable place – close to the city and the ocean. + development of the accompanying infrastructure (eg. shops).	Complex development of the new settlement – there was one investor
3. Derio – technological park	Urban areas in arable land	I	++	Sprawl of economic sites and infrastructures	++ Close location to Bilbao city, + nice location in terms of landscape and close to the airport	Complex development of new research and technological park – totally new investment outside of the city
4. Geldo – forest changes	Forests	S	+	Forest creation and management	+ Poor quality of land for other activities, extensive land use, plantations cultivated in terms of economic profits	No visible Corine changes – due to a fact, that there is big rotation in the cover-age of the woodlands
5. Bidart – sprawl of economic sites and infrastructure	Urban areas in arable land	I (in LCT - E)	++	Sprawl of economic sites and infrastructures	+ Good localization – close to the city and motorway	Urban residential sprawl
6. Mutriku – old city	Urban areas in transition	S	+	No changes ?	+ City located in valley- there is no more land for urbanization – just on the slopes	No visible Corine changes
7. Getaria – port city and agricultural land	Arable land	S	+	Agricultural Internal Conversions	+ Region located on the coast, without good connection to big cities	Internal changes in town and agriculture
8. Legutio – Urban residential sprawl	Urban areas in arable land	I	++	Urban residential sprawl	++ Access to social infrastructure: schools, health care, kindergarten, shops. ++ Good localization: close to big city, in nice landscape, near good road	New investment based on old part of town with services

In rural areas of the Basque Country rural tourism is rapidly developing (largely due to the fact that it is a more profitable form of tourism), geared toward foreign tourists from Scandinavia, Britain or Germany. With the development of rural tourism, agritourism farms and organic farms proliferate and thrive. Also, they are equipped with sports infrastructure such as golf courses and horse stables. In the farms, orchards and gardens are cultivated, which use only environmentally-friendly methods. The quality of agricultural products is improving steadily.

Nowadays, lack of biodiversity presents the most severe problem for environment. Forest areas cover 54% of the Basque Country, which admittedly is highly valuable, but one should bear in mind that these forests are mainly composed of two species of trees: eucalyptus and pine. In the area of the Basque Country there are virtually no natural forests; most of these are planted by human hands. In recent years, organic farms have also experienced a surge in popularity. Traditional agriculture is becoming less and less important, as traditional farmers reach old age. There is a fashion for healthy foods, thus organic and ecological farming is highly popular.

The Basque Country is strongly diverse in its land use and cover structure. We can distinguish specific regions with different land use and land cover: urbanized cities (Bilbao, Vitoria-Gasteiz, and Eurocity Bayonne-Donostia-San Sebastian); agricultural land in Araba, the mountainous region of Guipuzcoa. All these regions are well connected by transport infrastructure (express roads and highways).

The dynamics of change in each part of the analysed region are different. The Spanish side has seen low levels of intensification of rural conversion and negligible land acquisition. On the other side of border level of changes is higher.

On the French side, extensive or complex agricultural intensification took place. Changes were of low intensity. When analyzing the land cover flows in this area, we can notice some urban sprawl or urban land management. The Navarra region was classified as an agriculture extensification area, where the intensity of changes was low or with an inclination toward extensification. Araba was classified as region with internal agricultural changes or intensification. The regions of Bizkaia and Guipuzcoa were classified as the ones with internal changes pertaining to the forest, if we descend to a lower level of regionalization.

Looking closer at the broader area that includes the Basque Country Region, Atlántiques Pyrénées and Navarre, it turns out that the land cover and land use is closely related to the terrain. A high proportion of hilly and mountainous areas, large height differences or location on a rocky coast determine the type of vegetation and activity that can be seen in this region. More than 90% of the land is covered by undeveloped land-like forests, agricultural areas, special protection areas. The highest percentage of this type of land is registered in the mountainous area of Araba. But differences in relative numbers are not particularly striking. On the whole, agricultural and forested areas are dominant; other types of lands constitute barely 8%.

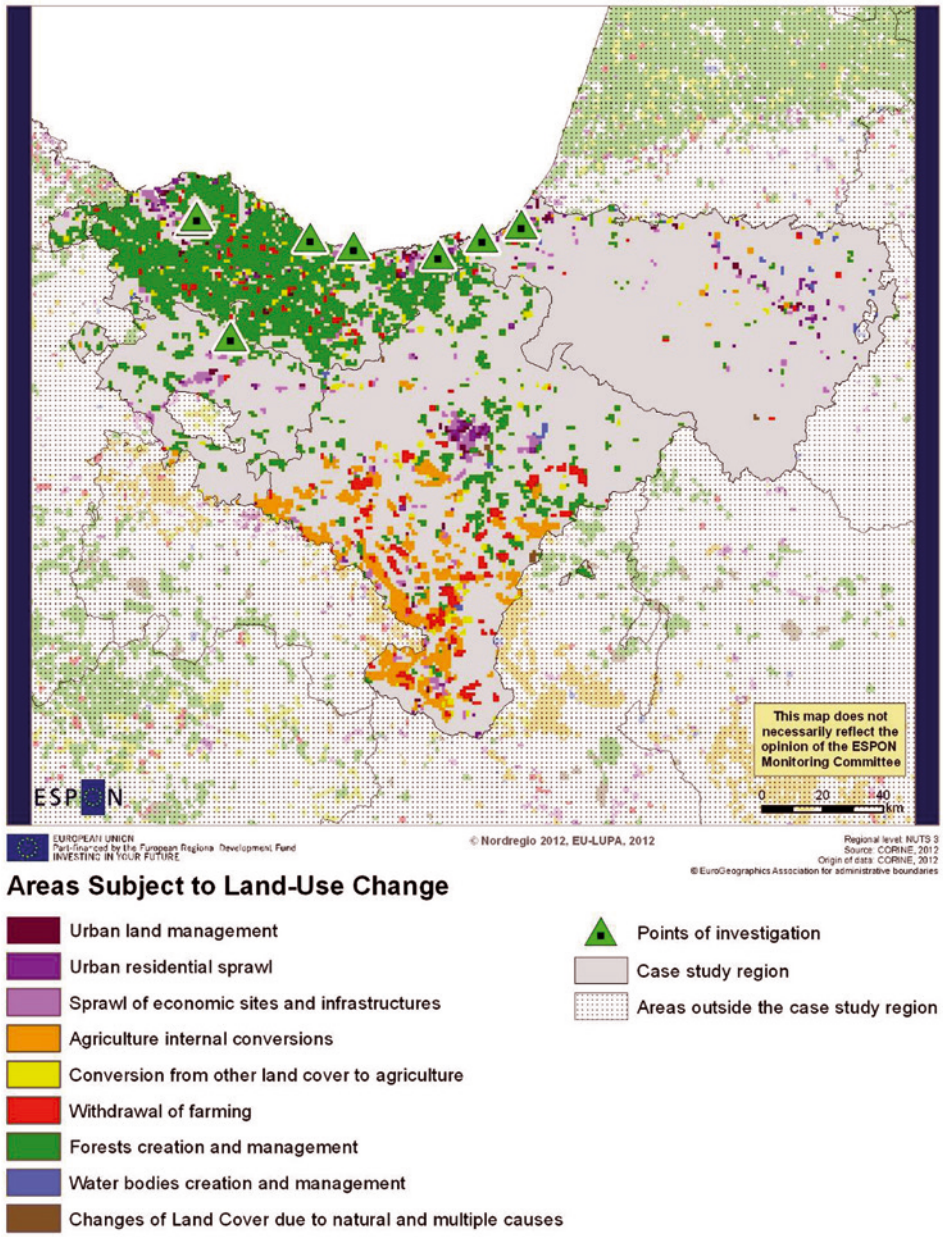


Figure 5.5. Land Cover Flows (1990-2006).
Source: Nordregio, based on Corine Land Cover.

The highest percentage of agricultural areas is in south part of the studied territory – in the Araba region. In the analysed period, the surface of the agricultural area decreased from 255,290 ha in 2000 to 242,780 in 2007. The critical factors that influenced this situation are urbanization processes and other avenues of intensification of land use.

The total area of arable land also decreased – in the 7-year period this area was reduced by about 8%. The bulk of the arable land was reserved for cereal crops (primarily wheat, spelt and barley). The area covered by root crops, potatoes and sugar beets decreased in the period between 2000 and 2007. Only fresh vegetables and industrial plants experienced an increase. The surface area of permanent pasture and meadows decreased in all the regions, thehe most significant drop being observed in Araba.

The coastal area in the Eurocity Basque Bayonne-Donostia-San Sebastian Region is highly urbanized – it belongs to Spain's industrial north. In this area many forms of industry, logistically-oriented businesses catering to tourists and services centres have grown roots. The towns (Bayonne-Anglet-Biarritz Conurbation community on the French side and San Sebastián on the Spanish side) of this coastal cross-border conurbation have a cumulative population of 600,000 inhabitants. Also, the two other big cities – Bilbao and Vitoria-Gasteiz, which are provincial capitals, boast a high degree of urbanization. Bilbao has 354,145 inhabitants, but Greater Bilbao – one of Spain's largest metropolitan areas – has almost 1 million.

The Basque Country in its structure is similar to other urban complexes in the world: it has a similar size and population. Many residents live in San Sebastian and work in Vitoria, and companies from the region use the port of Bilbao. Daily operations bring cities closer together, creating a consistent market. There are some characteristic features which define a city region like the Basque Country. First, urban sprawl and new forms of land occupation have a huge impact. In the Basque Country, we can identify the transformation of villages' residential centres, the rise of new communities, the rise of new centres in areas that have previously retained a peripheral character, and which are now being linked to the major shopping and leisure centres. Second, the new transportation systems link otherwise distant points, channeling growing demands for mobility. We should also mention the global connection associated with ports and airports, high-speed trains, new logistics platforms, public transport systems like metro and tram, improved intermodal connectivity between different systems, high-level telecommunications infrastructure. The last of this long list is a sophisticated and increasingly complex system of top-class services and facilities. In the new economy, operating globally requires an extraordinary level of complexity. For businesses to operate globally, the support of a wide range of highly complex and specialized services (intellectual capital, consulting, legal, marketing, new technologies, transportation, financial, etc.) is needed – support that can only be located in urban nodes of a certain size, that is, e.g., in cities and territories possessing a certain critical mass. Availability of specialized support services

to companies is, for cities, a key precondition to attracting competitive and innovative businesses that operate globally.

Actors and drivers of changes

In Spain, the responsibility for the housing policy rest on three different governmental levels: central, autonomous and local. As regards the central level of government, it has to coordinate housing as an economic sector, together with the general planning of economic activity. It is responsible for the planning and distribution of mortgages, applying housing taxation through income tax. The central government has to prepare and approve the financial framework for housing policies. The autonomous government exercises control over regional planning, as well as pursuing housing policy. In addition, this kind of government is obliged to provide a set of rules and regulations at the regional level, and to control the respect for and realization of basic regulations on the central and regional level. The autonomous government is responsible for managing housing policy programs. That level of authority has to facilitate the development of public housing, as well as acquisition and management of public land. Representatives of the autonomous government have the power to sign agreements with local corporations in order to develop public housing.

The third level of government has responsibilities concerning land planning, issuing building permissions, managing and controlling municipal inheritance taxes with regards to housing and land. The local government is obliged to develop local housing (Eastaway et. al, 2004).

One of the important driving forces of change in land use are prices of land and houses. In recent years prices have increased alarmingly. This is an important problem for the affordability of households. Cheaper land and houses are located at a greater distance from a city or in less friendly landscapes. The second significant driving force are changes in the ownership patterns of houses: on the Spanish housing market there are a lot of private investors and almost no public owners whatsoever.

Despite the fact that since the 1980s, the central policy regarding housing has focused on increasing the availability of private flats, the housing market has still not been provided a with significant stimulus. In the same period, other policies and laws were implemented, introducing, for example, rental laws or fiscal benefits for the owners. An additional factor that facilitates the development of housing estates is the state subsidy for developers and households for the construction or purchase of freehold flats (Eastaway et. al, 2004).

Scenarios and potential conflicts

First, the polycentric Basque system is a key factor inthe consolidation of the City-Region. The availability of three major urban areas is an important advantage. These are characterized by an exemplary territorial arrangement, and little distances between them. Bilbao, San Sebastian and Vitoria-Gasteiz are three cities that are full of attractive, increasing complementarities among one

another, and also they all experience, according to their own idiosyncrasies, exciting development processes and urban improvement. The future challenge is to continue improving the quality and consistency of internal nodes for each of these cities, fostering a development of close relationship between them and agreeing on strategic complementarities of urban profiles between each of them.

The Basque Country has an attractive network of medium-sized cities that are key areas for the integration of urban and rural landscapes, in which artifically constructed and natural areas may coexist, preserving the characteristic landscape of the territory. These medium-sized cities are urban centres of great importance to the overall balance of the territorial structure, and to maintaining the social balance by developing a strong sense of belonging in its citizens, as well as to maintaining the balance between places of residence, work and leisure that should determine the future model. Here, the challenge is to boost the quality of urban life and integrate it with the environment, a factor of key significance to widening the appeal and potential development of urban life, which may halt its deterioration and strengthen the economy and diversification of production in this model of the Basque system of cities.

The Basque Country, fortunately, plays a very marginal role as an epicenter of contemporary conflict This is largely due to superior spatial planning.

There are some conflicts caused by lack of continuity in the positions of power. Various political parties wish to pursue policies in different directions. A common nuisance is the discrepancy of interests of individuals and communities. The most common problem is the construction of shopping centers or new infrastructure. In addition to a confluence of interests, there are also coordinating mechanisms that enforce compliance with existing regulations. EU regulations state that spatial planning is of great importance and cannot fall under the rules of an open market. This is a new problem, since the government imposes more limits in the guidelines stipulating, for example, that reconstruction of old buildings in cities is more important than new housing developments in the same.

5.3.3. Conclusion

The Basque Country is characterized by a polycentric urban system: there are three cities (Bilbao, San Sebastian and Vitoria-Gasteiz), which play a major role in this structure. When we analyze this region in a broader context, we should add also the Bayonne-Anglet-Biarritz Conurbation as one of the major cells of the system. Those major cities with their respective outlying villages are connected via the transport system but also crisscrossed by social, functional networks. Land use is highly dependent on terrain and location relative to major urban units.

Urbanization is highly concentrated: the cities are surrounded by suburbs, housing expansion in settlements is concentrated along major transportation routes.

Urbanization in the Basque Country is closely related to the local lifestyle. Young people in search of a job consider it higher than any other priority, and usually stay at parents' houses because they cannot afford their own apartment. Around the age of 30, they start their own families and want to buy houses or apartments of their own. But then they rarely decide to change jobs and rarely opt for a drastic change of place of living. Therefore, the city is jam-packed with housing estates. Only a thoughtful planning process can effectively control and restrict the chaotic urban sprawl. Another limiting factor for moving to other cities and therefore causing pressure on the development of suburban areas is the specific modus operandi of the Spanish, whose working day exceeds 12 hours, with long, approximately 2-hour breaks for lunch in the afternoon. This mode of living is an impediment to people who live at a considerable distance from their workplace. To facilitate commuting, the Spaniards planned their network infrastructure in a very careful way.

Major changes that have occurred in land use and land cover are associated with urban sprawl and new forms of occupation of territory such as: transformation of villages' residential centers, development of new communities (especially located near transportation corridors and big cities), shopping and leisure centers. In particular, the new and modernized network infrastructure was of key significance. Some of the most considerable changes in land use are related to migration from peripheral areas to the coastal and urban areas. People living in rural areas desist from the cultivation of land, moving to towns and changing the mode of production to organic. In this region of Spain, rural tourism is more popular (to foreign visitors) than classic coastal tourism.

The highest pressure on land can be pinpointed in the coastal and urban areas. This is so because many functions are concentrated there: settlement, industry, harbours, wind energy plants, logistic centers, touristic zones. The idea of multifunctionality is connected with the mobility of people to reduce the overall environmental impact.

Taking into account all of the above-mentioned circumstances, three very simple yet very important recommendations can be given for proper land use policy management in the Basque Country. Since all of these recommendations have a much broader character, their applicability extends also to other territories:

- Holistic development of the region requires a very good planning system which is complex on both the horizontal and vertical level – this means that sectoral plans should be created in cooperation with territorial ones (cohesion in spatial planning).
- Very detailed planning on the municipal level – thanks to that there will not be many conflicts of function.
- Cooperation between different parts of the regions and division of functions within the territory – the development of stronger functions of some particular towns has an important influence on the whole region. There should be a regional competitiveness and not competitiveness within the region.

5.4. Jeleniogórski Region

The Jeleniogórski subregion is located in the south-western part of Dolnośląskie Region in Poland. The Jeleniogórski subregion consists of 9 counties – the biggest town being Jelenia Góra (84,000 inhabitants). In total, the subregion has 575,000 inhabitants (as of 2010), which is approximately 1.5% of Poland's population. The surface of the region is 5,570 km^2, and the density of the population is 103 people per km^2.

Some of the key elements that impact the current changes in land use in the region should be underlined:

1. The overall socio-economic situation in this subregion is very much below the average level that is noted in the Dolnośląskie Region.
2. We can observe an outmigration from the subregion – with only few exceptions such as the suburban areas (especially around Jelenia Góra), however these zones are very narrow. Also, areas possessing great touristic and cultural value witness people migrating from bigger towns (mostly from outside of the subregion) to settle there. New settlements are much more scattered. This leads to the chaotic development of spatial structures.
3. There is a dichotomous process in settlement development. There are some villages that are totally not inhabited, as well as some villages with a good location and attractive landscape that have noted a considerable influx of newcomers in the last two decades.
4. There is one principal and basic reason for outmigration – the collapse of the industrial functions that dominated these areas in the past.
5. High level of unemployment – collapse of many industrial activities; reduction in previous employment in industrial factories cannot be compensated by employment offered by the tourism sector.
6. In the lowland part of the subregion, large agricultural enterprises have appeared – and a consequent process of consolidation of land can be observed. In the highland, mountainous part, agriculture plays a less and less important function in spatial organization and economic structures.
7. The biggest tourist investments are now located in the touristic areas.
8. There still persists a stereotype that the region is very polluted and ecologically compromized – the so-called "Black Triangle". In the past, a number of large industrial factories did indeed generate much pollution; right now this situation has changed for the better. Now, the quality of the environment is much improved.

Table 5.7. Statistical survey and characteristics of Jeleniogórski Region

Jeleniogórski Region					
Location within Europe	Nordic	Western	East-Central	Mediter-ranen	
			X		
Type of location	Core	Transitional	Peripherral		
			X		
	Cross-border	Coastal	Mountain		
			X		
Size	Inhabi-tants (nb.)	Density (nb./ km$^{2)}$	Surface (km^2)	Pop. growth rate, 1990-2010 (increase/decrease/stabile)	
	576,145	103.4	5,571	Average -3.3‰ per year	
Qualitative description	Regions relatively sparsely inhabited (average in Poland 122.1 inhabitants per km^2) and with decreasing number of inhabitants, in region in 2009 domestic migration rate -1.7‰, natural movement rate -1.6‰). Urban rate relatively high in comparison to Polish conditions (Jeleniogórski 62.5%, Poland 61%), without big cities but with many small towns. The biggest is Jelenia Góra (84.5 thous. inhab.). Share of inhabitants in postproductive age relatively low (jeleniogórski 16,2%, Poland 16,5%). High share of unemployment (Jeleniogórski 17.5%, Poland 11.9%). High share of forests in land use structure (Jeleniogórski 39.3%, Poland 29.3%), and low share of arable lands (jeleniogórski 32.5%, Poland 44.3%). GDP per capita relatively low, poorest region in Dolnoslaskie voivodeship, only 71.5% of the average value in voivodeship, 77.7% of Polish average. – High level of forestation – Very diverse landscape – Valuable natural features and significant geo- and biodiversity – Dense, well-developed settlement network, many small towns – Development of service, residential and commercial functions – High spatial mobility of population – Relatively high number of post-socialist factories – Multifunctionality of most rural areas – Agritourism upland/mountain areas – Concentration of commerce and services around certain border crossings – Dense road system – Outstanding natural and cultural features plus attractive landscape as foundation for further development of tourism – Special conditions for health and spa-based tourism – Increased interest in buying land and second homes – Functional diversification of borderland area				
Land use structure (%)	Artificial surface	Agricultural land	Forested land	Water bodies	
		25% (2009 - NUTS 2)	51% (2009 - NUTS 2)		
Dominant land use changes 1990-2006 (see Nordregio said nb. 23)	Transformations associated with the takeover of land used for agriculture to industry, urbanization, and forestry forms of land use				
Description of land use changes (other important information)	– Increased area fallow and idle land – High forest cover				
Socio-economic level	GDP per head	Index of unemployment	Share of high educated inhab.	Degree of urbanization (densely/intermed./thinly	
	5,952 Euro	13.7% (2009)	18.4% (NUTS 2)	thinly	
Regional functions (2 – highly represented; 1 – represented; 0 – lack)	Agricul-ture	Forestry	Tourism and recreation	Settlement (Build up)	Industry	Others admi-nistrative, education,etc.)
	2	2	1	0	1	0
Other qualitative descrip-tion of region	Multifunctional region, well recognized by us, we have some research experience from this region.					

5.4.1. Structure and functional diversity of land

Surface and structure of land use

Surface and structure of land use is strictly connected with the topography of the Jeleniogórski subregion. The physical structure of land in this subregion is highly diverse. In the southern part there are the Sudety Mountains – the old chain of mountains lying on the border between of Germany, Poland and the Czech Republic. The Sudetes are divided into many ranges – the average altitude for these ranges is approximately 1,000 meters, however the highest range – the Karkonosze – is about 1,300-1,400 meters with the highest mountain summit – Mt. Śnieżka (1,602 m a.s.l, this being at the same time the highest mountain peak of the Czech Republic). More to the north, there are highlands – a diversified landscape with small hills, each around 300-600 meters high. Then, more to the north of the subregion, the average altitude is lower (around 100 meters).

About 88% of the land in the Jeleniogórski subregion is covered by agricultural land and forests. Such an amount is comparable with the national and regional average. But what is specific for the Jeleniogórski subregion is a higher proportion of forests. On average in Poland and in the Dolnośląskie Region the share of forests is around 30%, while in the analysed subregion it is almost 40%. Such an amount is correlated with two important factors – a diversified landscape and high proportion of forests in the mountainous part of the region in the south as well as a poor quality of the soils in the north, which overlap with the largest compact complex of forests in Poland – Bory Dolnośląskie.

A more detailed perspective on the contemporary diversification of land use, based on data from the Corine Land Cover, can be found on the map below. The map shows a clearly visible complex of forests and meadows in the mountainous part of the subregion and a large complex of forests in the north. Between these areas, there is a domination of agricultural areas. As presented on the map, the settlement system in that subregion is a polycentric one – there is a big centre with a dominant position (Jelenia Góra), but at once there are also other towns that play an important role in the settlement system. The settlement system is supplemented by many smaller towns and villages – most of them with a very linear character (houses are built along the main roads, which means that they are not complex settlements). It has to be mentioned that there are two important large complexes of artificial land that are not settlements.

Land cover specificity

Where the land cover in the Jeleniogórski subregion is concerned, two specific elements should be pointed out. There is a higher-than-average share of grasslands (pastures and meadows) as well as fallow and waste lands in the total area of arable lands. This situation is due to many factors, among which are: relief

and hypsometry – areas of inconvenient relief (all mountainous and upland areas in Poland have similar characteristics), poor quality of soils and other elements of agricultural space (e.g. short growing season in the mountainous areas), out-migration from those areas, resulting from the fact that fewer and fewer inhabitants wanted to remain active in agriculture. Changes of agricultural land into areas under construction due to the higher prices are also a factor. It has to be stressed that even that the arable lands has the highest share in total agricultural lands, but general in that subregion the share of grasslands is higher than average and as well relatively high share of arable land is not utilized.

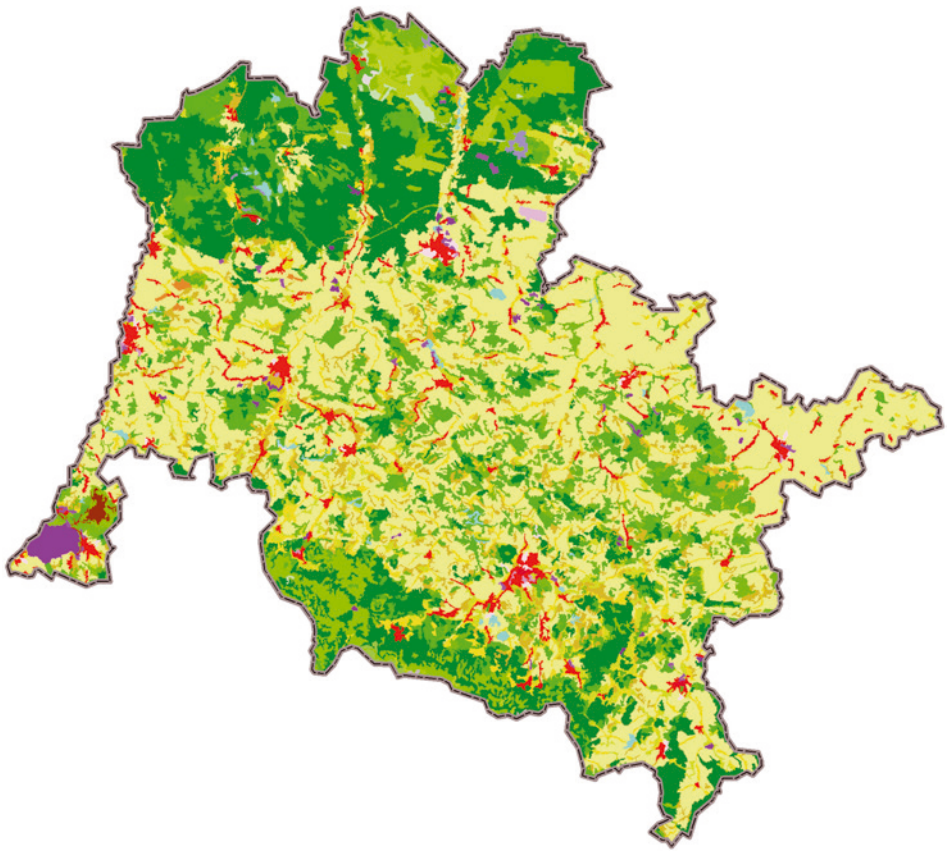


Figure 5.6. Land cover of the Jeleniogórski subregion (2006).
Source: own work based on the Corine land Cover data.

Other important element of that region, which greatly influences the land cover, is its diversified geological structure. The Sudetes Mountains are very old from a geological point of view, and hugely diversified. This is a corollary of a big

diversity in the condition of the soils. As visible on the maps below, generally, in that subregion, we can observe such a tendency – the less diversified relief, the better quality of soils. But that general relationship is varied, depending on locally occurring specific conditions. That is why we can observe and notice the very mosaic-like character of the soils' conditions, which is strictly connected with the land cover.

Current and potential multiple uses of land

There is a considerable heterogeneity of functions in this area, and at the same time significant interconnections and a polyfunctional, multiplex structure that defines the subregion. Generally, a few very important elements on the functional diversity of the Jeleniogórski subregion can be listed:

- Housing function – this area is characterized by a polycentric model of development of settlements; the urbanization index is in the order of 62%. A number set of different-sized towns is located there, each of which has housing as one of its most important functions. Suburbanization processes occur around the biggest settlements (especially around Jelenia Góra).
- Touristic functions – these are mostly concentrated in the southern part of the subregion, but at the same time they are very diversified internally. Different kinds of tourism activities are offered, e.g. holidays, health and wellness tourism, congress tourism, sightseeing etc. Also, a wide variety of sports activities can be identified in the region: winter sports (skiing, cross-country skiing), bicycle paths (on- and off-road biking), mountain trekking, spa facilities, extreme sports, aerial sports, etc.
- Agricultural functions – prevalence of grasslands in the mountainous part and arable land in the eastern and western part. In the areas with better quality soils the more demanding cereals are being grown (e.g. wheat), while in the areas with poorer-quality soils less demanding ones are the preference (e.g. rye).
- Industrial functions – the area was characterized by a very high level of industrialization in past decades. During the transformation period many of the factories collapsed or reduced their production, but some are still in operation, and new companies are also starting production. Some of them readapt old buildings, but for the majority of them it is much easier and cheaper to build new constructions. The biggest industrial zone in the analysed subregion, and at the same time in Poland, is located in the area near the brown coal mine.
- Forest functions – most of forests are under public administration. Forests have wood production, touristic and military training ground functions.

– Transport functions –two main important transport and transit corridors are located in the subregion. One is the motorway A4 (European code E40) which connects Germany (Saxony) with a number of large Polish cities (Wroclaw, Upper Silesia Conurbation, Kraków) and the Ukrainian border. The second one are the multiple roads connecting Poland to the Czech Republic.

Multifunctionality can be analysed at least on the two different spatial levels – local and regional. When analyzing that topic on the regional level it can be broadly stated that the Jeleniogórski subregion as a whole can be called a multifunctional territory. There are very important functions such as: housing, services, industry, transport, tourism, forestry, agriculture, mining, settlement and others. Intensification of each of these functions is different in each of the areas. Five functional zones can be delineated: (1) Jelenia Góra (multifunctional town), (2) the highly industrialized south-western part of the subregion (the brown coal mine), (3) the mountainous area – the Sudety Mountains (domination of tourism function), (4) the lowland area, with a domination of agriculture and (5) a complex of forests in the north. The importance of each function is different depending on the perspective as well (e.g. economic standpoint or land use). When looking at it from the economic perspective, the crucial functions will be industry, tourism, transport and services, and the opposite is the case when adopting the land use perspective, which places much greater emphasis on forestry and agriculture. Co-existence between many different functions is very natural in the subregion and is in line with the main strategic idea that is pursued in this area. The number of functions has remained rather stable throughout the last two decades – but other functions have started to be more or less important – a revaluation of the importance of certain functions was made. Previously, there was a marked domination of the industrial function. Nowadays, we can point out that in the mountainous part the tourism function is developing at a rapid pace, while in the northern agricultural one and in some localities industrial functions are on the rise.

When talking about multifunctionality from the local perspective, it can be stressed that the biggest changes in land use and functions are observed in two types of areas: suburban zones and touristic localities. In the suburban zones, there is a noticeable intensification of land use, as more intensive functions (like housing or production) are appearing. In touristic areas, open agricultural land is transformed into foundations for recreational houses and tourist infrastructure. Intensification of functions can be estimated, again, from the economic and land use perspective. The most common changes are transformation of arable land into the "built-up areas" (but only in the aforementioned zones of highest pressure – suburban and touristic).

In the future we can expect to observe a further outmigration of inhabitants from this subregion, generally, and a concentration of the population in the suburbs of major towns (especially around Jelenia Góra). Those demographic processes should be taken into account when designing development strategies for

this area, and planning the development of new or existing functions and investments.

In the future, this area will still be of a multifunctional nature, and should develop in such a way. In recent years, there has been a considerable decrease of agricultural functions. But this area is most suitable for sheep or cattle breeding due to a – prevalence of grasslands. Lack of agricultural activity has resulted in the collapse of the agro-food industry in this subregion. As such, in the future, some activities and programmes should be implemented to increase the role of agriculture based on harnessing the potential of the grasslands for sheep or cattle breeding. These activities will certainly improve the quality of the environment (there will be no abandoned pastures) and affect tourism by fostering the cultural and traditional values of this area.

Tourism as a function will still remain an important one. The problem with developing the tourism function is that tourists concentrate their activities in a few settlements, a few strategic locations, but all the region want to develop on the base of tourism activity; however, this is rather impossible. Also in the future the problem of developing the tourism function can be connected with the climate conditions (climate change). Those ski resorts which were developed in lower-altitude locations may face problems with snow and go bankrupt.

The development of industrial functions should be pursued in such a way that will not have a negative impact on the environment (supporting a so-called "clean industry"). In such densely populated areas as the Jeleniogórski subregion, it is only the development of the secondary economic sector that could provide enough work places to stop the negative demographic processes.

In the future, the macroeconomic conditions of the region will be of the utmost importance for the outbreak of spatial conflicts and multifunctional development. If economic decline takes place, there will be fewer investors and visitors, and at the same time, fewer possibilities for multifunctional development.

5.4.2. Analysis of land use changes

Dynamics and directions of land use and land cover changes

Generally we have observed very minor changes of land use in the Jeleniogórski subregion in the last two decades. This process is very visible on maps illustrating land cover flows. Less than 2% of the land changed its classification in the period between 1990 and 2006. More significant changes took place in the 1990-2000 period than 2000-2006. We can identify some places that underwent suburbanization processes (concentrated only near Jelenia Góra and Zgorzelec), some areas of agriculture went through internal transformations and (very locally) saw the creation of bodies of water (including the artificial lake Sosnówka near Jelenia Góra – surface area of 1.5 km^2, opened in 2001). But the most considerable changes were identified in the category "lcf7 – Forest creation and management". These changes take place in the mountainous areas as well in the forest complex of Bory Dolnośląskie in the north of the subregion.

Table 5.8. Identification of the factors and drivers of land use change according to type of land in the Jeleniogórski Region.

Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Factors ++ most important, + less important	Identified processes
Arable land	S	+	++ Lack of other opportunities, European Union payments, good environmental conditions	Consolidation of land in big agricultural enterprises, agricultural production in the areas with the best environmental conditions, stimulation of agricultural production due to European Union payments
Pastures with annual/permanent crops	S	+	+ European Union payments	Most of the grasslands are not fully utilized – small amount of cattle and sheep breeding, some utilization is apparent and done due to European payments
Forests	I	++	++ Renewal of destroyed environment	Big effort to renewal of destroyed forests after the ecological catastrophe
Transitional woodland – shrub areas	I	++	+ Activities of construction, industry, army	Forests and woodland are under the transformation processes due to construction of some infrastructure, industry plants, army activities or other human activities.
Core urban areas	S	+	+ Depopulating processes, collapse of industry	Small revitalization processes.
Urban areas in transition	S	+	+ Depopulating processes, development of some new entrepreneurships	Development of new industrial activities, construction plants not in the center part of towns (on ex-industrial zones) but outside of the centers or even outside of the town
Urban areas in arable land	I	++	++ Natural process of suburbanization – better quality of life	Development of individual housing, close to the city but in the open, rural space with high landscape values

Table 5.9. Analysis of land use changes in the Jeleniogórski Region according to type of land.

Name of investigated area	Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + – small	Land Cover Flows	Factors ++ most important, + less important	Remarks
1. Hotel building in Karpacz	Pastures, agricultural mosaics and mixed forest in predominantly rural areas	I	+++	Sprawl of economic sites and infrastructures	++ Big increase of popularity of skiing in Poland, lack of luxury hotels in that subregion	Big controversy according the spatial planning, according the typology there are not intensive changes – the building start after 2006
2. Sosnówka Lake	Inland waters	I	+++	Water bodies creation	++ Anti-flood protection ++ Reservoir of drinking water	Creation of the lake on previously wetlands
3. Forest changes – Izerskie Mountains	Forests	S	+	Forest creation and management	++ Reconstruction of forest after the ecological catastrophe in the 1980.	State Forest, Ecologist and National Park Policy
4.Jeżów Sudecki – suburban zone of Jelenia Góra	Urban areas in arable land	I	++	Urban residential sprawl	++ Natural process of suburbanization – better quality of life	Undergrowth of social and technical infrastructure
5. Bogatynia – heaps	Forested areas and agricultural mosaics in peri-urban areas	E	++	Forest creation and management	++ Intensive works in the brown coal mine near Bogatynia	Natural area to deposit the sand form open brown coal mine
6. Motorway A4	Rural forest	I	+++	Forest creation and management	++ Development of transport network in Poland	Motorway was planned from many years

It can be stressed that almost all of the changes presented on the Land Cover Flows typology can be explained by the environmental and socio-economic processes which took place in the Jeleniogórski subregion in the years 1990-2006 and are directly or indirectly affected by the previous conditions and general trends of development, both in Poland and in this general area, during the transformation period. Undoubtedly, there are more changes in land use or land use functions that have not been detected in the typology, owing to the fact that the resolution of those changes is too small to be identified. Lack of good spatial planning in Poland leads to the detached and chaotic development of some investments – built-up areas or industrial plants. When the changes in land use are very scattered and dispersed, the CLC data are not able to identify those changes.

Actors and drivers of the changes

The processes of land use in this subregion are very differentiated. In general we can observe a stabilization in land utilization and land cover. Given the peripheral location, outmigration and a large proportion of agricultural lands and forests, such a situation is natural. But in some parts of the subregion these changes are very intensive, even though they are not registered by the official statistics. Those changes are mainly concentrated in the suburban areas and touristic zones. Intensive development of houses (recreational or normal) and elements of tourism infrastructure are affecting the economical and functional structure of the area more than the land cover changes. This is so because the present-day settlements and production plants are scattered and do not form complex structures. Thus, in some delimitations and statistics, these areas are still registered and classified as agricultural areas. Even if they are registered properly, their influence and importance in the social, economic and functional structures are much higher than in land use structures.

Such processes can be described and explained by the intensity of the influence of both types of land use. Extensive land use – like agricultural or forests – even if it covers a higher share of area, does not have as big an influence as intensive land use – like built-up, industrial or touristic areas. So changes that are small from the point of view of the surface, changes from extensive to intensive in land use, have an important impact on the functional and economic structures of the area.

Consequently, we can point out the two main factors behind land use changes – they are primarily local representatives, who have a predilection towards extensive land use, and external investors as well as developers who are looking at a much more intensive approach to land use. Examples of representatives from the first group include: farmers, the national park, the state forest company, ecologists; exemplifying the second group are newcomers (in the suburban and touristic areas), owners of touristic infrastructures, investors in industrial activities, etc. Thus, generally speaking, all the factors that influence land use changes, can be classified into those two groups. Of course, there are a lot of exceptions, but on the whole the representatives of the first group are much more conservative

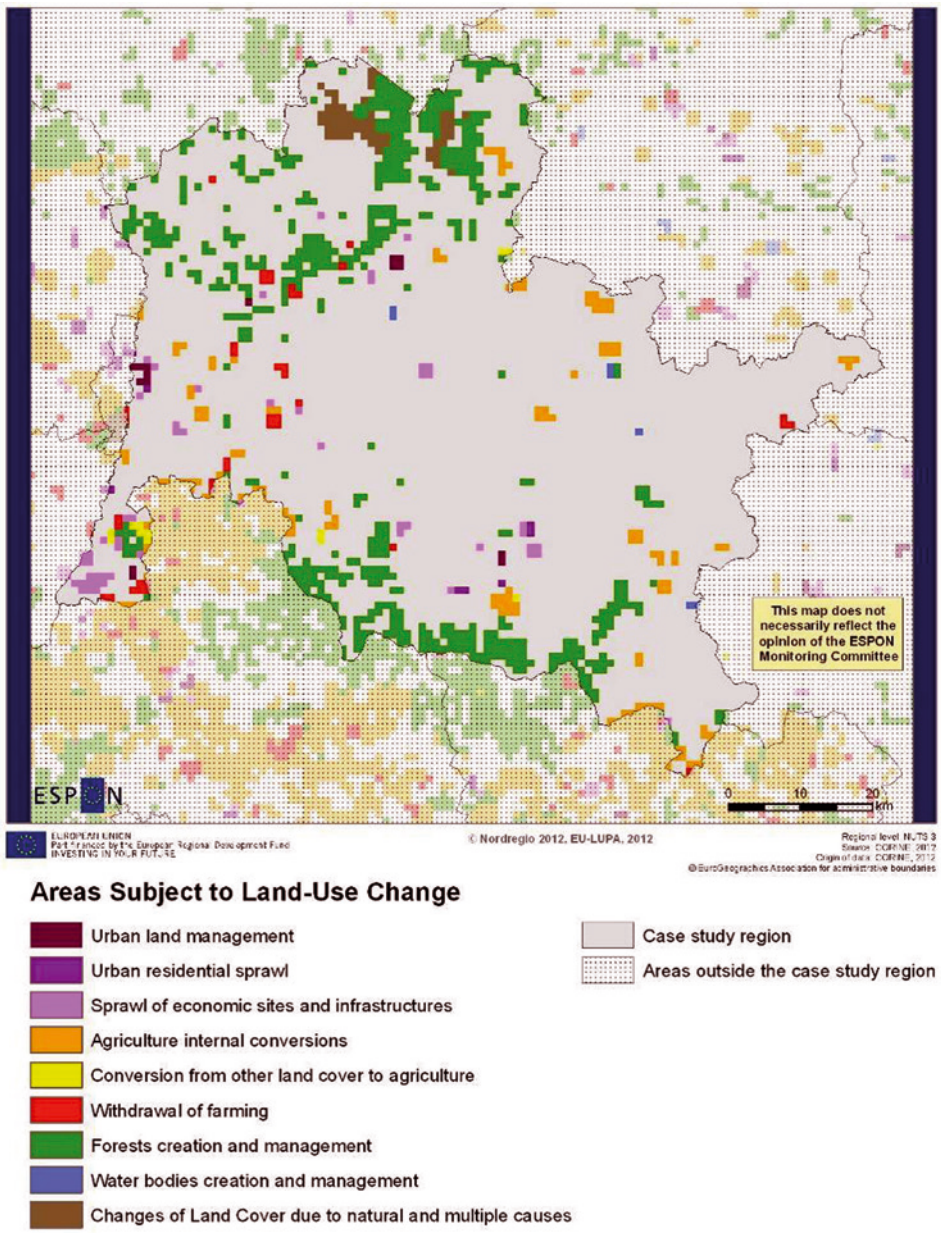


Figure 5.7. Land Cover Flows typology in the Jeleniogórski subregion (1990-2006).
Source: Nordregio, based on Corine Land Cover.

(in terms of land use), live in the subregion and are characterized by a high level of so-called "territorial capital". On the other hand (also with a few exceptions), the second group is much more liberal, does not care much about the spatial planning, and economic profits are the most important factors behind their activity. As one of the interviewed experts put it: "the most effective and desirable actors are those who offer the new workplaces to people and provide income for the budgets of local self-governments. However, more often than not, the biggest investors come from the outside of the subregion in question and it is financial benefits that are of the greatest importance to them, rather than environment protection, cultural values or so-called territorial capital".

The present-day land use processes are affected by two central drivers of change – legal status and economic pressure. The legal status of spatial planning in general is a good tool for proper administration and management by local governments in Poland. But since local plans are not obligatory nor legislatively defined for the local governments, the situation is very diversified in different communes. Some of these have local plans and some do not possess such documents at all, or have them dispersed or incomplete – usually it is these communes that exert the most intense pressure on the land use changes (suburban, touristic). In such places the second driver – economic pressure – can play the crucial role. All local governments want to utilize land more intensively – as it is tantamount to a greater number of investors, increased incomes for the local budget and better opportunities for employment on the local labour market. The economic pressure from external investors is more intensively felt in the attractive areas (with better location, accessibility, higher touristic values, etc.). If these areas do not have local plans or otherwise are not protected as highly valuable land from the environmental point of view, then the economic pressure prevails, and it is easier for external investors to develop and change the land in any direction, way or form they may wish. This causes some serious problems with proper land management, leading to spatial chaos, confusion of functions and fragmentation of land use.

Scenarios and potential conflicts

The situation described above can be treated as one of the most important and common circumstances that set the stage for spatial conflicts. Intensive functions and intensive land uses compete with extensive ones. We can provide some examples of these competitive pressures – intensive and massive tourism development versus environmental protection, built-up areas and industrial plants versus the agricultural function, heavy industry versus environment, spatial harmony versus new built-up areas and new industrial plants (they are located not in old industrial areas, but are very dispersed, which leads to chaotic spatial organization). Some spatial chaos is created by the mixture of functions and investments. In almost every case, it is the more intensive investment and more intensive function that come out of this competition as the victors. The more intensive land use has to be protected by a legal framework or by spatial planning tools – e.g. protection of a national park, of very good soils for agricultural production

or well-prepared spatial planning (e.g. local plans). But it has to be stressed that these conflicts are not common to the entire subregion – they are rather limited to some places and localities. Therefore, the conflicts have a local character and are connected with the location of individual sites – e.g. production plants that were built too close to a built-up area or a mine that started its operation in a very quiet touristic village close to the old palace. Previously, the industry was adversely affecting the environment of these areas on a much larger scale – which, in combination with acid rains, caused pollutants to be deposited on vast stretches of land.

We should also draw attention to a very interesting example of spatial conflict within the framework of the tourism function. Some of the tourist activities are mutually exclusive – for example, in one small town (Świeradów Zdrój), one dynamically developing function is spa treatment, which requires quiet and the so-called "benign atmosphere of health" – and, at the same time, the town witnesses a massive growth of the skiing function – i.e., vigorous investment in ski lifts. There have been no problems to date, but in the future, it is possible that a serious conflict may arise. Fortunately, this is only an isolated example, not representative of the whole subregion.

As regards the future, there are two potential causes of spatial conflict that may become characteristic of the subregion. There are now – and there will be in the future – numerous problems connected with the construction of retention reservoirs. The main source of the problem is associated with vertical agreements between the central government and local self-governments – there is no effective co-operation on this issue. Also there are social problems – building retention reservoirs is associated with the necessity to remove some settlements and homes. The second potential cause of conflict in the future are climate conditions (climate change) and the development of skiing functions. Those ski resorts which were developed in the lower altitudes can have problems with snow and face the risk of bankruptcy.

However, both now and in the future, these conflicts may generally have a rather local character – thus it is difficult to predict their intensity or extension at this point. Analyzing spatial conflicts from a broader perspective, it can be concluded that in the future, macroeconomic factors will be of crucial importance – these will decide whether spatial conflicts arise. If there is an economic decline, there will be fewer and fewer investors and visitors, and at the same time, fewer spatial conflicts. And also it has to be remembered that in the areas with high quality of landscape, which is suitable and attractive for many other functions and purposes, spatial conflicts are absolutely normal. The multifunctional character of these areas causes many actors to pursue their own concepts or ideas.

As was mentioned earlier, the potential conflicts will have a local character in the future, so they should not influence the general trends of land use in the Jeleniogórski subregion. The contemporary changes and processes should be continued in the future – because it means that agriculture and forestry will continue to have a privileged status in the land use structure, while undoubtedly from

an economic point of view, services and industrial functions will be of much relative importance.

According to local strategies and the regional strategy of socio-economic development, in this subregion, the co-existence of the touristic, agricultural, industrial, forest and ecological functions and their intersection with land use is envisaged. So the present-day processes will be further supported and strengthened by the management of local and regional governments. Since it is very difficult to accurately predict different scenarios of land use management and land use changes, we are inclined to assume the continuation of existing trends.

5.4.3. Conclusion

In the Jeleniogórski subregion there are important functions such as: housing, services, industry, transport, tourism, forest, agriculture, mining, settlement and others. Intensification of each of these functions is different in each zone of the area. One can delineate five functional zones: (1) Jelenia Góra (multifunctional town), (2) the highly industrialized south-western part of the subregion (the brown coal mine), (3) the mountainous area – the Sudetes Mts. (domination of tourism function), (4) the lowland area with domination of agriculture and (5) in the north, complex of forests.

Total changes in land use have not been very intensive for last 20 years. On the whole, a domination of two types of land use can be noticed – agricultural land and forestry. Nonetheless, in some places, there is a concentration of other types of land use, and the changes are much more visible. The most considerable changes are noted in the areas that register the highest pressure from different activities, different functions – especially where an area is attractive for many actors.

However, in general, the spatial conflicts have a local character. This is why the contemporary changes and processes in land use should be continued in the future – it entails maintaining the privileged position of agricultural and forest functions in the land use structure, while, from the economic point of view, certainly the most important activities would be services and industrial functions.

According to local strategies and the regional strategy of socio-economic development, the touristic, agricultural, industrial, forests, and ecological functions and land use will coexist in the subregion. So, the present-day processes will be supported and strengthened by the management of the local and regional governments. Owing to this, it is difficult to construct and envision different scenarios for land use management and land use changes other than those that assume continuation of already existing trends.

The greatest challenge for proper land management in the Jeleniogórski subregion is complex and holistic planning – connecting sectoral (socio-economic) planning with territorial planning. This will help to achieve sustainability in planning. That two parts of strategic planning – sectoral and territorial – should be equal to each other, and, at the same time, treated in a coherent way, is a very

important point to make. Also, a higher share of land should be covered by local plans – it will certainly help to preserve spatial harmony.

Another important point, partly connected with the first one, is that on the regional and local levels, the permanent, annual monitoring of spatial organization should be conducted in such spheres as: environmental protection, industry investments, housing, cultural landscape and infrastructure. Nowadays, spatial monitoring is under operation only for the purpose of keeping records on the borders of houses and plots – a simple cadastre. This is rather more useful for keeping records of the situation, and does not work as a tool for planning the development and creation of new functions. Evidently, in the future, this system should evolve to a more complex and holistic tool for spatial management.

Another challenge for spatial planning is the fact that, currently, the low and institutional assets are not effective in appropriate spatial planning. The easiest thing to do will be to impose national regulations on all the settlements to adopt obligatory local plans of spatial organization. While the general planning procedure might be correct and transparent, it remains ineffective because it is not mandatory. This will undoubtedly help to resolve some spatial conflicts in the future.

The last main challenge is connected with the higher activity of local institutions – local self-government has to have the initiative. It is difficult from the perspective of the regional or national government to indicate and decide what kind of functions are to be developed in each commune. The regional government, in general, can support the development of parts of its territory, but it is the responsibility of the *local* government to utilize endogenous potential and exogenous sources to the maximum. Thus the local governments cannot wait for the decisions and initiatives of the higher levels of governmental bodies, but instead have to be very active in the creation of new possibilities of development.

According to the interviewed persons, the Jeleniogórski subregion will continue to be still a very multifunctional area in the future. In some parts of the region, a domination of one function (e.g. agricultural or forest) will be noted, while, in others, there will be concentration of many of these (industry, housing, tourist, transport, services of general interest etc.). So the challenge for the local and regional government is to manage that region in such a way that will help to overcome the demographic, social and economic problems of the transformation period and, at the same time, harmonize the spatial organization of that subregion.

Taking into account all of the mentioned challenges and situations in the Jeleniogórski subregion, the following recommendations can be given for proper land use policy management in this area (since all of them have a broader character they should be also useful and applicable to other territories):

– The holistic development of the region requires a very good planning system, which will be complex on the horizontal and vertical level – this means that sectoral plans should be created in cooperation with territorial ones (cohesion in spatial planning).

- Equal importance of sectoral and territorial planning.
- Very detailed planning on the municipal level – this will curb conflicts between and among functions.
- Cooperation between different parts of the regions and division of functions within the territory – development of stronger functions of some particular towns has an important influence on the whole region. There should be regional competitiveness and not competitiveness within the region.
- Permanent monitoring of socio-economic and spatial changes in the region and its communes.
- Coherent visions of the development of communes, counties and the region – there should be some hierarchical way of planning strategies of development, because thanks to that the "added value" of a larger scale of development will be created.
- Engaging many institutions, local actors, representatives of main institutions that are important in spatial planning, and fostering of socio-economic development – thanks to this social consultancy the whole process of planning will be more coherent, transparent and complex.
- Good management – giving priority to public needs and public goods over private benefit.

5.5. Chełmsko-Zamojski Region

The Chełmsko-Zamojski region is located in the south-eastern borderland of Poland, in Lubelskie Voivodeship, not far from the Ukrainian border (Fig. 5.1). The area under analysis covers 9,300 km^2, with 644,000 inhabitants (2010). Geographically, it is mostly a hilly region in the eastern part of the Polish highland belt, graced with extraordinary agricultural conditions, e.g. fertility of the soil. The region extends from the San valley in the south-west to the Bug river valley, which defines the Polish-Ukrainian border in the east. Favourable environmental conditions for agriculture have had an impact on the current character of the region, which is the most rural and agricultural in Poland as a whole.

It is distinct for its high input of labour into agriculture (49.1% employed in agriculture and forestry, 2010, second place among 66 NUTS 3 regions in Poland), high share of small farms, and marginality of other functions. In the industrial structure, small entrepreneurships dominates, with a decreasing domination of the food processing industry and characteristic small furniture factories. The only relatively important mineral industry is located in Chełm and its surroundings (northern part of the region).

Both the geographical and historical context of the region have had a significant impact on its current economic structure. For most of the time, Chełmsko-Zamojski has been a peripheral region, with a relatively low level of indus-

trialization occurring, within impermeable boundaries that inhibited innovative processes. In the 1975-1999 period, the administrative division supported the development of medium-sized towns in Poland by creating 49 smaller voivodeships substituting the earlier partition into 17 regions. In that period, Chełm and Zamość were capital cities of two distinct voivodeships, which resulted in a period of dynamic development for both of them, including a prominent role for the food processing industry. The cultivation of Industrial plants developed and hence agriculture became more market-oriented.

The region is distinct for a very low urbanization coefficient (38.2%, 2010). Population density was at a level of only 69.3 inhab./km^2 (2010), almost twice below the national average. Two of the biggest towns, Chełm and Zamość, have over 65,000 inhabitants each. Zamość is located in the central part of the region and Chełm is situated in the north-east. Apart from them, only the city of Biłgoraj (south-western part of the region) has over 20,000 inhabitants.

The permanent outflow of young people, from both rural areas and towns, is a very strong determinant of the ageing of the region's population. The migrants target external labour markets, both domestic and foreign, and centres of higher education. The demographic situation in the rural areas shows a negative tendency due to a significant majority of males, especially in younger age groups, which is a result of the weakness of the rural services sector monolithic, monofunctional character of rural areas.

Lack of successors to less specialized farms on the one hand and desire to be owner of cultivated agricultural land and benefit from direct EU payments on the other gave rise to the process of enlarging the most specialized farms by leasing land, a notable trend in recent years. Land concentration is taking place in land users structure aspect much more than in land ownership.

Chełmsko-Zamojski is one of the poorest regions of the EU. Less favourable macroeconomic conditions for agriculture have meant inefficiency of the agriculture in contributing to the Polish GDP; the gradual abandonment of the food processing industry in the region was the second pillar of poverty. When combined, these two conditions have relegated the Chełmsko-Zamojski region to the 63rd position out of 66 Polish NUTS 3 regions with respect to the GDP per capita index, which makes up 85.9% of the region's GDP and only 59.6% of the mean GDP for all of Poland. The region is an appropriate case to analyse the impact of the economic aftermath of EU policy on changes in agricultural land use for the new member states.

5.5.1. Structure and functional diversity of land

Surface and structure of land use

In the Chełmsko-Zamojski region, agricultural land is dominant (69.7% of total area, 2005) (Fig. 5.8). In the spatial pattern, there is an improvement of natural conditions for agriculture, in particular from north and south towards the middle of the region and to the east. Therefore, the highest share of agricultu-

Table 5.10. Statistical survey and characteristics of Chełmsko-Zamojski Region

Chełmsko-Zamojski Region					
Location within Europe	Nordic	Western	East-Central	Mediter-ranen	
			x		
Type of location	Core	Transitional	Peripherral		
			x		
	Cross-border	Coastal	Mountain		
	x				
Size	Inhabi-tants (nb.)	Density (nb./km^2)	Surface (km^2)	Pop. growth rate, 1990-2010 (increase/decrease/stabile)	
	644,007 (2010) 649,318 (Euro-stat)	69.3 (2006) 70.0 (Eurostat)	9,291 9290 (Eurostat)	decrease	
Qualitative description					
Land use structure (%)	Artificial surface	Agricultural land	Forested land	Water bodies	
	3.17	72.38	23.55	0.32 (+0.58 wet)	
Dominant land use changes 1990-2006 (see Nordregio said nb. 23)	Conversion from agricultural land cover to artificial and forested land				
Description of land use changes (other important information)	Stable increase of forested land increase of artificial surface Domination of arable land in agricultural land diversified plant cultivation				
Socio-economic level	GDP per head	Index of unemployment	Share of high educated inhab.	Degree of urbanization (densely/intermed./ thinly)	
	5,700 Euro	13.8 % (2009)	-	thinly	
Regional functions (2 – highly represented; 1 – represented; 0 – lack)	Agriculture	Forestry	Tourism and recre-ation	Settlement (Build up)	Industry	Others (admini-strative, education, etc.)
	2	2	2	0	0	1
Other qualitative description of region	Poorly developed industry low income households dependent on agriculture untapped tourism potential negative migration balance unfavorable age and sex structure of population					

ral land is observed in the east of the region (79.4% in the Hrubieszów *powiat*), and the lowest in the south-west (56.1% in the Biłgoraj *powiat*). Arable lands predominate (80.5%, 2005). The area covered by orchards is rather low (1.2% of agricultural land area, 2005). Meadows and pastures occupy the remaining 18.6 % of the agricultural land area (2005). These are concentrated along river valleys, hence the highest share is observed in the vicinity of Chełm, near Bug river, where the agricultural quality of the land is slightly lower.

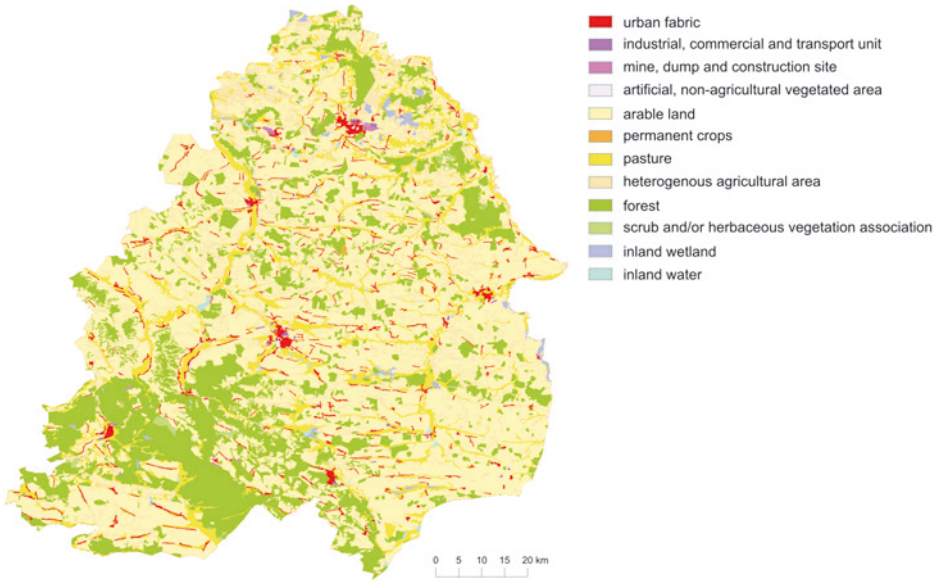


Figure 5.8. Land cover (2006).
Source: Corine Land Cover Image, 2006.

The forestation index is relatively low (22%, 2005). A relatively high portion of forested area is observed only in the Biłgoraj *powiat* (38.7%, 2005), where infertile sandy soils dominate. In this region and in the Roztocze Hills, only a small furniture industry has developed. Inland water surface takes up a negligible percentage of the total mass, mainly due to the existence of several artificial water reservoirs with combined functions. The biggest one of these is situated approximately 20 km west of Zamość and has an area of about 950 ha.

Land cover specificity

Environmental conditions influence the spatial pattern of land cover to the greatest extent. Other key contributing factors contributing include fertility of soils, water balance and relief. The region is typically agricultural, with traditional, scattered farms. Most of the area is occupied by arable land. Its spatial distribution depends very strictly on favourable natural conditions for agriculture, driven mostly by soil quality. Meadows and pastures have a significant share in the slightly less agriculturally favourable area surrounding the city of Chełm and in river valleys. Agricultural conditions are less ideal there, and these areas are see low cultivation of crops, if any. The regional urbanization index is low and the artificial surface covers an insignificant share of the total area. The area reserved for housing is particularly large. There is no extensive industrial or transport areas in the region. Forests dominate in the south-west and the south, where infertile soils on

sands or the steep slopes of the Roztocze Hills make agricultural activity difficult. The forested areas are partly protected within the Roztocze National Park. In the eastern part of the region there are several unique habitats, with natural steppe flora and fauna. These are protected areas within wildlife reserves.

Crop production includes mostly wheat and other cereals, sugar beet, maize and rapeseed, while vegetables, hop and tobacco are of some local importance.

Current and potential multiple uses of land

The dominance of the agricultural function is clear. The second function in the land use sense is forestry. The agricultural function coexists with the tourist function to a greater extent as new investments are made in the region (accommodation infrastructure, ski lifts, studs and reservoirs).

The agricultural function dominates in the central part of the Chełmsko-Zamojski region. It consists of slightly larger and more market-oriented farms in the north and east and very scattered, mostly self-supplying farms in the south and west. Forestry has a predominant role in the south-western corner of the region. The tourist function is associated with agriculture and plays a significant role, mainly in the Roztocze Hills and in the vicinity of reservoirs. However, the region is rather peripheral and traditionally not a tourist-oriented one. Therefore, it does not receive many visitors and the tourist function does not change land use to a significant degree.

The agricultural function's coexistence with the tourist function is an effective way of implementing multifunctional development in the region, especially for rural areas, despite the lack of significant impact on the local economy so far. The areas of greater potential for tourism are located in the Roztocze Hills, the south-western forested outskirts of the region and in the river valleys, whose relatively deficient natural conditions favor traditional methods of farming with little use of mechanization. The development of the tourist function relies on an attractive and natural landscape and recreational infrastructure for skiing, biking, swimming, fishing and horseback riding.

Another field of potential multifunctionality is to be seen in the framework of agriculture and its linkage with energy production. Green energy production has become a new trend as an effective direction of development for European agriculture and it seems to be one of the future opportunities for the Chełmsko-Zamojski region's economic activation. Use of agricultural land for crop cultivation or for wind power stations is only in its incipient stage.

There is an opportunity for introducing energy production in the region at a larger scale. Wind power plants can coexist with agricultural activities, which gives a chance for development for peripheral rural areas. According to the national plan, from 2005 to 2014 the production of energy from renewable resources in the Lubelskie voivodeship should increase from 3.12 to 11.63 TWh, and its contribution to Poland's total – from 2.2 to 7.5%.

However, it is difficult to decide where new investments should be forbidden in the interest of protecting the unique landscape because this would deprive some

poor communes of important short-term and relatively accessible sources of income. In that area it is probably more reasonable to introduce crops and plants with large energy-producing potential that interfere less with the landscape, for instance the willow.

Exploitation of shale gas deposits requires transformation of the entire region's character and creates significant environmental pressure. It could not function within the current land use structure. Exploitation of the shale gas deposits would create a spatial conflict on a regional scale. Nevertheless, the opportunity of using these deposits as an endogenous resource for regional development seems to be attractive as a direction of regional policy.

The co-existence of agriculture and rural tourism is an effective way of harnessing land use in this case but, as contemporary experiences show, rural tourism in the peripheral region without unique natural conditions and longer traditions as a tourist region with a young entrepreneurial society cannot exist as a main direction of development. That said, this multifunctional approach of land use can have a role as an additional source of income for some individual farms offering not only bed and breakfast but some creative scheme of spending one's leisure time that is linked with traditional farming, as already takes place in some villages.

5.5.2. Analysis of land use changes

Dynamics and directions of land use and land cover changes

The major trends of land use changes depend on economic and, to a lesser extent, demographic processes, which are strictly interrelated. Their impact reflects especially in the agricultural economic situation and changes in land structure. For centuries, this region used to be covered mostly by arable land. Generally, recent decades have observed a gradual incursion of forests on meadows and pastures and a consequent reduction in the area of the latter. This process is strongly linked with the concentration and intensification of cattle breeding in the region, abandoning meadows and pastures as a source of fodder. Small farms do not uphold animal production due to macroeconomic changes in agriculture and their meadow and pasture areas often come under a process of "renaturalization". Most farmers of the region sustained animal production on a small scale up to the beginning of the 1990s, but largely to serve their own requirements. Another process that has defined recent years is the readaptation of meadows for cultivation of willows. This positive tendency contributes to a greater use of renewable energy in the Chełmsko-Zamojski region.

The impact of the economic situation within the region is also observed in the shift of the sowing area. Chełmsko-Zamojski was famous for the cultivation of such industrial plants as sugar beetroots, flax, tobacco and hop. The cultivation of these plants, including potatoes, shifted to cereals in the modern day due to various economic circumstances. The cultivation of these once-traditional

plants became increasingly rare, and today it is upheld on a small scale only. On the other hand, the food industry, and particularly the prosperous fat processing factories, have introduced rapeseed into the agricultural repertoire of the region. The economic difficulties that have arisen in the last years, however, have contributed to a decrease in rape cultivation.

While the intensity of plant cultivation in the region has declined, the breeding industry and related agricultural production is currently developing further. Although the number of cattle and pigs has been decreasing, production has switched to concentrating on a smaller number of specialized, larger farms. As a result, exploitation of the meadows has been increasingly abandoned, and maize cultivation as a source of fodder has been promoted instead.

The forested area has slightly increased, because cattle-breeding is in collapse and meadows are no longer mowed on the one hand, and the furniture industry is not developed enough to exploit the forests and significantly reduce their area on the other. The economic condition of the agricultural sector does not put pressure to reduce the forested area that overlaps with weaker soils.

In the last years an increase in land use for tourism purposes has been observed. There are new investments in the region, such as a ski lift, an artificial water reservoir and a horse farm. This process is particularly prevalent in the Roztocze Hills region (south), where the entire territory of the national park is located. In the 1990s, the largest artificial water reservoir in the Chełmsko-Zamojski Region was built on Wieprz river, in the western part of the region. This has since injected life into the recreational function in the surrounding area. Another sub-region of where development of the leisure activities and agritourism functions has been noted since the 1990s are the Central Roztocze Hills, nestled in a landscape of parks near the border of the Roztoczański National Park.

The dynamics of land use changes were rather slow and is processing both, within the agricultural land, even in plant production on arable land itself, and between agricultural land and forests or multifunctional land use. The domination of the agricultural land has been gradually giving way due to the afforestation of the weaker soils and steep slopes. This trend changed after Poland's accession to the EU in 2004 due to direct payments for good practice on agricultural land. With the exception of the suburbs of Chełm and Zamość and areas along the main roads, in the Chełmsko-Zamojski region it is still more profitable to have such agricultural land due to the increase in land prices. Nevertheless, the accession turned back the afforestation trend *per saldo* within the region for two years only.

The area of arable land is gradually increasing due to a greater demand for land by large farm owners and the extensification of plant production. However, changes in the agricultural land use structure generally depend on the limitation of the proportion of meadows and pastures. It is the reduction of their area that is noticed most clearly, given its intimate link with the intensification of husbandry and increase in number of livestock, greater specialization and concentration of cattle stock.

Table 5.11. Identification of the factors and drivers of land use change according to type of land in the Chełmsko-Zamojski Region.

Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Factors ++ most important, + less important	Identified processes
Arable land	E	++	++ Collapsing of food processing industry + Macroeconomic circumstances for agriculture + Needs of energy production	Shifting of cultivation area structure from industrial plants, like sugar beetroots, potatoes, flax or tobacco, to cereals and some energy willow on weaker soils. Forestation of steep slopes and plots with weaker soils
Pastures with annual/ permanent crops	E	+	++ Cattle breeding concentration and intensification + Drainage systems in river valleys abandon	Forestation of wetlands and wildlife growth. Pastures not fully utilized due to cattle breeding concentration
Forests	S	+	+ Market circumstances of wood supply for building and furniture production + Environmental protection	Maintaining activity of sawmills and small furniture factories. Environmental protection in some areas. Gradual enlarging of forest areas on worse conditioning agricultural land. Gradual leisure function growth in forests and in their neighborhood in some areas, especially in Roztocze Hills
Natural Grassland	S	+	+ Environmental protection	Wildlife growth, forest succession and drainage systems abandon in some areas
Transitional woodland – shrub areas	S	+	+ Environmental protection	Wildlife growth
Marshes, coastal areas and inland waters	I	+	+ Flood protection + Leisure function role growth	Some new artificial water reservoirs appearing. Predominance of their recreational function with second houses zone appearing in neighborhood. Some small ponds for recreational fishing appeared as well

Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Factors ++ most important, + less important	Identified processes
Core urban areas	E	++	++ Emigration of young people to bigger educational centers and bigger labor markets ++ Collapsing of industry in the region + Decreasing of administrative role of Chełm and Zamość + Revitalization of Zamość old town	Stagnation of towns development. Ageing of population due to emigration of young people due to educational and labor market purposes and suburbanization. Shifting of their functions from administrative-industrial to trade-educational. Strong increase of relatively big moles wining competition with small enterprises in the town center. Revitalization of historical Zamość old town is going to strengthen tourist and cultural function in it
Urban areas in transition	I	+	++ Suburbanization with predominance of housing and services functions, improving quality of live	New housing areas along main roads from Chełm and Zamość with small entrepreneurship. Lack of spatial planning in suburbs in some cases, especially further from main roads, causing spatial conflicts regarding housing areas and infrastructure networks development
Urban areas in arable land	I	+	+ Local fresh food market	Some cases of vegetable production and greenhouses investments for local market
Urban areas in pastures with annual and permanent crops	E	+	+ Macroeconomic circumstances of agriculture + Local fresh food market	Abandon of cattle breeding in suburbs. Some orchards supplying local market with fruits

Table 5.12. Analysis of land use changes in the Chełmsko-Zamojski Region investigated areas according to type of land.

Name of investigated area	Type of land	Change E – extensification, S – stabilization, I – intensification	Dynamics +++ high, ++ medium, + small	Land Cover Flows	Factors ++ most important, + less important	Remarks
1. Huczwa river near Malice village – Agriculture internal conversions	Pastures with annual/ permanent crops	E	++	Agricultural internal conversions	++ Macroeconomic circumstances for agriculture + Non maintaining drainage system	Conversion arable land with cereals and maize cultivation to pastures for cattle breeding during 1990s'. Wildlife growth
2. Werbkowice – Urban residential sprawl	Urban areas in transition	I	++	Urban residential sprawl	++ Life quality improvement + Potential accessibility + macroeconomic circumstances of agriculture	Majority of houses is from 2000s, arable land with very good quality of soils were transformed into housing area on outskirts of little town. Neighborhood of main road, but underdeveloped local road infrastructure
3. Polanówka – Forest creation and management	Forests	S	+	Forest creation and management	++ Macroeconomic circumstances of agriculture + Macroeconomic circumstances of wood production + Ownership of forest	Natural succession of forest on fallow private agricultural lands on slopes. Wood production inside state forest area

This general trend concerning changes in the agricultural land structure changed dramatically after the year 2004, much like overall trends. The impact of the general economic conditions is not clearly visible only in the case of changes in permanent crops. However, orchards have a rather insignificant role in the agriculture of the region.

The changes, which are taking place outside of agricultural land and forests, rely on the linear growth of housing areas from Chełm and Zamość along the main roads. It is also the only zone where the importance of the third sector is growing. In some localities the coexistence of agriculture and the leisure activities function is becoming more noticeable. In towns and their suburbs, the most important land use change is transformation of industrial areas for the trade or housing function. Nevertheless, there are still some post-industrial sites that require organization and adaptation for new land use functions. The other artificial areas, e.g. those that rely on the industrial or transport function, are appearing very locally.

Actors and drivers of the changes

The main actors of land use changes in rural areas are farmers contributing to afforestation, agricultural land and changes in the structure of plant cultivation, and new leisure activities being introduced. Investors are a new actor in the agricultural land use game, one interested in harnessing the potential of wind power stations in rural areas. The major factors causing land use changes in towns and suburbs are entrepreneurs who are investing in former industrial areas by building stores and supermarkets or developers are transforming them into new estates.

The major actors of land use changes in the suburbs are their new inhabitants. New investments in the suburbs of Chełm and Zamość are taking place along major routes as a principle, but in more peripheral sites there are cases where individuals are obligated to obtain permission for the construction of their house at some distance from the infrastructure but in a more natural setting.

Scenarios and potential conflicts

The next 10-15 years will bring a further decrease in the rural population, and most probably in the total population, of the Chełmsko-Zamojski region. The only areas of population increase are most likely to be observed in the vicinity of several of the biggest towns and along major roads. The average level of education of rural inhabitants will gradually improve.

The economic significance of agriculture for rural households' income will be reduced. Thus, the regional character of land use as well as the landscape of rural areas will undergo gradual change. However, the decline in the significance of farming will be associated with the diversification of farms. Commercial farms will continue to develop and will become more specialized as investments are made. This can partly compensate for the regional declining trend in the significance of agriculture, which is the case of the majority of individual farms. As a consequence, the number of small farms conducting production and applying traditional methods will decrease. This is expected to shift the entirety of the pur-

pose of agricultural production from a market-oriented activity most useful as a source of income to a self-supplying, casual production.

Taking into consideration the land use changes implicit in the low economic development scenario (also called the marginalization of declining rural regions scenario), a further afforestation in the south-west of the region and meadows in the other parts of it can be expected. This scenario brings economic stagnation and the adoption of such state policies as preferring efficiency over equality. In the marginalization scenario, the changes in land use will be proceeding very slowly, with various processes of marginalization simultaneously running in areas located far from the acknowledged cores of development. Wild life will become richer and the conditions will become more supportive for it, therefore with the proper marketing of the region, the tourist function can intertwine with traditional agriculture to a broader extent.

In the moderate development scenarios, the interruption of the afforestation process can be expected, with a gradual introduction of settlement and services along main roads in the rural areas, especially near major towns. The first of the moderate scenarios, called the polarization scenario, relies on dynamic economic development, coterminous with the adoption of national policy preferring efficiency over equality and cohesion. According to this scenario, the space will be polarized through diverse processes in the vicinity of towns of regional importance and in the rest of the region. The second moderate scenario, called the depression scenario, predicts economic stagnation but with a functional policy of equalization in level of development. In theory the policy would aim to neutralise interregional disparities. The current economic crisis, however, will not allow the region to stimulate real rural development.

In the fast economic growth scenario, called the unification scenario, the previously described process concerning land use will be accelerated. In this scenario, generally favourable economic circumstances will contribute to applying effectively a policy of cohesion on a European, national and interregional scale. Although the development of agriculture, intensification of livestock production and increase in environmental pressure can be expected, competition between regions is inevitable and is determined by the limited development of peripheral rural areas. Despite the forced promotion of lagging of them by stronger performer it will allow to create at the most averagely-developed region. However, such a scenario will probably not be sufficient to develop the Chełmsko-Zamojski region into a competitive one in the long run, and with the loss of traditional advantages, sustainable development may be impossible. In this scenario, traditional agriculture will be gradually disappearing. There is also a variant of this scenario that foresees the introduction of energy production based on wind energy and/or the exploitation of shale gas. Both land use and economic structure will then change majorly and permanently.

The only important contemporary spatial conflict concerns social protests related to investing in new mobile telephony base stations. There are also potential threats of future spatial conflicts. These may originate from possessing the ener-

gy from new sources such as wind power plants or shale gas near settlements or environmentally valuable areas. There is also a threat for environmental protection in the further intensification of livestock production. On a very local scale, there have been cases of forced construction at a distance from the bulk of the infrastructure and in natural places with no prior environmental or spatial planning. This is a real risk in the Roztocze Hills especially.

Significant potential conflicts concerning the functional spatial structure of regional development come from the discovery of rich shale gas resources. This energy potential needs to be harnessed for the stimulation of the regional economy, but maintaining awareness of the local landscape and its preservation, at least in the most valuable areas. This will probably become a common dilemma between the two ways of thinking about regional development: dynamic investments with a concentration on exploiting the most economically profitable regional resources in the short run or multifunctional and sustainable development that will preserve the character of the region based on a broad spectrum of regional strengths. The second way, although more time-consuming, guarantees a longer perspective of development. The choice between these two options will have a great impact on the future land cover the direction of changes in future land use.

5.5.3. Conclusion

In this peripheral, mono-functional agricultural region, the dynamics of land use changes are relatively low. The natural conditions are mostly very favourable for agriculture, but at the same time, the region is among the poorest in the EU. Chełmsko-Zamojski suffers from an imbalance in demographic structure and consequent difficulties in the local economy.

Over the last two decades, the changes have reflected the macroeconomic condition of agriculture as a principle, and this too was the major actor in the transformation of the land cover. Certain gradual land use changes within agricultural land are observed. Generally, its area is slowly decreasing. mainly due to the fact that meadows are no longer being mowed, in combination with the neglected drainage systems in the river valleys and the forestation of steep slopes. The most common change in land cover is the increase of cereal cultivation and the abandoning of sugar beetroots, tobacco, flax, hemp and potatoes. This trend reflects a general extensification of plant cultivation. The introduction of raperesults from the development of one of the best prospering sub-branches of the food industry – fat processing factories. Maize cultivation for fodder purposes has also commenced in the region, supported by the intensification of cattle-breeding. Average farm size is increasing dynamically, mainly due to the accelerated dynamics of land leasing.

There were no other important external impulses which could become initiators of change in land use, like for instance far-reaching investment brought on by transport, industry or tourism. The only major expenditure of that kind

included new artificial water reservoir with an area of approximately 1000 ha. However, multifunctionality is making great strides in rural areas. The residential areas along the main roads in the vicinity of Chełm and Zamość are expanding. On the other hand, the area of the Roztocze Hills and the surroundings of the reservoirs are gaining in importance in the field of tourism and recreation, with some highly encouraging development in infrastructure. Agriculture is becoming more frequently associated with green energy production, mainly because of wind power plants or cultivation of plants with high energy potential. Only 1% of the total area of the Chełmsko-Zamojski region is protected as a national park. The function of environmental and landscape protection is more closely linked nowadays with agriculture and, as a result, the wildlife is significantly richer than, for instance, 20 years ago, when more intensive farming and industrial activity predominated.

The transformation of the region towards further multifunctionality is a fitting opportunity to implement more restricted spatial planning and organise optimal, spatially varied functions, working parallel to the preservation of the most valuable natural sites. Unfortunately, some unfavourable decisions concerning the location of certain investments in the region have also been made.

A very important methodological conclusion is the statement that although in the Chełmsko-Zamojski region the general direction of land use changes and land use functions is rather stable and clear, more in-depth analysis is providing more detailed information about the strong diversification of the processes on a local scale.

5.6. Conclusions

The investigations contained in this study have allowed us to establish, check and verify our own typology of the land owner and develop the conceptualization and methodology of Land Use Functions. One important object of focus and analysis in fieldwork were the four types of Land Cover Flow (urban residentail sprawl, sprawl of economic sites and infrastructures, internal agricultural transformations, and forest creation and management), which were identified on the land use maps of the regions in question. Care was taken in the course of fieldwork to identify these areas correctly. We also described the detailed characteristics of the previously identified types, placing special emphasis on the contemporary changes in land use and its dynamics.

Urban residential sprawl represents the intensification of multi-level land utilization and of the average dynamics of land use changes (conversion of agricultural land into built-up areas in most cases). The main factors of those changes are: location close to road or railway infrastructure, good connection to core towns, access to social infrastructure. All of the in-depth investigations pertained to areas represented under cluster 6 (Dynamic rural and peri-urban changes). In accordance with the definition of Cluster 6, in these regions the development of non-land-based economic activities occurs. The highest pressure on peri-urban

areas is observed around big cities, which will certainly become a challenge for regional green structure plans like the Fingerplan in Denmark or sectoral planning in the Basque Country. Highly dynamic expansion of individual housing is clustered along the major roads, which causes problems with accessibility. Urban sprawl is less chaotic in countries with standardized spatial planning, and therefore the land use follows a mosaic-like pattern (there are a lot of single houses scattered over a large territory, between the forest and agricultural areas). In the Polish cases there are also difficulties with lack of development in technical and social infrastructure in the suburban area.

Sprawl of economic sites and infrastructures characterises the intensification of land use. Dynamics and directions of land use as well as the changes in land cover are high or very high and are connected with the location and the pressure exerted by new investors. All analysed areas represented cluster 6 (Dynamic rural and peri-urban changes). There are some spatial conflicts in this area. For instance, in Lomma (Sweden) the nature reserve is located on one side of the road and new services are situated on the other. There was significant pressure on this nature reserve, which resulted in the construction of a protective fence. In the Øresund Region, mostly on the coast, conflicts between the construction of second houses, areas of leisure activity and wind power plants are appearing. Also in the Polish cases, the highest level of development of infrastructure is to be seen in the most attractive places (e.g. development of tourism infrastructure in mountainous areas). One very common type of infrastructure are the leisure-designated areas, such as golf courses and horseback riding paths, especially in the vicinity of cities, but in an attractive landscape.

Agriculture-internal conversions characterise the extensification or stabilisation and differentiated dynamics of land use changes (from high to low), depending on the region. Some of the territories represent high natural environment values and, consequently, are protected by law. The investigated areas represent a wide range of clusters (cluster 3 – extensification of rural activities, cluster 8 – high extensification in rural and sparsely populated regions and cluster 9 – stable rural and peri-urban activities), which is confirmed by relatively diverse directions and dynamics of land use changes. Agricultural areas were gradually transformed into more peripheral ones, where the building pressure and land prices were lower (e.g. in Denmark, farmers moved to Jutland and the new EU member-states). The internal conversions are mostly observable in the neighbourhood of big cities: there are more ecological farms, which produce healthy food and sell it to a local market. One of the most considerable changes in land use is related to the migration from peripheral areas to the coast and the city. People living in rural areas give up cultivation of land, move to towns and effectuate a change towards more environment-friendly means of production In the Basque Country rural tourism is more popular (to foreign visitors) in comparison to the most typical coastal tourism. Internal conversions in the Chełmsko-Zamojski region derive from the economic transformation. Changes in the structure of land use are related to the profitability of production: high extensification of a region's

agriculture results in an increase in cereal cultivation and the abandoning of sugar beetroot, tobacco, flax, hemp and potato cultivation.

Forest creation and management represents stabilization and low dynamics of the land use changes. The major reason for this stabilization is the poor quality of the land in relation to other economic activities and land protection. The investigated areas represent cluster 3 – extensification of rural activities – and cluster 9 – stable rural and peri-urban activities. The Basque case elucidates the shifting function of the forest. There are a lot of areas classified as forests that in reality turn out to be tree plantations. There are no visible changes in the landscape or in CLC data, but they do influence environmental issues. In the Chełmsko-Zamojski case, over the last decades, the encroachment of the forest on meadows and pastures has been observed and results in the reduction of their respective areas. This process of renaturalization is strongly linked with the concentration and intensification of cattle breeding within the region, and the concurrent abandoning of meadows and pastures as sources of fodder. Small farms do not uphold livestock production due to macroeconomic changes in agriculture and their meadows and pastures are often undergoing a process of renaturalization. The processes taking place in forest areas (extensification and stability) have no major impact on land use change, such as intensification. The changes often appear as a point, invisible to the Corine Land Cover, but exerting a very strong influence on the functional and economic structures.

Fieldwork also involved conducting a series of interviews with representatives of the local authorities who are directly engaged in local land use issues, as well as with scientist from the academic institutions of the region. Participants of the project also took part in a series of workshops that also involved included local representatives. In effect, the most important challenges and recommendations related to land use were drawn up, and are summarized below, in Table 5.13.

Table. 5.13. Challenges and recommendations concerning land use changes based on interviews.

Case study region	Challenges	Recommendations
Øresund	– Green energy production, from wind power plants for bio-fuel cultivation. It is necessary challenge due to predicted future energy prices rising.	– Concentration of urban sprawl in isochrones from railway stations. It helps to develop more effective railway transport and modal shifting among daily commuting people. – Converting rural areas should be conducted dual. In the first direction relatively good connected with agglomeration parts of the region should be transformed into leisure activities for citizens or summer houses areas. In the case of rest of such areas should be introduced function of green energy production, from wind power plants or plant for bio-fuel cultivation.

Basque Eurocity	– The challenges for the region is division of Basque Country into three provinces and the level of responsibilities that each of them have. – Connection and cooperation between the three main cities is important – thanks to such situation there can be stronger functional specialization of each of the city and cooperation between them.Thanks to that level of development of each of the functions can be much higher and much more competitive on national and EU level. – The development of the Basque Country should be based on criteria of interconnection (spatial and sectoral) and fulfil the main objectives as: reinforce and rebalance urban system, improve urban areas and stimulate creation of medium cities network.	– Holistic development of the region needs a very good planning system which will be complex on the horizontal and vertical level – – these means that sectoral plans should be created in cooperation with territorial ones (cohesion in spatial planning). – Very detailed planning on the municipality level – thanks to that there will not be many conflicts of functions. – Cooperation between different parts of the regions and division of functions within the territory – development of stronger functions of some particular towns has an important influence on the whole region. There should be regional competitiveness and not competitiveness within region.
Chełmsko-Zamojski	– Co-existing agricultural activity and environmental and landscape values protection. – Introducing of services sector on rural areas, which will help to limit young people outflow. – Exploitation of the energy sources with coexisting regional unique character.	– Key of financial support for farmers should stronger motivate to conducting really traditional agricultural activity, which could substitute potential profits from crops in intensive farming. Support for traditional farms for diversified forms of co-existing agricultural activities and services for agrotourism and leisure activities based on regional heritage. – Different forms of support for selfemployment in rural areas in third sector. Dispersing of offices and regional institutions from the biggest towns to smaller ones and to rural areas. Special funds deducted from wind power plants owners dedicated for really local societies. Rules for investors exploiting slate gas resources regarding minimal share of employment in non-specialized professions among local societies. – On regional level strictly planned zones of the highest landscape values, which are excluded from energy production function, but especially supported in conducting of traditional agriculture and developing services connected to leisure activities and agrotourism.

Jeleniogórski	– Complex and holistic planning – connection of sectoral planning (socio-economic) with territorial one. – Conducted the permanent, annual monitoring of spatial organization in such spheres as: environment protection, industry investments, housing, cultural landscape and infrastructure. – There should be obligatory in establish the local plans of spatial organization for each settlement. – Higher activity of local institutions – local self-government has to have the initiative.	– Holistic development of the region needs a very good planning system which will be complex on the horizontal and vertical level– these means that sectoral plans should be created in cooperation with territorial ones (cohesion in spatial planning). – Equal importance of sectoral and territorial planning. – Very detailed planning on the municipality level – thanks to that there will not be many conflicts of functions. – Cooperation between different parts of the regions and division of functions within the territory – development of stronger functions of some particular towns has an important influence on the whole region. There should be regional competitiveness and not competitiveness within region. – Permanent monitoring of socio-economic and spatial changes in the region and its communes. – Coherent visions of development of communes, counties and region – there should be some hierarchical way of planning of strategies of development, because thanks to that will be "added value" of bigger scale of development. – Engaging many institutions, local actors, representatives of main institutions important for spatial planning and creation of socioeconomic development – thanks to that social consultancy the whole process of planning will be more coherent, transparent and complex. – Good management – giving priority to public needs and public goods over the private benefit.

6.

Summary

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6.1. Recommendations for policy development

Within the EU-LUPA project, land use changes and dynamics in Europe have been approached as policy-driven processes in the context of the European Spatial Development Perspective, although the evaluation of the policy impacts was definitely outside of its scope.

Policy makers should rely on research-based evidence in order to define the most appropriate measures and policy responses in line with the EU development principles and objectives (mainly under the EU Cohesion Policy, EU2020 Strategy and the Territorial Agenda)

- to support responsible land management, monitoring land use intensity
- to resolve conflicting land use demands affecting the economic, social and environmental performance of a region
- and to identify the potentials for improving regional competitiveness and territorial cohesion towards sustainability

Based on scientific evidence from the regional-level characterization of land use in Europe undertaken within this project, and considering the outcomes of the case studies, the EU-LUPA project has provided a non-binding set of policy areas which are far from being *ad hoc* regional policy recommendations, but rather a general interpretation of suggestions for policy development towards a more responsible and sustainable use of the land.

Our key recommendation is that each region in Europe should undertake a regional assessment following the strategy defined for the assessment of the case studies which would allow a proper contextualization of the land use patterns and dynamics and support the identification of the policy options that better respond to the territorial challenges and opportunities in each territorial reality.

The enlargement of the EU to 27 Member States presents an unprecedented challenge for the competitiveness and internal cohesion of the Union.

The assessment of the intensity of land use change revealed that there is a clear East-West dimension that could be partly explained by the enlargement of the European Union in the 1990s. Significant levels of land use extensification are almost exclusively found in the Eastern European member states, particularly in

Poland, the Czech Republic and Hungary. This pattern is clearly dominant in the 1990-2000 period but continues into 2000-2006 as well. The land ownership reforms in Eastern Central Europe during the 1990s resulted in marked changes, a process which was further fuelled by expectations regarding future membership of EU in the period up to and after the accession of ten countries in 2004.

These are important observations because they highlight the types of changes that can be expected by current or future candidate countries.

The integration of the EU in global economic competition is accelerating, offering regions and larger territories more options to decide their development path, as development is no longer a zero sum game for Europe.

Interaction is growing within the EU territory and between the surrounding neighbour countries and other parts of the world.

This is apparent through e.g. migration pressure on more developed countries, which are themselves confronted with population decline, and by access to and investment in new markets.

Borders are almost synonymous with political, demographic and economic remoteness, the meeting place of different competences, structures, legal and social affairs, and they also behave as functional and territorial discontinuities (ESPON, 2012b).

From the reading of the EU-LUPA maps, there are very clear disparities between neighbouring countries, but also high differences between many neighbouring regions. Thus, on one hand, the visualization of these differences only reaffirms the importance of considering land use implications in the border regions when assessing the feasibility or appropriateness of policy. Consequently, how can these developments, e.g. through cooperation initiatives, be coordinated and create development potential?

Interactive mega-drivers on the pan-European scale provoke territorial processes on the regional and local scales

Changes in land use and land cover date to prehistory and are the direct and indirect consequence of human actions to secure essential resources. This may first have occurred with the burning of areas to enhance the availability of wild game and accelerated dramatically with the birth of agriculture, resulting in the extensive clearing (deforestation) and management of Earth's terrestrial surface that continues today. More recently, industrialization has encouraged the concentration of human populations within urban areas (urbanization) and the depopulation of rural areas, accompanied by the intensification of agriculture in the most productive lands and the abandonment of marginal lands. All of these causes and their consequences are observable simultaneously around the world today.

Processes such as urbanization, agricultural intensification, afforestation, rural abandonment, land use specialization are land use processes resulting from interacting driving forces.

The assessment of the prevailing characteristics of land use in Europe at a grid level highlights that with an average coverage of 32.4% of Europe, the "Rural forest" is the most extensive land type, follow by "Arable land in predominantly rural areas", which accounts for an average of 22.36% of the total, and "Pastures, agricultural mosaics and mixed forest" in predominantly rural areas covering an average of 21.61% of Europe.

The ongoing mega trends are to some extent linked to the implementation of certain policies. Certain EU policies are affecting land use changes and will do so in the future in different ways: some of them tend to homogenise the European territory and others, like the Common Agricultural Policy, provoke regional inequities, as is the case of eastern Poland near the Ukrainian frontier or the border between Germany and Denmark, reflecting different approaches to such policy, as derived for the assessment of the project's case studies.

There is a need for a more integrated policy approach towards sustainable land use

European economies depend on natural resources, including raw materials and space (land resources). The EU thematic strategy on the sustainable use of natural resources includes space as a resource. It applies to areas of land and maritime space that are needed for production purposes (e.g. minerals, timber, food, energy...) and for various socio-economic activities. These interests often compete for the same territorial resource.

It is increasingly understood that a more integrated, comprehensive and up-to-date policy approach is needed, one able to boost European territorial development towards sustainability through increased efficiency and multi-functionality.

Policy decisions that shape land-use involve trade-offs between sector interests, including industry, transport, energy, mining, agriculture, forestry as well as protection / conservation and recreation activities. There is a lack of a comprehensive and an integrated approach that takes those trade-offs between many sector-specific, social and environmental issues into consideration.

We could suggest many examples of trade-offs between different land uses and territorial conflicts. For instance, the territorial conflicts between hydropower generation and the goals of the Water Framework Directive, the indirect land-use effects of bioenergy production, the generation of wind power and landscape or impacts on bird life, and on a larger scale, the urban sprawl phenomenon and the goal of polycentrism.

Another example is the urban phenomena. One of the main failures in effectively controlling urban sprawl is the lackof horizontal (spatial) and vertical (institutional) integration of policies. City boundaries are becoming diffuse, thus increasing the complexity of levels of governance (e.g. intermediate metropolitan administrations).

There is still a double-sided relationship between land and growth in most of the regions in the European territory

As it was already argued in the text. We need land to grow, but our growth puts pressure on the social, economic and environmental services we can obtain from it. But it also shows that the drivers, the enablers and the ingredients of what we require for development are the very things pressuring the over-consumption of land. This pressure cannot continue to escalate as we continue to develop, and this means that a growth model that is blind to the host of thresholds related to land and its resources cannot continue sustainably.

European economies depend on natural resources, including raw materials and space. Land is a limited resource. Different sector interests are often competing for the same territorial resource.

Europe's Resource Efficient Strategy sets the goal of no additional land consumption after 2020, yet this mandate will mostly likely work against the goals of a number of regions – particularly those seeking to ascend the socio-economic ranks toward the most established European nations. The fact that the magnitude of land change has been more or less maintained throughout the period from 1990 to 2006, and prospective new members of the EU appear ready to make use of land change as a vehicle for economic progress, it seems that measures of compensating any limitations in this respect would be needed. Therefore, it is both an unlikely and unrealistic goal for a number of European regions.

Economic growth matters

The behaviour of macro-economic sectors such as tourism, industry development, agriculture, energy (production, supply, distribution and consumption) and transport is translated into land use changes in the EU.

Considering the amount of change, within the entire 16-year time period analysed in the EU-LUPA project it is notable that some very significant levels of land change have taken place – in some regions almost 30% of the total area has reported change. The spatial distribution of these changes is also quite territorialized, where vast changes are especially evident in areas such as Spain, Portugal, the Czech Republic, the Netherlands and Ireland.

In terms of per capita urban land take, the main influences are the existence of second homes, large touristic infrastructures and a dispersed settlement structure. Relatively large shares of second homes are notable to varying degrees in the Mediterranean regions, as well as in Finland, Estonia, Denmark and Sweden, often tied to coastal or mountainous areas where former small-scale primary sector activities (fisheries, farming, forestry) have been or are in decline. Meanwhile, extensive touristic infrastructure coupled with a very high average population density is the driver of such a high degree of urban land take in Malta and coastal zones, especially around the Mediterranean Sea.

The shift from 1990-2000 to 2000-2006 also relates to changes in mobility, where halted subsidies for dwellings and an increase of suburbanization have been influential on the slowing down and decline in extensification (Vobecká, 2010), an issue which is dealt with further in connection with the Land Change Hotspots. In the 2000-2006 time-period, significant intensification is especially notable in certain regions of Norway. These are regions that we know have undergone relatively low levels of land change (by area); however, the changes that have taken place were very intensive. This is due to the development of intensive mining, hydrocarbon extraction and other heavy industrial activities in rural and remote locations. Interestingly, these intensifications are not taking place in parallel with extensification of other land covers in these areas, which indicates that these are "new" economic activities that are taking place on previously stable and unchanged land.

Relatively high rates of intensification are notable for many regions in Spain in all three time periods. The highest levels of intensification have taken place for coastal regions along the Mediterranean and for the island regions. This is clearly related to the growth of artificial surfaces in urban areas. CLC flow data and EEA land cover analysis (EEA, 2011) indicates that much of this intensification is due to the sprawl of economic sites and infrastructures (in which both construction areas and transport infrastructure are grouped).

European tourism is an activity requiring still larger areas, and the development of the Spanish coastline illustrates that it is not only a question of short-term changes, but seems to have been a consistent development process throughout the whole period from 1990 to 2006.

Geographical intrinsic features and physical conditions ISSUES

This is particularly relevant in border regions, for instance. The geographical features and conditions of a region determine the availability of resources, including existing land for the development of certain activities which are highly dependent on the demand of specific locations (including land productivity) such as agriculture, aquiculture, forestry, tourism, energy production (particularly renewal), and associated industrial sectors (industries dependent on raw materials--iron and steel industries, mining activities). Most of these categories are included in the Corine Land Cover classification. The use of land is seen here as means of production.

Land price matter

One of the lessons learned: land is still too cheap for new development, while redevelopment is too expensive (e.g. regeneration of brownfields). However, in the long run, redevelopment of urbanized areas and areas with new development is the only sustainable approach.

The real estate market is an important player from the supply side. According to Bertaud, the land price profile approximately follows the population density profile in market economies. This promotes the urbanization of the less dense areas within a certain distance of the main centre.

The differential price between agricultural land and already urbanized land discourages the revitalization or recycling of built space, generating derelict land. It also has a strong impact in fertile flat areas where accessibility generates a conflict of uses leading to the marginalization of agriculture.

A change in the price of agricultural and forest products, and also in the prices of land for housing or the location of an industrial site, can affect landowners' decisions on whether to keep the land in those uses.

Technological push and market pull matter

Market forces and the evolution of society in general support a geographical concentration of activities.

The ongoing demographic changes within an ageing European population, in addition to migration, affect regions differently and increase the competition for skilled labour.

Yet all things considered, the most dramatic land change process taking place in Europe is predominantly driven by Europe's path of socio-economic develop ment, which is taking place due to globalization and its effect on the global division of labour. The result has been the continued decline of land-based economic production – i.e. agriculture, forestry, mining and quarrying, etc. – in favour of knowledge-intensive, innovation-driven and service-based economies on the other hand. And this is where the notion of intensity adds to the understanding of processes and mechanisms behind land changes.

Ireland being a "hotspot" for Information Technologies development during the 1990s had some spin-off in relation to increased intensification of activities related to land use. This was partly because the attraction of the labour force away from direct land use to industrial activities required adjustment in land-related activities, involving technology having to replace the missing workforce. With the partial collapse of the IT-adventure after 2000, the process described above came to a halt, and the shift is apparent when comparing the 1990-2000 and the 2000-2006 periods.

Population dynamics and future scenarios including visions and strategies matter

Population growth or decline, due to both natural and migratory processes, implies changes in the need for housing, services, employment, resources including energy, food, goods and services. It is also important to bear in mind that the demand for housing units is also determined by the average number of people living in a household, which is a changing variable.

As has been seen in the previous sections, however population growth is not the only determinant of the outward expansion of built-up areas. There are other elements related to cultural aspects and individual decisions modulated by the supply side and other external conditions (price, transport).

The feedback between drivers and urban processes can be seen in the case of population dynamics:

- Population change is an important consequence of urban conditions, especially the availability of economic opportunities (Green and Owen, 1995; Champion and Fisher, 2004; Storper and Manville, 2006). Migration is a response to differences in employment or the quality of life between places, even if the process of adjustment is inefficient. The bigger the differences, the more worthwhile it may be to move, subject to barriers such as distance, legal restrictions, housing constraints and information on the opportunities available. The propensity of people to move is affected by their age, qualifications, financial resources and sense of attachment.
- Population change is also an important influence on urban economic conditions (Glaeser et al., 2001; Glaeser, 2005; Florida, 2004; Krugman, 2005). There is evidence that sheer population size and deep labour pools increase agglomeration economies and productivity (Rosenthal and Strange, 2004; Rice et al., 2006). Loss of population has certainly caused wider economic and environmental problems for cities (Cheshire and Hay, 1989; Begg et al., 1986). Numerical shifts in the population affect local jobs through demand for consumer goods and services, housing, schools etc. Changes in number of working age residents also affect the supply of skills, which may influence mobile investment decisions. The composition of the new population is bound to have an important bearing on the scale and nature of the economic impact.

Urban growth matter

Urban growth comes at the expense of other land uses. In the core cities there is a clear dominance of new building development on previous agricultural land. This is due to several factors. Firstly, most of the available land for urban growth is agricultural. Secondly, agricultural land is in most cases technically more suitable for construction than forest areas, both topographically and in economic terms. Thirdly, natural areas are often considered valuable hotspots for recreation and hence cities have protected them from building activities. Grouping cities by regions highlights some specificity – e.g. in Eastern countries about 30% of construction is developed on what used to be forests. In large urban zones, agricultural land is still the primary source. However, in Eastern cities most of the land is developed on forests.

Subsidies, funding and investment matter

In the Czech case it is interesting to point out the seemingly high degree of rural extensification, countered by urban-related intensification in the capital region of Prague. Further, when comparing the 1990-2000 and the 2000-2006 results, even when taking into account the much larger time span in the former

time period it appears that extensification processes have slowed for the country as a whole. The European Environmental Agency country analyses show that the main driver of extensification has been the conversion of different crop areas into land for pasture. This is a process which has been driven by national policy that uses subsidies to encourage the grassing of arable land and extensive grassland management.

The situation in Poland was, however also affected by the lack of funding for investments in many of the small farms that function more as subsistence bases for a still older population – a situation that can be found in rural areas, not the least in regions remote to the capital regions or in mountainous areas in most of the former "Eastern Block". And several of the regions where this has been the dominating characteristic have continued to constitute regions of declining intensity through to the 2000-2006 period as well. In Poland, one important element in this connection has been the small size of a substantial part of the already private farms. The advantage in other parts of East-Central Europe has been that, in the aftermath of the first round of extensification, the new private farms were able to establish themselves not as subsistence activities but as professional and capital-intensive ventures on previous state- or cooperative-owned large-scale farms. Similar situations have appeared in relation to other types of land use.

Land ownership and land tenure matter

The question of land ownership and land tenure has been extremely important in relation to the registered observed in Southern Europe, and especially on the Iberian Peninsula.

In contrast to the situation on the Iberian Peninsula, the immediate effects of the inclusion of East-Central European countries – previously part of an "Eastern Block" mostly characterized by state and cooperative ownerships – are reflected through a drastic decline in intensity over substantial areas in the period from 1990 to 2000. In contrast to the situation in Spain and Portugal, the basic land reforms distributing former estate land to small and medium-scale farming had taken place pre-Second World War, and in many cases during the 19th century. The structural changes connected to the post-WW2 reforms in ownership instead resulted in the establishing of state farms and cooperatives. This had some immediate consequences in relation to both intensity and productivity, and was paralleled by regional policies on rural areas due to the state's interest in maintaining a high level of production to serve the requests from the Soviet Union through COMECON. As a consequence, transfer payments and subsidies enabled intensities and productivities that were unrelated to market conditions. So the development from 1990 onwards, primarily abandoning the former state and cooperative forms of ownership, has had some immediate consequences in relation to intensity. On the one hand, many of the new private farms were small and did not have the necessary means to ensure high intensity in land use. On the other hand, the larger farms with potential for intensification entertained, in many ca-

„ses, foreign investments, which did not necessarily lead to intensifications. The situation in Poland was different in this respect because of a dominance of private land use activities, and as a consequence, the effects as described above only pertained to the relatively smaller areas owned by cooperatives and a few state holdings as well.

Environment

The occurrence of hazards due to climate change is increasing and different parts of Europe experience different types of hazards.

EU policies on adaptation to climate change are directly relevant to current and future land-use practices and economic sectors depending on this. Thus the promotion of climate change adaptation strategies is seen crucial. EU policies on adaptation to climate change are directly relevant to current and future land use practices and remarkably important for economic development in several sectors.

There are development opportunities for the production of renewal energy sources

Increasing energy prices and the emergence of a new energy paradigm have significant territorial impacts, some regions being more affected than others. This presents unique development opportunities for the production of renewable energy sources.

The ReRisk project (ESPON, 2010) on the implications of energy poverty in EU regions for economic competitiveness and social cohesion, provides valuable information on the economic and social vulnerability of the European regions.

Climate change varies and will vary from region to region – with coastal and mountainous areas and flood plains particularly vulnerable – and therefore many of the adaptation measures will need to be carried out regionally. Impacts are likely to be severe in the southern regions of Spain, Greece, Portugal and France, both in terms of energy production and demand. In these regions, summers are going to be complicated for energy companies, due to diminishing water reserves, higher average temperatures and heat waves, and consequently, forest fires. The supply problems will coincide in time with higher peaks of electricity demand, derived from more extensive use of air-conditioning.

Evaluate the feasible potential of all renewable sources in the most vulnerable regions

Regions should thoroughly evaluate the “feasible” potential of the different technologies available, including concentrated solar, geothermal, wave / tidal technologies, biomass, and hybrid solutions. Regions with different types of potential for renewable energy can cooperate to improve the reliability of energy supply

from these sources. The generation of "maps of untapped energy reserves" can be of great use for developing longer-term plans in the regions.

Making extended use of biofuels in the region could lead to social and ecological problems. Biocrops compete with other uses for scarce resources, such as land and water, in agriculture, forestry or natural sites. Specializing in certain types of plants with high energy yield could jeopardize other objectives of agricultural policy, such as that of promoting a higher level of regional sufficiency with regard to food production (by growing subsistence crops). Large-scale biomass plants could accelerate deforestation or endanger local biodiversity. Apart from choosing technologies and crops that are appropriate in a given regional context and robust with regard to possible climate change impacts (droughts), attention must also be paid to the parallel development of local social and educational skills, which will be needed to manage and maintain the installed facilities.

The way land is used has impacts on biodiversity and ecosystem services

The way land is used is one of the principal drivers of environmental change, having impacts on climate, biodiversity and ecosystems services, and causing degradation and pollution of water, soil and air (EEA, 2010a). In turn, environmental change, particularly climate change, will increasingly influence the way we use land as communities strive to adapt to and mitigate the effects of a changing climate (EEA, 2010b). Changes in land use could be seen as a driving force and also as an impact, to the environment, biodiversity, climate change, natural resources. For instance, a change in the land use resulting from urbanization or from converting forest into agriculture may have an impact on ecosystems, biodiversity and on the climate (affecting the carbon balance).

Biodiversity loss

Biodiversity is often dramatically reduced by land use changes. When land is transformed from a primary forest to a farm, the loss of forest species within deforested areas is immediate and complete. Even when unaccompanied by apparent changes in land cover, similar effects are observed whenever relatively undisturbed lands are transformed to more intensive uses, including livestock grazing, selective tree harvesting and even wildfire prevention. The habitat suitability of forests and other ecosystems surrounding those under intensive use is also impacted by the fragmenting of the existing habitat into smaller pieces (habitat fragmentation), which exposes forest edges to external influences and decreases core habitat area. Smaller habitat areas generally support fewer species (island biogeography), and for species requiring undisturbed core habitat, fragmentation can cause local and even general extinction. Research also demonstrates that species invasions by non-native plants, animals and diseases may occur more readily in areas exposed by land use changes, especially in proximity to human settlements.

The increase in the demand for food, fibres, energy, water and other resources, derived from changes in lifestyle, is expected to continue, although demographic scenarios for Europe forecast stabilization in population growth over the next decades. This is putting great pressure on biodiversity, particularly due to the intensification of land use – directly, through habitat destruction and resource depletion, for instance – or indirectly – through fragmentation, drainage, eutrophication, acidification and other forms of pollution.

In fact, developments in Europe might have an impact on a global scale, since the demand for natural resources nowadays exceeds both availability and production in the European case.

We can infer from the analysis of the urban dimension in the EU-LUPA project that slow-developing cities are more common in urban cores and metropolitan areas. It reflects, to a certain extent, the limits of growth of current metropolitan areas due to physical constraint – there is no more space to grow, but additional restrictions are related to more strict planning and the development of green infrastructures, which delineates new boundaries. This is complemented by the finding that the lowest percentage of urban centres can be classified as very rapidly growing cities. The rapidly-growing cities are found in suburban areas while arable land is characteristic of the peri-urban. This reflects the current trend of new developments close to existing poles either in the periphery (suburban areas) or in regions that used to have a more compact distribution of cities in a rural context.

The concept of "Green Infrastructures" offers a promising way to integrate biodiversity and ecosystem services in urban planning and governance, in a variety of contexts and purposes. Green infraestructures is understood as a network of natural and semi-natural areas, features and green spaces in rural, peri-urban and urban, terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation in an integrated manner, and benefit human societies through the maintenance and enhancement of ecosystem services. (Naumann et al., 2011a). In urban areas, green infrastructures cover a diverse array of green spaces, ranging from parks, green roofs and walls to urban farms and forests.

The multiple benefits of green infrastructures are recognized by many high-level initiatives, such as the EU's 2020 Biodiversity Strategy, the New Charter of Athens, the Leipzig Charter, and EU soil sealing guidelines. Green infrastructures have also begun to be implemented through policy and planning instruments (EC, 2012b). The relationships among relevant green infrastructures features and objectives, and their multiple impacts on biodiversity and ecosystem services, are the subject of much existing research.

However, more work is needed to enhance the evidence base for the maintenance, restoration, enhancement and sustainable use of urban biodiversity so as to translate the broad concepts of green infrastructures into operational and implementable frameworks, methods, and tools for integrating green infrastructures into urban planning and governance.

The role of green infrastructure and site protection under Natura 2000, as well as the re-use of land, are also important aspects of land resource management. Green infrastructures and their provision of ecosystem goods and services are linked to land take issues.

- They contribute to minimising the risk of natural disaster. Surface water run-off is used to reduce the risk of flooding, prevent soil erosion, connect habitats, mitigate the urban heat island effect etc.
- Land take / spatial planning - key role in facilitating and delivering green infrastructures.

The way land is used has impacts on land degradation, and pollution of water, soil and air

Monitoring and mediating the negative environmental consequences of land use while sustaining the production of essential resources is a major priority of policy-makers around the world.

Land alongside energy resources, water and climate, EU policies on adaptation to climate change are directly relevant to current and future land use practices and remarkably important for economic development in several sectors. we need to use within a sustainable level in order not to endanger our continued development. But we could even go a step further by saying that land is the most tangible of these conditions. We rely on it in the sense that land type is one of the most integral components for determining how land is used.

Changes in land use and land cover are important drivers of water, soil and air pollution. Perhaps the oldest of these is land clearing for agriculture and the harvesting of trees and other biomasses. Removal of vegetation leaves soils vulnerable to massive increases in soil erosion by wind and water, especially on steep terrain, and when accompanied by fire, also releases pollutants into the atmosphere. This not only degrades soil fertility over time, reducing the suitability of land for future agricultural use, but also releases huge quantities of phosphorus, nitrogen, and sediments to streams and other aquatic ecosystems, causing a variety of negative impacts (increased sedimentation, turbidity, eutrophication and coastal hypoxia). Mining can produce even greater impacts, including pollution by toxic metals exposed in the process. Modern agricultural practices, which include intensive inputs of nitrogen and phosphorus fertilizers and the concentration of livestock and their manures within small areas, have substantially increased the pollution of surface water by runoff and erosion, and the pollution of groundwater by the leaching of excess nitrogen (as nitrate). Other agricultural chemicals, including herbicides and pesticides, are also released to ground and surface waters by agriculture, and in some cases remain as contaminants in the soil. The burning of the vegetation biomass to clear agricultural fields (crop residues, weeds) remains a potent contributor to regional air pollution wherever it occurs, and has now been banned in many areas.

Other environmental impacts of land use changes include the destruction of stratospheric ozone by release of nitrous oxide from agricultural land and altered regional and local hydrology (dam construction, wetland drainage, irrigation projects, and increased impervious surfaces in urban areas). Perhaps the most important issue for most of Earth's human population is the long-term threat to future production of food and other essentials by the transformation of productive land to non-productive uses, such as the conversion of agricultural land to residential use and the degradation of rangeland by overgrazing.

Socio-economic processes

Growth is possible without major new land intake

The correlation between population growth rates and land take (2000-2006) shows that in most regions the pattern has been that of a correlation between average population growth and increases in the average annual growth rate of land take. Land take is growing faster than population. However, in certain regions (mainly of Spain, The Netherlands and Ireland), urban development has been a dynamic phenomenon, particularly during the analysed period, with irrelevant population growth. At the European level, housing, services and recreation made up a third of the overall increase in urban and other artificial area between 2000 and 2006. (LEAC Database (based on Corine Land Cover 2000-2006 changes, version 13, 02/2010), ETC/LUSI, (EEA, Land Take GDI 5 March 2012) Western European countries, but in particular Spain, Ireland and Portugal, suffered an unsustainable rise in the price of real state from the 1990s to 2008, commonly known as property bubble.

House ownership in Spain is above 80%. The desire to own one's own home was encouraged by governments in the 1960s and 1970s, and has thus become part of the Spanish psyche. In addition, tax regulation encourages ownership: 15% of mortgage payments are deductible from personal income taxes. Certain parallelisms between the increase in employment rates and land artificialization could be seen in several Spanish, Irish and Portuguese regions. Again, this could be explained by those countries' dependency on construction/building sector

Green growth

Today, it is widely acknowledged that the economy has grown so great and global that it is transforming all other activity on Earth. As presented by UNEP: "The concept of a green economy does not replace sustainable development, but there is now a growing recognition that achieving sustainability rests almost entirely on getting the economy right". Therefore, it is recognized that to change the way society functions there is a need for a new economy, perhaps even a new paradigm, incommensurate with current values and ideas. A Green Economy, or a green growth, builds on the idea of developing cleaner production processes, developing new products and energy solutions, and reducing waste. At the same

time it takes into consideration the planning of societies, structural changes needed to facilitate this transition and the distributional impacts of such vast changes.

The territorial dimension to Green Growth captures the interaction of resources, people, structures, etc., and the possibility of a nation or a region to become greener in production and consumption. The transformation to a green economy is both driven by the need to reduce emissions and resource use, but also by a recognition that that there are opportunities for investment and growth in wealth and jobs.

One view of sustainable rural development considers agriculture as an important driving force in developing sustainable rural communities in Europe. Knickel and Mikk (1999) maintain that farming, more than any other rural activity, has a role to play in integrating the natural environment with the cultural landscape and socio-economic development. Petrezelka, Korsching and Malia (1996) discuss whatthey call 'the sustainable agricultural paradigm', stating that sustainable farming is concerned with the protection of the environment and the place of the community. Parallel to this, EU-LUPA project presents a typology of land use functions going beyond agriculture, and at the same time emphasizes that at least four types of linkages are needed in connection with the definition of land use categories: The use of land as a means of production where qualities of the land itself becomes an important contributor; The use of land as a *locus stand* for production purposes which includes activities that are localized, but not necessarily directly linked to a "consumption" of the qualities and productive forces of the land itself. Instead, qualities such as accessibility, proximity, water, sewage disposal, etc. are important issues; The use of land as a means of recreation includes land areas where the consumption of land areas is important in relation to recreational purposes in a dual perspective, both in terms of environmental functions for recreation in the current society but also in terms of recreating (preserving) the environment for future development. Besides its natural qualities, land consumption is directly connected to socio-economic growth through housing, recreational parks, amusement parks and sports facilities, not only in near-urban areas, but also including summerhouses and second homes in rural areas.

The green economy can be either understood as (a) an overarching development framework aiming at the consecution of sustainable development goals including environmental, economic and social targets, (b) as a means for achieving a more resource-efficient production model, thus mainly focusing on the environment-economy interface, or (c) as a number of concrete economic activities that jointly form a growing economic sector, (a "green economy") which in the medium-to-long run is supposed to bring about an implicit environmental benefit.

Urbanization and urban sprawl ISSUES

Urban sprawl is identified with some of the most critical and negative impacts of the current model of territorial development, including increasing greenhouse

gas emissions, social exclusion and biodiversity loss. Key political concerns with climate change and uncontrolled urban sprawl are all fundamentally related to the interconnected land-use – transport – environment nexus of urban development.

The analysis of the prevailing characteristics of land use at regional level resulted in 10 classes, from which 3 included most of the analysed cities are related to urban phenomena. These typologies are shortly described below as a recapitulation:

- **Urban cores and metropolitan areas** – 29 regions – regions of this type are generally smaller regions which can be characterized as regional city-states, where peri-urban areas and rural hinterland are accounted for in neighbouring regions. Thus, the urban land features in this type are influential not only for the social, economic and environmental performance of regions within this type but also the regions in close proximity to them.
- **Suburban or peri-urban areas** – 53 regions – either situated in near proximity to large urban centres – such as London or Paris – or are similar to the previous land type in the sense that they have a higher urban land component because of the relatively small area of the region. The urban and infrastructural component typically covers around 15% (and up to 20%) of the land. Relatively high levels of artificial surfaces are also evident in certain regions where large urban areas are situated in relatively large regions (by physical size).
- **Arable land in peri-urban and rural areas** cover more than 70% of the land in the 41 regions characterized by this type. The historic role of the agricultural production potential of this land use type for Northern Europe, Central Europe and the Balkans is clearly indicated through its distribution as the immediate hinterland around the major urban centres in the Central-North, and the matrix which constitutes the core population areas along the rivers in the Balkan area.

When analyzing the evolution of urban areas in the EU for the 2000-2006 period, a first look at the overall changes in the European cities indicates an increase in the land that has undergone some urban development. However, the areas under redevelopment have significantly increased in both the core city and the larger urban zone during the 2000-2006 period. The development of new residential areas has been reduced, while industrial and commercial areas are still increasing in size and becoming the main source of urban expansion. This is a general trend observed in the last 20 years where urban sprawl is less and less associated to increases in the size of residential areas and more to other economic developments. However, there are some exceptions like the Mediterranean coast, specifically in Spain, where second homes and speculation have been driving factors for urban sprawl up to and including the period from 2000

to 2006. Many Eastern cities also exhibit a trend in which the development of new residential areas dominates over that of new industrial and commercial ones.

All in all, the densification process (redevelopment plus infilling) is slightly increasing in the overall balance.

Coming to the question of the extent to which compactness is relevant for the different typologies, the conclusion is that the existing structure can modulate future evolution, but not to such an extent as to overcome other driving forces like land price, people's preferences and lifestyles. However, from the policy and planning perspective it is always desirable to retain this compact structure as much as possible to avoid long-lasting impacts. Some of the legacies of the past are include brownfields, lands and buildings in urban areas that have lost their original use and bear heavy ecological costs. Very often they are associated with abandoned industrial areas with potential problems of contamination. Their extent varies rather significantly, depending on the country. For example in Belgium (Flanders) they were estimated to represent around 0.5% of the total area of the country, while in Romania they reached 4%. The redevelopment of brownfields is often only marginally economically viable (or not at all) as compared to greenfield development. To increase competitiveness, there is a need for the implementation of a complete package of measures, including economic, legal and fiscal incentives. In the 2000-2006 period, the Structural funds expended for the EU25 included 2.25 billion EUR for the rehabilitation of industrial sites and about 2 billion EUR for the rehabilitation of urban areas.

The assessment of the urban phenomena in the EU-LUPA project reveals that city form, and city compactness, are the result of the history and evolution of urban areas, including geographic and cultural factors. The available information indicates that several factors combine in the more compact cities:

- Higher proximity of urban patches to the city centre or core city
- Mixed uses of land

However, more dynamic indicators like soil sealing per capita reveals that urban morphology and compactness alone do not explain the complexity of the system. Moreover, urban development in the last decade shows that intermediate cities are the most dynamic ones, at the risk of being less efficient in their use of land resources (soil sealing per capita).

Urbanization in central and eastern countries

The political changes that occurred at the end of the 1980s and 1990s in the former socialist countries represent a special case because the factors that shaped cities in the previous period were very different from the rest of Europe. The centralized planning and the non-existence of land markets resulted in more compact cities compared to their western counterparts. By 2000 most of the cities were still below 100,000 inhabitants (25% between 100,000 and half a million, 6 between half a million and one million; and only 3 with more than one million –Budapest, Warsaw, Prague).

Although regional differences exist and the process has taken a different pace depending on the city, some commonalities have been found:

- General decline in population in the last decade, except in Poland, Slovakia and Slovenia.
- Privatization of the housing stock. After the transformation, a large number of dwellings were sold to the inhabitants at low prices. As a consequence the new member states register the highest number of owner-occupied dwellings in Europe (96.7% in Lithuania in 2001). The exception is the Czech Republic (47% in 2001), which has never introduced such privatization plans (van Kempen et al., 2005).
- Gradual deterioration of housing blocks as a consequence of low income of many new owners, who are unable to repair and maintain the dwellings (Murie et al., 2005).
- Progressive deterioration of city centres. Increase of pollution derived from inadequate transport policies.
- Changes in the economic base in the cities, increasing opportunities in the service sector. However, the workers in demand for the service sector are not always those who have lost their job in another sector.
- Commercial development constitutes an important force that has substantially contributed to a massive reorganization of land use patterns. Such development has been recognized as a tool of local economic regeneration and growth, often supported by government policies.
- Revitalization of city centres raises the prices in the inner city, which consequently becomes too expensive (e.g. Lithuania).
- Disparity in prices between capitals (more expensive) and other cities of the region.

All these elements have led to a situation consisting of:

- Increased suburbanization and sprawl, although most of the cities are still more compact than in the Western Europe. The acceleration of city sprawl is evident in Hungary, as well as in Poland and the Czech Republic.
- The situation is more dramatic in cities where sprawl has been combined with decline, implying a strong environmental impact (e.g. Budapest).
- Social, and sometimes ethnic, polarization.

Policy responses are needed to respond to the major constraints so as to further improve the situation in these countries.

Land use characteristics are becoming increasingly multi-functional, crossing not only sectors but also administrative borders

The expression "multifunctional landscapes" refers to areas serving different functions and combining a variety of qualities, i.e. that different material, mental, and social processes in nature and society take place simultaneously in any given landscape and interact accordingly. Multi-functionality in landscape, therefore, means the co-existence of ecological, economic, cultural, historical, and aesthetic functions.

Thus, landscape multifunctionality is not necessarily synonymous with multiple land uses. Different land uses can be a criterion for multifunctionality in landscapes, but even a single land use can involve numerous functions. Different land uses can result in different functions, but not all functions can be expressed as land uses. The problem in this connection, however, is that the concept of "land use" is often – as emphasized in the report – only related to the physical characteristics of the land cover identified through, for instance, the Corine Land Cover characteristics and the economic activities related to its use.

Different land uses can be a criterion for multi-functionality in landscapes, but even a single land use can involve numerous functions. Paracchini et al. (2011) therefore emphasizes that the concept of multifunctional land use provides a favourable approach based on the recognition of the fact that in order to maximize the benefits obtained from a given parcel of land, a more equitable balance of the competing economic, environmental and social demands on land is more sustainable in the long term than an unbalanced system based on individual sector-based rationales. In such context there is also, however, a need for evaluation tools which allow a more sensible approach to the assessment of whether competing demands in a multifunctional land use system are sustainable or not. In particular, there is a need to integrate information and data from a wide variety of sources into a single evaluation framework, recognizing that different land uses can result in different functions, but not all functions can be expressed as land uses.

The approach to "land use" should therefore not only be seen from the land cover perspective but also from the perspective of "functionality", which provides linkage with other transversal issues. "Functionality" could be a motivating approach in the integration of land cover, land use management, socio-economics, transportation, energy conservation, water management and climate change. While the concept of "land use" traditionally has been considered to be (to some extent) binary – i.e. one land use activity would exclude other activities – the situation in Europe is that the functionality of land areas has been increasingly diversified: on one hand towards exclusiveness, with mono-functional large scale production, and on the other hand towards inclusiveness, which stresses the fact that different activities co-exist.

Past and current policy decisions can influence the rate at which land use and land cover change. Our hypothesis is that cosequently different planning systems may affect land use and land cover changes in different ways. Centralized vs de-

centralized planning systems alongside spatial planning traditions: the regional economic planning approach (France, Portugal and Germany); the comprehensive integrated approach (Nordic Countries and Austria); land use management (UK, Ireland, Belgium); and the urbanism tradition (Mediterranean countries) (EC The EU compendium of spatial planning systems).

As a preamble to the upcoming discussions on the European Landscape Convention in 2000 the Pan-European Biological and Landscape Diversity Strategy Landscape is recognized as having an active part in spatial development:

"Spatial impact" or "regionally significance" in this context means that Community measures modify the spatial structure and potentials in the economy and society, thereby altering land use patterns and landscapes." (ELC 2000, p. 13).

The recognition of landscape as a policy issue was codified the European Landscape Convention, adopted on 20 October 2000 in Florence in co–operation with the Council of Europe. It became binding in 2007. The integration of the European Landscape Convention as a tool in territorial planning would become an important contribution to the planning process.

The border effect

Borders are almost synonymous with political, demographic and economic remoteness, the meeting place of different competences, structures, legal and social affairs and they also behave as functional and territorial discontinuities (ESPON, 2012).

Cooperation on territorial matters is in line with § 35 of the Territorial Agenda. The adoption of this principle recognises the importance of developing and supporting interregional, transnational and cross-border cooperation initiatives, aimed at actively promoting territorial integration. Territorial cooperation must consider the territorial and urban dimensions of economic and social development and include the EU neighbouring countries, specifically in the context of the EU Programmes for European Territorial Cooperation.

From the reading of the EU-LUPA maps there are very clear disparities between neighbouring countries, but also considerable differences between many neighbouring regions.

- The internal EU-15 borders are, from a structural point of view, still more favourable for cross-border governance than, for example, the external EU borders.
- The borders seem to continue functioning as a limit for the diffusion effects of development poles. This essentially indicates that, besides the European effort in promoting territorial cohesion, the national level maintains a prime role in regional development.
- The key drivers are different spatial planning cultures and traditions: For instance, for France *vis-à-vis* Spain, we know that large numbers of building, infrastructure development and agricultural changes have taken place in Spain while, apart from selected regions, in France land use has been very stable.

Similarly, we see marked differences in the volume of land change between the former East and West Germany since the fall of the Berlin Wall. With regard to territorial development and spatial planning, the systems of France and Spain are also quite different. From an institutional point of view, France has a much more centralized system, while Spain is much more focused on the Autonomous Communities. On the content side, France has traditionally focused on the comprehensive approach of *aménagement du territoire* whilst Spain is following, to some extent, a land use regulation approach without an excessive degree of regulation.

- Upper Rhine metropolitan region (France – Germany). The economic situation of the rural areas concerning agriculture is strong in comparison to other European regions and has a relatively solid added value. This is due to concentration on winery and arable crops. The average area used for agricultural purposes, however, is shrinking. The available data does not allow us to get insight into conflicts of land use. As a result of its topographical circumstances, agglomeration takes place in the plains of Rhine valley. Urban development and agriculture have to share the most valuable soil, so there are conflicts which cannot be described with the data.
- Øresund case study region. Strongly developed zone of summer houses along sea coast for many decades. Now landscape conflict with needs of wind power plant on the sea and spatial conflict about access to sea coast and recreation, which is a barrier for further enlargement of the residential zone intensification. Urban sprawl according to spatial plans (controlled by law). Transformation of regional industry and economy shining through in deceleration of high-tech economy and R&D sector activities connected with demands for a clean environment, improving conditions of work and spatial accessibility, lowering costs and decreasing role of agglomeration profits.
- Chełmsko-Zamojski region. It is located in the South-Eastern borderland of Poland in the Lubelskie Voivodeship, by the Ukrainian border. Both the geographical and the historical context have a significant impact on the current economic structure. Location of the region is one of the most important factors in determining its economic structure. On the one hand, it used to be a peripheral region for over two centuries, and in the industrialization period in the 19th century it constituted the borderlands of the Russian Empire. On the other hand, there are very favourable conditions for the development of agriculture in the region. Currently the region remains fully peripheral in the European Union and on a national scale, as it is located relatively far from Lublin, the core of the Lubelskie Voivodeship. On the other hand, there are three Polish-Ukrainian border crossing points and three main routes that run across the region. They are frequented mainly by vehicular traffic and form the main axis of development in the region. The lo-

cal cores of development are Chełm and Zamość. However, their influence on the surrounding rural areas is rather weak and has a rather narrow range. Considering the issue of the economic activation of the region, its location is a strong barrier for further development. This is reflected in insignificant foreign investment dynamics, tourism development etc.

- While many border regions used to be characterized by differences in land use due to the influence of differences in national land use policies, the Common Agricultural Policy has contributed to a withering of many of these differences and are instead in a process where differences in land use patterns tend to be much more reflecting of a combination of natural potential, settlement patterns and infrastructural characteristics, and less dependent on national policies. One localized example is the border between Denmark and Germany, previously marked and prominent. With the incentive of EU membership for Denmark, a marked intensification in cattle and milk production in the border region of Southern Jutland developed, while the land use south of the border continued to be characterized by extensive land use. Today the differences in land use characteristics have been considerably reduced. A large-scale example could be the aforementioned East-West divide in land use characteristics due to previous differences in economic systems. A general characteristic in this connection is the process of de-population and retracting/extensification of agricultural activities from mountainous and sparsely populated areas, and replacing it with tourism – often in combination with agriculture and other traditional land uses.
- In the effort to strengthen territorial cohesion, particular emphasis should be placed on the role of cities, local development and macro-regional strategies.

Thus, on the one hand, the visualization of these differences only reaffirms the importance of considering the implications of land use in the border regions when assessing the feasibility or appropriateness of policy. Tailored measures and policy instruments for specific locations or land-use types are needed All this should serve to build up an answer to the question, "How can these developments, e.g. through cooperation initiatives, be coordinated and create potential for development?".

6.2. Challenges in analyzing sustainability of land use trends

There are several challenges and questions that remain unresolved or in need of further explanation and rationalization.

Most policy targets are territorially blind

One of the difficulties in understanding the performance of European territories in relation to land use is that most of the policy targets do not have a direct

translation to land use. Even for polices that have a more direct relationship with the land (e.g. Biodiversity, CAP) there are no specific targets on percentage of land that should fulfil certain requirements. This is strongly related to the fact that Europe does not have any legal mandate on land planning. On the other hand, the relevance of cities and the phenomenon of sprawl have raized many concerns, and the recommendation to limit urban sprawl appears in many documents. Moreover, land reclamation is strongly promoted by different agencies, and even in the a potential threshold in soil sealing that is currently proposed in the EU2020 Strategy.

Furhtermore, as highlighted by the ESPON SIESTA Spatial Indicators for a "Europe 2020 Strategy" Territorial Analysis (ESPON, 2012a), the spatial dimension of the strategy is not obvious. Indeed, the report refers to scholars such as Böhme *et al.* (2011) and others who have recently stated that the spatial derivative of the EU2020 is territorially blind.

The methods developed by EU-LUPA are flexible enough to accept more detailed data whenever available. Despite the valuable data and concept assets provided by ESPON and Corine Land Cover, there are significant shortcomings associated with their use, which underline the importance of further analytical work leading to a deeper understanding of the phenomena at work.

Due to the ongoing changes in land use characteristics in Europe, however, important limitations in relation to identifying mono versus multi functionalities are apparent. In many cases the previous secondary activities have become dominant, for instance when aesthetic or recreational functions come to define what kind of land cover would be acceptable. Such considerations have become key questions in, for instance, the current discussions of how the future CAP should be structured.

There is a need for **more frequent data updates**. The use of Corine Land Cover 2010 and updated socioeconomic data at the administrative level would allow the identification of what has happened during the economic crisis. Much of the ESPON data comes from the late 1990s and early 2000s.

There is a need for **better resolution and further improvement of the data coverage on a regional scale**. One of the limitations in EU-LUPA is that the spatial coverage is not entirely consistent for each time series in Corine Land Cover. This prevents full European coverage of the typologies for the entire 1990-2006 time period.

There is obviously a **need for developing tools that would enable the inclusion of differences in relation to both intensity and diversity of the use of landscapes**. These tools and the findings they enable could later become an asset in regional development towards sustainability. Such tools – both quantitative (intensity) and qualitative (functionality) – are needed in order to, for instance, facilitate the analysis of questions relating to balances between landscape protection and social welfare combined with different types of economic development.

More research is needed to detect territories with complementary potentials, often neighbouring territories that can join forces and explore their comparative advantages together, creating additional development potential.

In fact, different regions have developed different data sets depending on their own geographical characteristics. Northern regions might require the analysis of some data that might not make sense for the Mediterranean countries, for example.

Further research with regard to the assessment of land use performance and land use efficiency would be needed, since the research undertaken in EU-LUPA has not provided the expected results.

In-depth analysis of urban phenomena is needed. A closer comparison to land changes resulting in new or maintained urban areas could be undertaken and compared with regional – or even municipal – population data. This could give interesting insight into places that are either maintaining or increasing their population (labour force) and what the implications are in terms of land take and urbanization.

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The following research paper documents the results of a three-year-long applied research project entitled European Land Use Patterns (EU-LUPA), which was carried out under the auspices of the European Observation Network for Territorial Development and Cohesion (ESPON) 2013 Programme. The project had a number of overarching goals. The first of these was the creation of a cohesive methodology for the analysis of land use in different regions of the Eu-ropean Union. The second was the production of knowledge and valuable information integrating the physical dimension with the socio-economic as well as with environmental protection – knowledge that would allow us to comprehend changing modern-day trends in land use, their dynamics and underlying conditions. The third goal was to identify the main problems and challenges in terms of land use in different territories and regions as well as to identify remediating steps and offer recommendations that would help us resolve these problems.

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