

## **Working Group 1.5**

# **LAND USE PRESSURE INDICATORS**

**Background Report**

**December 1999**

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# 1 INTRODUCTION

The Stockholm status report resulted in certain conclusions on the definition of indicators of land-use pressure. In the report that had been presented and discussed in Nijmegen, three proposed indicators were explained and discussed in more detail. The comments made during the discussion in Nijmegen resulted in the proposal to set up a questionnaire on land-use pressure indicators. The meeting in Rome had made clear that environmental pressures should also be included in this theme. This paper summarises the findings since Stockholm and highlights the main findings in studying the process of defining, selecting and presenting a useful set of indicators for Land-use pressure in Europe.

## Land-use Pressure: State of the Art

After starting activities to identify indicators of land-use pressure it became clear to us that not much effort had been made in the past to address land-use pressure in a coherent indicator research framework for Europe. The available examples of analytical studies on land-use pressure address mainly urbanisation issues, or refer to specific locations or thematic issues, which will require more attention (e.g. tourism in coastal areas, agricultural marginalization). Most actions address action on the sub-national or national scale. It became clear that land-use pressure is a topic that is gaining interest, depending on the urgency to diminish the negative consequences of the pressure.

### 1.1 The Importance of Land-use Pressure

Land-use structure is the outcome of a complex process of development in which private property, capital investment and policy interests are intermingled. This process is historically dependent and geographically differentiated, responding to the development of the division of tasks and responsibilities in each country and region. The current land-use structure also exerts pressure on local and distant resources and thereby on future land use.

Under the new conditions of economic globalisation, land-use restructuring and the pressures exerted upon it, is gaining importance worldwide. The two main reasons for this are:

- First, the increasing importance of sustainable growth and the environmental protection of natural and cultural assets, leading to new forms of regulation and planning of land use.
- Second, the need for complementarity and cohesion of sectoral policies, formulated and implemented at various geographical levels, with a decisive impact on the land-use structure and trends.

Despite differences in the role of public planning policies concerning land use in various countries, there has been a similar shift in the content and objectives of planning policies in the 1980s and 1990s. There has been a move away from comprehensive and regulatory policies towards the development of piecemeal, fragmented and selective forms of governance, directed to relaxation of public control, increasing diversification (new

institutional bodies), mobilisation of public–private partnership and introducing market-oriented changes into the planning system. These new forms of land-use policies have to balance between the new environmental guidelines and the pressures of property and investment interests at all geographical levels.

Urban–rural relationships play an important role in dynamics of land use. Resources from the countryside (in terms of both primary production and amenities) are crucial for all inhabitants, largely concentrated in towns and cities. Conflicts can be identified between natural and cultural assets on the one hand and agriculture on the other, while specialisation, intensification in agriculture as well as abandonment may conflict with amenity values of cultural landscapes. Last but not least, growing cities and urban sprawl may jeopardise the countryside.

### *1.1.1 Diversification in land use in the European territory*

European space reflects an heterogeneous constellation of different modes of development and of regulation, mainly at the national level. In most industrialised European countries, the development of land-use policy was part of a comprehensive public policy system during the post-war period. Land-use planning was developed to regulate changing land use, allocate resources and establish a balance between different kinds of development at local and regional levels. Indeed, land-use planning did not only assume the regulatory role of promoting, coordinating and stabilising investments, but also had a legitimising role, mediating conflicts (use, ownership and valorisation of property) and establishing bargaining processes to work towards a consensus.

Differences between the particular mode of socio-economic development in each country or region correspond to differences between land-use structure and planning policies. There is a major difference between the countries that have established coherent regulatory and institutional frameworks, setting the limits and preconditions for market mechanisms to operate, (e.g. Germany, United Kingdom) and the countries and regions (e.g. Greece, southern Europe) where land-use policy emerges ex-post, in a fragmented and incoherent manner in an attempt to regulate land-use conflicts requiring institutional control.

This fact is also manifest in the differences between zoning based on institutionalised land-use planning and monitoring mechanisms, on the one hand, and uncontrolled land use, determined through illegal market processes (parcelling, construction of squatter housing) or ad-hoc legal building permissions on the other. However, there are differences between land-use planning systems among most of the developed countries as well (e.g. between regulatory and mandatory land-use planning, and participatory flexible land-use policies).

Despite the heterogeneity of land-use policies, there is a common shift in the last decade in most European countries: new forms of land-use policies, based on the principles of efficiency, flexibility, cohesion and sustainability, are emerging.

The diversification of land-use structures in Europe's space concern: land and property, structure (private versus public, small owners versus large), intensive mixed-land uses

versus separated land-use zones, planning and institutionalised control instruments versus unregulated land development etc.

Despite these differences concerning the structure of land use and the land policy in each country, European social and economic integration demands the development of a common framework of basic indicators, reflecting the spatial differentiation and the pressures on changing land use.

### *1.1.2 Impacts of land use.*

Additional to the land-use pressure, where the conversion from one land-use type into another is analysed, this study will explicitly survey the local and distant impacts of current land use on future options of this use, concentrating on environmental issues.

During the meeting in Rome it was agreed to use these pressures.

The impact of current land use on the quality of the land is assumed to be a relevant indicator. Land is in this context broadly defined; it is not only restricted to soil and groundwater but also includes the deeper groundwater reservoirs. An example is the pollution of the groundwater in areas that are used rather intensively for agriculture and where high nutrient loads are applied. In such cases the suitability for crop production is not affected, but a secondary function of the land, the supply of good-quality groundwater, is endangered.

Another impact is the change in suitability of the land for certain applications. Besides being influenced by pollutants (e.g. nitrate in groundwater), the actual and potential land use is affected by environmental stresses due to activities that are not strictly the consequence of the land use itself (ozone, climate, acidification and eutrophication).

These stresses affect the characteristics and the quality of land and, subsequently, the actual and potential suitability of the land. It is because of the change in suitability of the land that environmental stresses are addressed in this context.

Both examples interfere with spatial planning and affect decisions in this field

### *1.1.3 Two purposes of the ESDP study on land-use pressure*

Though land-use policies are a matter for consideration at national, regional or local level, the study of a 'common framework of indicators' offers the basis for a comparative analysis and synthesis of the most relevant factors, illustrating the dynamics of the Spatial Organisation of European Territory.

The ESDP mentions several policy options that have to do, in one way or another, with land-use pressure and suggests, first, that European policy (or national policies based on common principles) could help regulate the pressures on land use. Second, the research should be aimed at determining whether or which *ambitions for policy on European level* are realistic, given the differences between the member states and the nature of the problems.

## **1.2 Central Concepts**

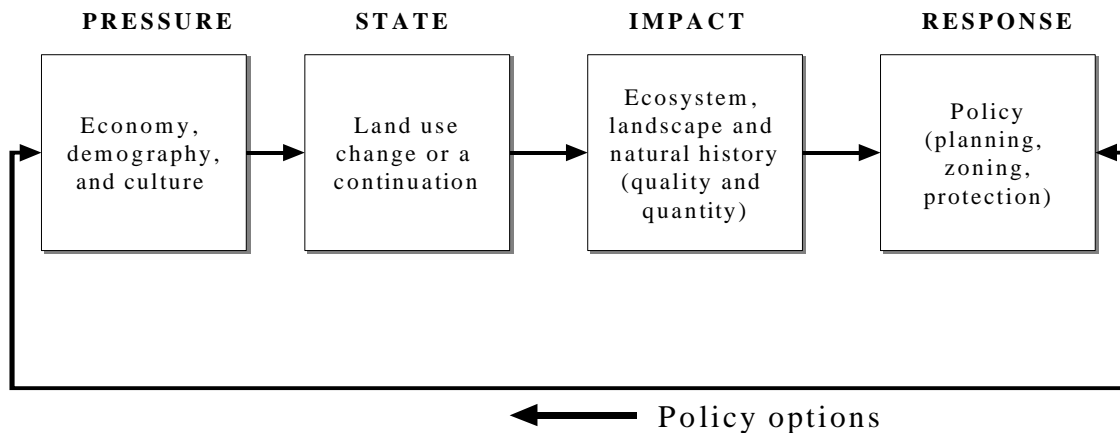
The discussion on indicators of land-use pressure needs an intellectual debate on the central concepts. Otherwise, a high or increasing level of land use (intensity) may too

easily be defined as a problematic ‘pressure’, without much attention to evaluative standards and disregarding problems of ‘underuse’. Aspects of economy and demography, motivating land use, should be balanced against ecology and culture, defining the sustainability of land use. If put in such a broad and realistic context, it would be no problem to then concentrate on impacts of land use on natural and cultural values. Spatial differentiation in intensity as well as promoting multiple use may be strategies of land-use planning. The existing causal linkages between pressures and policy (or in this concept land-use pressure and land-use planning) are illustrated in a pressure-state-impact-response chain (see Figure 1).

### 1.2.1 Land use

Land use can be broadly defined as human use of space in ecosystems: not only the use of soil, but also of minerals, water and air, of vegetation and wildlife, and of artefacts once constructed by men. It also includes emissions into soil, water and air, influencing both local and distant resources to be saved for future use. *Current use* includes the sheer presence of humans, their cattle and machines, and the activities and emissions

Figure 1: Pressure-State-Impact-Response chain



Performed or guided by humans during a certain period in time. Since many activities are bound to daily, weekly and seasonal patterns, current use is usually defined over a year. If annual cycles of activities are continued, more-or-less unchanged, in the same space over several years, we can call it *occupation*.

In practice, however, land use seems to be predominantly applied to the context of agriculture and forestry, concentrating on farmers working on their parcels of land, but influenced by and in turn influencing their surroundings. Special attention is often paid to

the sustainability of current yields in terms of water, nutrients, erosion, contaminants, food security etc.

### *1.2.2 Land cover*

Current use (e.g. crops) and especially occupation leave recognisable traces, mostly through clearing vegetation, moving soils, subtracting minerals and constructing artefacts. The pattern of such recognisable traces at ground surface we can call *land cover*. At any moment we can identify spatial patterns of recent land uses, varying with current use, occupation and land cover. Land cover alone may be an insufficient indicator, especially if defined in broad classes.

### *1.2.3 Levels of land use*

Levels of land use can be measured by a multitude of indicators: number of inhabitants, jobs, cattle, machines, visitors, etc.; length of roads, volume of buildings etc., if we include occupation. In order to make a multitude of indicators comparable, we must weigh them according to impacts on social values. Indicators of 'intensity' may be gross production or real estate prices for the economy, naturalness or biodiversity of ecosystems, continuity or revitalisation of culture.

### *1.2.4 Impacts of use*

Land use is defined as a 'dose' in terms of activities or depositions (incoming emissions) of any kind; it is a dose having some 'impact' on other actual or future land use, both on the spot and in the surroundings. In many cases, the impacts on the spot from construction (buildings, pavements etc.) and from activities by local people living and working there deserve a lot of attention. But in the wider context of environmental impacts, the spread across distance by transport through the air (wind), water (stream) and soil (erosion) deserves attention as well. Moreover, the transport of goods and people, as well as visits of people from other regions to vulnerable areas, include impacts from distant sources. The spread over distance is a spatial dimension of land-use over and above the location of sources and resources. In the case of tourism, the preference for short distances and the division over wider areas may be compensated by attractiveness of rather unique resources in areas farther away. For emissions, wind and rain, and streams and erosion determine speed, distance and direction of transport. Any specific land use has a different local and distant impact, depending on the vulnerability of resources. These impacts are evaluated differently, depending on the worth attributed to resources for present and future use. The worth of resources are primarily thought to be based on naturalness, history and scarcity. Thus, in order to analyse land-use pressure in terms of dose-impact relationships, we should consider all of these aspects

### *1.2.5 Single use vs. multiple use*

Some regions are dominated by a few types of land use. This may jeopardise stability of the ecosystem and landscape, and also make the region vulnerable to economic crises. Monoculture may be a major problem if it dominates large regions, but a lesser one if embedded in other land uses within short distances. Multiple use at strategic spots, both urban and rural, may strengthen the position of a whole region. There may be

underspecialisation as well, if potentials for specific products or services remain underdeveloped.

### *1.2.6 Land-use changes*

Cultural, ecological, economic and political processes (and demographic consequences in birth, death and migration rates) cause changes in land use, both current and occupational.

There has been a general *intensification* of land use but with spatial differentiation: intensification of agriculture in rural areas with favourable soils, a concentration in mining and industrial regions, a growth in large and medium-sized cities. In remote and disadvantaged regions, however, there have been tendencies for gross extensification, up to abandonment of agricultural land, business and houses, combined with depopulation. In some old mining and industrial regions, there are also signs of decline. Within urbanised regions, there has been some 'urban sprawl' from central cities to suburban fringes.

There has also been a general *specialisation* of land use. Traffic concentrates along routes and trade in nodes of routes where urbanisation had its starting points. Mining was restricted in areas with mineral deposits, and especially surface mining replaced old forms of land use. Housing and industrial areas also replaced rural land use. In rural areas, food processing was split off from farms and concentrated in villages or even in towns further away. In agriculture, there has been a trend to specialised crops and cattle.

Actually, we need models to forecast land-use development, including expected changes in the speed and direction of processes.

### *Over- and underuse, over- and underspecialisation*

Spatial concentration and specialisation of land use, and especially changes in such patterns, pose questions about preferable patterns of land use. The discussion concentrates on related differences in income levels and migration flows, as well as on consequences for the environment, nature and landscape. Spatial policy needs standards to evaluate what processes of land-use change or continuation should be influenced rather than accepted. Desired and undesired land-use changes should be identified, and both further intensification (pressure) and extensification (lack of pressure) can be undesired; the same applies to further specialisation (monocultures) and trends towards multiple use.

### *1.2.7 Land-use planning*

Land use is primarily determined by private actors who own or rent land. But it is also influenced by public ownership, legal regulations in the real estate market and on special products, including quotas, subsidies and tax levies by permits to households and enterprises for specific activities in specific zones.

High intensity and a broad spectrum of land use have invoked active planning by public authorities, especially in highly developed countries. Overcoming underuse and coping with rapid changes are also motives for active planning in countries showing economic

growth as well. Regional programmes of the EU are needed to promote a balanced and sustainable development among member states, adding to national and regional programmes. Can indicators show the need for specific programmes and show their effectiveness and efficiency?

From this point of view, it would be worthwhile to study the European interest in a zoning of land use. We are thinking of a trans-European Network of protected nature areas and multiple-use landscapes, including revitalisation of agricultural areas with extensive use or even abandonment. Such a network could compensate for environmental losses in nearby regions with intensifying and specialising trends of use. Moreover, we could concentrate on a specific resource like water, which is showing overuse and misuse on a continental scale, jeopardising sustainability by regional shortages, temporal peak flows and pollution.

#### *1.2.8 'Land-use Pressure'*

It is obvious that at the conceptual and application level the items of land-use pressure indicators must be analysed in co-ordination with the subject 'Spatial Integration' and especially 'Natural assets' and 'Cultural assets'. But besides some overlapping, the leading difference is the composite dynamic aspect of land-use pressure indicators versus the static aspect of the others.

Considering the Models of European spatial organisation, the first methodological problem that has to be dealt with is the definition of land-use pressure, initiated from the dynamic interaction of human activities as is discussed above.

To summarise, we define the concept of land-use pressure as the dynamic aspect of direct changes occurred in land-use patterns, and the indirect effects induced by these changes. Although land use describes the land surface from the social perspective and is characterised by some identifiable purpose(s) leading to tangible or intangible products or benefits, the categorisation of land use and land cover is not sufficient to evaluate the pressure on specific land uses. After all, pressure is a result of some kind of human activity on the land. The most appropriate method to recognise and capture the process of this activity is to identify the patterns of the processes that cause land-use pressure. The main source of pressure is human activity, requiring more space, a more intensive use of space, or requiring another type of use. For example, economic, urban, tourism and agricultural processes can cause land-use pressure. Even ecology can cause land-use pressure, if the spatial policy accepts ecology as an expanding form of land use.

## 2 INDICATOR SELECTION AND DEVELOPMENT

### 2.1 Introduction

The measurement of indicators of land-use pressure is not obvious. Equal pressure from human activity can result in different pressure on land. For example, a pressure indicator of the average built-up area per person shows great differences between countries, highlighting the crucial importance of land management policies.

At the operational level to identify patterns we used criteria such as availability, accessibility and quality of data on the one hand and the nature and value of land-use pressure analysis of the available information itself in the other hand. The data need to support and reflect land-use pressure, both in terms of time and space. Besides, the available information should have a level of detail that is adequate for the pressure that is the subject of analysis.

The confrontation of land use on the one hand and processes that cause pressure on the other (possibly in a GIS) can give us a picture of the nature of the problems on a European scale. Similarities as well as differences will emerge between the spatial situations in European regions to provide important information on the possibilities for intervention at European level, or for national interventions with common targets or instruments. European member states must then be able to settle on an adequate *plan* for co-operation on this theme.

We adopted the following arguments as research goals on land-use pressure:

- 1a Identify the driving forces (population changes, change in GDP, etc.) that influence land use in source locations
- 1b Identify the use that directly causes land-use pressure (intensity of construction, activities, depositions etc.) on resource locations
- 2 Identify the relevant forms of land use in terms of vulnerability and worth of resources
- 3 Confront the pressure (1b) with the land-use resources (2) to identify the spatial structures under which these processes occur
- 4 Analyse these areas of sources (1a) and resources (1b and 2) and interpret the results
- 5 Use the results as the basis for further recommendations possible for policy targets and instruments on a European or national level

The confrontation (3) is the crucial step and other aspects will be elaborated to realise that. We are concentrating first on current levels and will proceed to changes in recent periods and then develop prognoses for the future. Further, we will start with crude indicators from available data and gradually refine them. Moreover, we will start with the most relevant scale and then generalise to NUTS 2 to fit into the general pattern of the whole ESPESP study.

The main valuable sources of information, disposable to the whole of Europe, for realising the goals of the research are the Geographical Data Base (GISCO), the regional Data Base

(REGIO), the CORINE land cover database, EUROSTAT Land Use Statistics and Meeuws' European Landscapes. In the process of developing indicators for land-use pressure, the categorisation and availability of data on land use and land cover is an important aspect. The more technical aspects of land use/cover are explained in Appendix 1. The most valuable and often vulnerable resources are found in natural and semi-natural areas, including forests, wetlands and open waters, especially vulnerable for potential users and for depositions of pollution. Natural and cultural assets in the agricultural landscapes are especially vulnerable to shifts in agricultural use and to urbanisation. The value of agricultural areas as amenities varies according to history and scarcity of cultural landscapes. The reports about Natural Assets and Cultural Assets should provide further information on that. We concentrate on amenity values in this phase, but bear in mind that future productive and consumptive use is also at stake.

## **2.2 Indicator Selection**

The above methodology was applied to the following set of indicators. In the first final report on land-use indicators, I, II and IV were discussed. Indicator III was added at a later stage.

The first set encompasses a set of indicators for local land use:

- I Indicator of Agricultural Intensification (Ia) and an Indicator of Agricultural Abandonment (Ib)
- II Indicator of Land-use Pressure due to Urban Expansion

The second set encompasses a set of indicators of potential pressure

- III Pollution indicators: drinking water pollution
- IV Price of land

The selection of these indicators was not done through a systematic analysis of predefined criteria. The conceptualisation of the issue and the drafting of a first indicator for European-wide application got more attention than the criteria for selection. The selection for the first indicator was strongly based on experience with the pressure and its impact on land use, the local/regional and national importance, and the accessibility and availability of data. To find out whether the first selection would be useful for other member states, a questionnaire was distributed requesting their comments on the selected indicators and suggestions for other indicators on land-use pressure (see Appendix 5).

### 3 PRESENTATION OF SELECTED INDICATORS

#### 3.1 Selected indicators of local land use

##### I *Indicators of Agricultural Development: Intensification and abandonment*

In examining land-use pressure affecting non-urban areas, one of the most relevant dimensions is the changes in land use caused by the rural development processes themselves. Six different processes can be distinguished:

- Agricultural industrialisation
- Spatial concentration of the agricultural system
- Increase of scale
- Extensification and new economic carriers
- Extensification and pluriform activity
- Marginalisation

In terms of land-use pressure all these pressures have to be in confrontation with natural resources, conservation of landscapes and protection of most of the important ecosystems. The reports propose a number of indicators and compiled maps based on information that is not largely accessible, like land prices, soil suitability for different types of agriculture production, intensity of production measured in European Size Units, etc.

It is obvious that the availability of all that information on a GIS system for all the EU countries and on a regular basis of time periods is not realistic. We analyzed only two indicators: one that deals with agricultural intensification and the other with agricultural abandonment or marginalisation

##### Ia *Indicator of Agricultural Intensification*

The composite indicator is mapped with six pressure values (high pressure, important pressure, eventual presence of pressure, neutral pressure and negative pressure) and one class showing incomplete data availability (see MAP Ia). The input data are from EUROSTAT and CORINE (agriculture area, urban agglomerations, forest and protected areas). For a technical explanation is referred to Appendix 2.

To compose the indicator the following data have been used:

- Percentage growth in agricultural accounts for the period 1989-1996
- Percentage of agricultural holding (>50%)
- Percentage of land use (agriculture + permanent crops + arable land) / total area
- Percentage of land use (vineyard + olive plantation) / total area

For the interpretation of the results on the map it is important to analyse the structure of agricultural sectors per country and region. Nevertheless, we can observe the delineation of Mediterranean areas and the coastal zones. These results can be challenged with the land-use codification in order to detect areas with potential conflicts.

Remark: A set of indicators showing trends in major land uses has been recently published by EUROSTAT (Statistics in focus: Agriculture, 1998). The information

provided by the indicator corresponds well with the last two indicators that were used to compose the indicator for agricultural intensification. EUROSTAT shows two sets indicators: one on the evolution of the Utilised Agricultural Area as a percentage of the total surface, and one on the growth of specific land-use types as a percentage of the total growth. Besides, the EUROSTAT statistics clearly indicate the difference in data availability amongst the EU countries.

Questionnaire comments

*This indicator is of great significance for dealing with issues of agricultural land use in several countries (Germany, Spain, France, Luxembourg, the Netherlands), whereas in others (Sweden, Austria) the indicator is valued as an indicator of little interest or the approach requires an application for other land uses (forestry in Finland).*

*Observation: Spain made a remark that indicators on agricultural performances in the southern European countries should sufficiently consider the technology that is applied. Especially in the Mediterranean area it is fundamental to make the differentiation between irrigated and dry areas, and between areas irrigated with surface and underground waters. In France this indicator is used by different agricultural administrations. In France the indices used are based on temporal changes in production and productivity, or specific inputs (e.g. use of chemical fertiliser).*

*Denmark suggests using agricultural yields and other economic inputs. The use of ratios (agricultural land versus total) is not meaningful in Denmark because the process of expansion stopped there long ago. It is suggested to consider not only the changes but also the absolute levels. Denmark proposed considering the agricultural specialisation more than intensification. Denmark made an observation from an economic point of view, which suggested using a measure of the regional demographic and economic current state and potentials as a result of the rationalisation of agriculture (see table 1). Therefore what is needed is the extent to which there is a surplus population in rural regions, and the knowledge if the rural regions are prosperous or marginal. Denmark proposes an indicator of land-use pressure caused by the rationalisation of agriculture, e.g. a measure of the population per ha occupied within the agricultural sector and their earnings.*

<b>Indicators for agricultural intensification</b>	<b>Earnings</b>	
<i>Occupation within agricultural sector pr HA</i>	<i>LOW</i>	<i>HIGH</i>
<i>LOW</i>	<i>Insufficient marginal and non-competitive farms Land-use pressure: low</i>	<i>Highly productive farms (economy of scale) Land-use pressure: high</i>
<i>HIGH</i>	<i>Potentials for specialisation or rationalisation Land-use pressure: low</i>	<i>Highly specialised farming (e.g own brand [=eigen merk?]-production) Land-use pressure: medium</i>

*Table 1: Indicator scheme proposed by Denmark.*

*Belgium suggests constructing an indicator on intensification based on three objectives: 1) historical development of agriculture (rather detailed level, using agricultural statistics – yields, areas, number of animals, productivity, land price, labour input. 2) impact of intensification on the environment (animals and inputs per ha). 3) economic figures on inputs, equipment, investments and services, expressed in monetary as well as employment terms. Belgium suggests using ‘agriculture value added’ as indicator for intensification.*

*In Finland forest is the most important form of land use. The currently proposed indicators do not take into account the effects of forestry as a pressure. Forestry does cause pressure to original ecosystems and biodiversity (e.g. more roads causing fragmentation, type of forest management) and has effect on other land uses (e.g. agriculture). In Finland initiatives are undertaken to take above pressures into account in the methods of forestry (e.g. implementing certificates).*

#### **Ib      *Indicator of Agricultural Abandonment***

The composite indicator is mapped with two values (important decline, decline) in combination with the existence of holdings. The input data are from EUROSTAT

The following data have been used to compose the indicator:

- % of decline of agricultural accounts for the period 1989-1996
- Non-presence of agricultural holdings (NUTS3)
- % of decline of population density
- Outside buffer of 50 km for urban settlements

The results of the GIS-based composite indicator of land abandonment for Europe are presented on a map (Map Ib)

The applied method is similar with that of the previous indicator. However, the variable of per cent decline of population density was ignored, giving the very important number of regions with missed values. In the same time, the initially proposed distance of 50 km from the settlements was diminished because it was too restrictive. After the evaluation we can once more observe on the map that the Mediterranean countries with a negative intensification pressure correspond with the results of the previous indicator.

#### **Questionnaire comments**

*According to Germany this indicator is of great significance for dealing with issues of land use. In Spain too, the indicator is certainly of use in measuring marginality and spatial trends, and suitable to represent the process of change and the ‘crisis’ of given spaces. In Finland this indicator is relevant, especially when concerning the services and distances. In some countries the process of land abandonment does not seem important (Belgium, Austria, Denmark, the Netherlands) this indicator is not very relevant, as abandonment of land does not occur.*

*Observation: Spain suggested indicating the typology of crops which are abandoned and the new uses of land (ecological, forestry, extensive cattle breeding, etc.), and the causes*

*explaining land abandonment processes. France suggests using CORINE Land Cover to show land abandonment. Belgium suggests constructing an indicator, for example, by using the ratio of used versus total agricultural area, the number of exploitations in relation to total population and forested areas versus total agricultural area. Denmark suggests not representing the abandonment as discussed here. They propose an alternative indicator that represents the 'controlled abandonment' of agricultural land into forestry, meadows and energy crops. Denmark valued this alternative indicator as highly relevant. The comments from Finland and Luxembourg are in line with the Danish observation.*

## II *Indicator of Land-use Pressure due to urban expansion*

One of the most important forms of land-use pressure is urbanisation. Europe has become highly urbanised in recent decades. In the eighties some 80% of the West European population lived in urban areas. This trend is found in all member states, although the stage of urbanisation differs from one region to another. The southern European countries are still (to some extent) in the industrialisation and urbanisation phase. Post-industrial cities have grown in southeast England, southern Germany, northern Italy and the south of France, whereas cities in northwest Europe are dominated by a high-grade service economy (Kunzman and Wegener, 1991). In this context human settlement presents drastic changes to patterns of distribution and concentration, not to mention the expansion of infrastructure.

Although the vast majority of Europeans live in urban environments, there has been a remarkable tendency since the 50s for dispersal and sprawling of urban settlements. This has been translated into lower urban population densities, higher requirements for infrastructure, and the permanent conversion of land from other uses to built-up areas.

In the EEA report on Land-use and Land Cover Changes, an indicator illustrating this purpose is the percentage of built-up area by major watersheds in Europe. The relevant information on this indicator is susceptible to forms of criticism. First, the arbitrary choice of territorial units has a tendency to produce a biased result related to spatial discontinuities (Grasland, 1999). Second, the dynamics induced by the spatial proximity of settlements and the economic growth of the areas is not considered.

The proposed indicator combines the evaluation of indicators concerning urbanisation with variables that express the dynamics of economic expansion of each area. The structure of settlement system should also include its spatial pattern as well as the typology of the spatially neighbouring non-urban areas, which tend to be negatively affected by the dispersal and sprawling of urban settlements. In order to obtain more interpretable and meaningful results, the inferential presumed spatial interaction of human activities (evaluated from the presence of urban agglomerations, transport network and GDP growth) are referenced in the land cover information.

Taking into consideration the geographic data and information mentioned, we selected the following variables:

- % variation of Gross Domestic Product from 1989-1996 at NUTS level.

- CORINE grid coverage with a resolution of 250 x 250 m can illustrate completely the urban areas and the spatial distribution of settlements. The road network has been added to that zone area and integrated in the same raster.
- Non-urban space categorisation is based on the 21 European landscape categories (Meeuws, 1998). These perform a compound illustration of structure of rural activities.

The combined indicator on land-use pressure due to urbanization makes obvious the potential urbanization pressure on ecological and economic-sensitive areas using a weight coefficient. To formulate spatial interactions the spatial neighborhood potential is used. Map IIa, b, c, and d show the results of the GIS-based composite indicator of land-use pressure caused by urbanization in Europe. Each of them referring to a certain land cover

This indicator allocates a higher value to each cell (1 x 1 km) of European space, which is even higher in the proximity of diffused settlements, a higher increase in GDP in this area and a dense transport network

After the calculation and according to the distribution of values, we have considered three classes (low, medium and height) that as sum we arbitrarily decide to call *low, medium and high diffusion probability*. For example, a pattern of diffused settlements with a dense network will demonstrate much higher diffusion probability rates of human activity than of a compact isolated urban space. For more information is referred to Appendix 3.

It is obvious that the results provide a first alarm signal, and the expert must evaluate each case with additional, more complex, information considering that the space reflects a heterogeneous constellation of different modes of development and regulation.

None the less, on the resultant map, we can observe that in the proximity of monocentric and compact metropolitan agglomerations we obtain low values, while in normally distributed settlements and polycentric structures we obtain high values. We must remark that in the case of values missed we obtain low values for the indicator (as is the case in the UK).

It is relevant for further interpretation to compare the results with other significant information like the map of European Landscapes or the map of land-use, in order to detect sensitive or critical regions.

#### Questionnaire comments:

*The proposed indicator is assumed to be suitable for identifying those regions or subregions in which increased settlement pressure can be expected in the medium to long term. It is regarded as a meaningful addition to the status-quo oriented indicators. In Austria, Belgium, Finland and Sweden the proposed indicator is or might be useful. In Denmark the indicator seems less valuable at the national level because the pressure from urban expansion is marginal to the transition of land-use patterns caused by environmental programmes (forestry, extension of meadows). At local and regional level it may support the identification of urban pressures (planned new locations of industrial sites along highways and urban expansion, and 'hidden urbanisation' in metropolitan regions).*

*Observation: Germany observed that comparative analysis of economic development and land-use-dynamics did not reveal any significant correlation. From this was concluded that knowledge of the demographic and economic development of a region may allow initial pronouncements to be made concerning future settlement growth in that region but that such pronouncements are not conclusive. Alternative: systematic observation of planning activities at all scales, but above all, the local level. Such observations are done in the Federal Republic every four years, and is known under the heading of 'type of intended use'. A more straightforward approach is to estimate future area utilisation requirements. In the Netherlands comparable indicators are used for the scenario-based analysis of future urban demands and other land demands. The use indicators give a reflection of the spatial interaction between living and work, living and recreation, and agriculture and nature. This approach is to a certain extent scale-independent. The suggested indicator covers the main processes in Belgium: sub-urbanisation, shift of production and services from the centre to the periphery, and diversification of activities in the rural zones. Additionally, Belgium mentions considering the change in price of land and estate as an indicator of urban pressure.*

### **3.2 Selected indicators of potential pressure**

#### **III Indicator of pollution**

##### **III Land-use pressure and drinking water quality**

Additional to the land-use pressure, where the conversion from one land-use type to another is addressed, the impact of the land use on the quality of the land is also a relevant indicator, which fits well within the earlier discussed concept of land-use pressure indicators. A clear example is the pollution of the groundwater in areas used for intensive agriculture.

To assess the impact of land use on the quality of groundwater we used an expert model for water abstraction and pollution (Beusen, 1999). The model is a one-layer GIS-based model, which is designed to calculate the nitrogen and phosphorus concentration and load in surface water, groundwater and coastal seas. For more details is referred to the background report. Nitrogen at land surface is transformed into nitrate loads of the groundwater underneath, which are then transported to the surface water. As an indicator for pollution of groundwater we use the nitrogen concentration in deeper groundwater. The load of nitrogen compounds on land surface consists of fertiliser, manure and atmospheric deposition (diffuse) and from all human activities (point source), apart from agriculture, have been derived from the number of inhabitants multiplied by an equivalent load per person, reduced for waste water treatment and treatment efficiency.

The difference in concentration is presented in 6 classes, ranging from 0 to about 6 mg NO<sub>3</sub>-N/ltr (see Map IIIa). A qualitative valuation, which is required for further application of this indicator, is not executed within the current framework

##### **General comments (not strictly directed towards the above indicator) :**

*The inclusion of further environmental and ecological indicators in spatial planning makes sense (Finland, Belgium the Netherlands, Germany), They noticed that an approach towards that direction is underway, is beginning to be integrated in policy, or*

*is already established for specific themes. In Finland several of such indicators are tested for potential application in spatial planning (biodiversity, forest features). According to the Swedish comment the increasing interest should not be described as land use pressure. In their view the land use pressure is driven by the growing demands for built-up areas and not the existing green areas.*

*Observation: Instead of being the pollutant (e.g. nitrate in groundwater), the actual and potential land use is affected as well by environmental stresses due to activities that are not strictly the consequence of the land use itself (ozone, climate, acidification and eutrophication). These stresses affect the characteristics and the quality of land and subsequently the actual and potential suitability of the land and its use. To assess the impact of multiple environmental stresses on land use, frameworks have been developed that enables the description of the status of land (past, present and future) and establish relationships with various socio-economic and environmental developments in an integrated, policy-oriented manner. In future work on the relation between land use and potential pollution such analysis might be considered as integrated part of the planning and zoning (see Appendix 4). Based on the experience in Belgium with setting up a ecological network (NATURA 2000) the remark was made to integrate the environmental dimension in a set of indicators to the extent that it is likely to facilitate the arbitrages associated with conflicts in land use.*

#### IV *Indicator of Land Prices*

The price of land reflects the actual economic value of current and potential land use. On the open market it is determined by the suitability of the land for current use, for instance, agricultural production or forestry. It will rise, however, if the land becomes more suitable for more intensive uses like industry or housing. Only if the current use is submarginal, will the land price become low enough to allow change into less intensive uses like nature conservation. So, in addition to long-term price levels, we need information about recent changes in order to predict the chances for autonomous land-use change.

On a semi-open market, as in most EU member states, product-oriented regulations like agricultural guarantee prices or land-oriented income allowances the economic profitability or marginality of current use is influenced. Moreover, land-use zoning for urbanisation may prevent price increase for land otherwise suitable for industry or housing, though planning uncertainty may cause land speculations. Finally, authorities decide on land-use changes in favour of public goods like natural and cultural assets, which cannot be sufficiently regulated by the free market. In a way, such impacts make land prices not only an indicator of free-market processes but also an indicator of recent and current policies.

Land prices may influence authorities to buy land for such use at specific spots. This may go to the point that authorities may be either hampered or provoked to buy land. For this

reason too, changes in land-use prices are very relevant for land-use planning. An illustration of this indicator is not available

Questionnaire comments:

*Greece evaluated the indicator to be of incontestable importance. For Spain the suggested indicator is certainly relevant to measure pressure on the land use. In Denmark land prices are relevant indicators of hidden urbanisation in the metropolitan regions and also as indicators of shortage of land in highly specialised agricultural regions (pig farming). Belgium assessed the indicator as representative for land-use pressure in rural areas. The impact of urbanisation is well reflected in the prices of land. In the Netherlands land prices are good indicators of pressure. The weak point is the unanswered question about what is behind the value and/or the changes. In the Netherlands specific legal regulations (often based on EU directives) also affect the value (e.g. slurry rights, and milk quota).*

*Observation: Spain observed the importance of taking into account that the price of land is affected by various factors: agrarian economy, space functionality, urban planning, protection measure, and that in the rural areas there are also psychological factors affecting land markets, particularly in areas with small estates. The Belgium and France comment is in line with Spain's contribution. France assessed the indicator as very critical. Additionally the impact of the policy inside each territorial division was mentioned. France made the observation that the differences from country to country may be rather large. In the Netherlands zoning plans have a strong impact on the land-use type that is allowed. Changes in zoning plans, a strong instrument in spatial planning, strongly affect the price of land. In the Netherlands forecast are made of the price of land in the rural areas.*

## 4 RESULTS AND AREAS OF POSSIBLE POLICY IMPLICATIONS

The development of indicators of Land-use Pressure for Europe is a challenging but complex task. The past, current and future developments in demography, socio-economics and technology did affect and will continue to affect the changes in land use and land cover, either through intensification, extensification, or through significant shifts in land use.

The questionnaire comments show that the 'Land-use Pressure' as a topic does receive serious attention in most countries or is recognised as an issue that requires more attention in spatial planning. The comments suggest that the level of interest depends on the specific geographical/physical and socio-demographic situation on the various scales, from local to national. Some specific aspects of the proposed indicators are discussed below:

### I *Indicators of Agricultural Development: Intensification and abandonment*

The presented results seem to be in line with existing knowledge on agricultural intensification. The results for land abandonment seem to be less valid, which is the result of lacking data. Both proposed indicators present the recent development in agriculture from a rather high level of aggregation. Such a level is limited, as it does not really correspond with existing geo-fysiographic boundaries. Besides, both indicators are strongly based on economic and demographic characteristics, whereas other aspects related to sociological and cultural aspects need attention as well (e.g. services). The indicator selection, the used data and the followed approach are certainly not free of criticism. Further research and analysis is necessary. Especially, the research that has been executed by IEEP/LEI (1996) in the field of marginalisation should require more attention within this context.

The policy implication of such indicators might be quite significant. It may be relevant to test whether the indicator is sensitive enough to detect rather early the signals of intensification, but especially of marginalisation and abandonment of land.

### II *Indicator of Land-use Pressure due to urban expansion*

We can observe, at first glance, a number of administrative areas with high values on all maps. This is the case for Ireland, Greece, the west coasts of France, the east coasts of Spain and sum of areas in central to north Europe (Germany, the Netherlands). The more important reason is the growth of GDP coupled with the presence of a relatively important infrastructure. Considering the results for each of the three land-use/cover categories we can suggest a number of working premises. The presence of semi-natural areas on the coastal areas, with a number of activities such as intensive cultivation or tourism, can explain the high values observed on Greece, Spain and France. A remarkable deviation that needs to be analysed, is the case of Italy. On the other hand, for the natural areas (forests), a kernel is demarcated in central Europe. The only important exception is the west French coasts on the frontier with the Spain. The case of surface waters and wetlands is simpler. The geographical position of rivers outlets and estuaries, water bodies such as lakes and wetlands, can be recognised and in conjunction with the economic activities can be proposed for further analysis and policy measures.

The policy implication of this indicator is high in those areas where urbanisation or related phenomena do occur. Urbanised regions in Europe have much in common, but there are differences as well. A rather uniform indicator will tackle the common characteristics, but less the differences. Therefore efforts should be undertaken to develop indicator sets for city development, preferable in combination with forecasting, while considering the specific characteristics of the region, both geographical and sociological and cultural.

### III *Indicator of pollution*

The indicator presented here reflects the consequences of the land-use pressure, in particular the intensive agricultural land uses, on the quality by means of the N concentration in the deeper groundwater. The result shows that the nitrogen concentrations in the deeper groundwater in regions with intensive agriculture are the highest of the Netherlands, Belgium, Luxembourg, Denmark, Germany, and France. In other parts of Europe these levels are very low and are assumed not to be a threat to the drinking water quality, except for cases.

Policy implication: groundwater in Europe is the major source of drinking water, and therefore its quality is of great concern. In urban areas the need for enough water of good quality is steadily increasing. Not seldom this implies that certain land use(s) are becoming restricted or forbidden. In spatial planning these aspects require more and more attention, and following the comments and observations these aspects should be an integrated part of spatial planning.

### IV *Indicator of Land Prices*

Whether the price of land is a valuable indicator in the context of this framework is not yet certain. However, the indicator has certain qualities that might not be neglected. The availability and accessibility of the data depends on the juridical constructions and institutional structure and varies by country. In cases where data are available the price itself is the ultimate reflection of the current pressure.

Policy implications In the context of spatial planning and development of indicator sets the land price might be an type of early warning indicator for increasing pressure on land.

## 5 RECOMMENDATIONS FOR FUTURE WORK

The first promising steps have been made, but lots of work still has to be done. Both in the field of data collection and data harmonisation on the one hand, and knowledge of the causal links between the drivers of land-use pressure on the other hand, and the development of indicators to support spatial planning policy.

### Scale and land use pressure:

From the questionnaire response and discussions on land-use pressure it becomes clear that there is a strong link between the issue/problem occurring and the scale at which the issue is studied (local, regional, national, supra-national/European). Whether in a region or country, the various levels are linked (regional or national framework for spatial planning) seems to depend on the importance of the problems and on the efforts that are made to reduce the negative consequences of the land-use pressure. Linkage between different levels of scale, with the aim of analysing the land-use pressure issue in a more aggregated way, is rarely takes places. In the current context most of the indicators address the provincial level, whereas most spatial planning problems and their solutions are occurring at local level. In future work the scale needs more attention since some issues are bound to a specific location whereas others have impact on larger regions. In this context also the use of GIS based information system versus polygon information systems requires attention both at scientific level as well as the political level.

### Heterogeneity and homogeneity in land use pressure throughout Europe:

The various examples of land-use pressure throughout Europe do show on the one hand common land use pressures (e.g. urbanisation, intensification) but on the other hand very country specific land use pressures (e.g. forestry in Finland, tourism in southern Europe). Much depends on its specific economic, demographic situation, the geographical/climatic conditions and juridical and policy directives in the field of spatial planning. A general indicator set will never be adequate enough to cover the needs of the individual regions and countries and therefore if applied at European level, not include specific land use pressures. These differences affect the national priority setting regarding indicator development, data collection and monitoring. It is likely that the priority will be based mainly on the seriousness of the, often local/regional, pressure and the consequences of the pressure for the economy, ecology/environment and health. It is recommended to consider the regional/national priorities and support these indicators as part of the overall framework.

### Forecasting of land use pressure:

The discussed indicators use historical data, while spatial planning is oriented towards the future. So far, the use of modelling tools and scenarios for forecasting is briefly mentioned. It is very likely that in the near future the use of local to national spatial planning tools, as part of a framework of expert modelling (agricultural development, urbanisation, industrial development, tourism etc.) will be more accepted and become part of the forecasting activities executed by planning agencies or on behalf of planning agencies. It is recommended to consider the use of indicators within activities (e.g. GIS based modelling) which goal is to make future outlooks.

### Presented/proposed indicators:

The results of the indicators presented in this paper are preliminary results that have been developed given the current timeframe and facilities. In all cases these do require further research and analysis, both regarding the used data as well as the relationships between the pressures and their impact. The data and data availability will be discussed in more details in the background report. This issue requires more attention, since it is proven that still a lot of data are lacking or not detailed enough, especially GIS based data. An issue that requires attention is the aggregation of GIS based information and modelling results to the NUTS3 or NUTS2 levels. In fact, such an aggregation causes the loss of valuable information, while such information is very adequate at the planning level (e.g. urban pressure is lost if aggregated at a too high level).

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## **LIST OF MAPS**

- Map Ia: Agricultural Intensification Indicator.
- Map Ib: Agricultural Abandonment Indicator.
- Map IIa: Land-use Pressure due to urbanisation and economic growth.
- Map IIb: Land-use Pressure due to urbanisation and economic growth (impact on semi-natural areas).
- Map IIc: Land-use Pressure due to urbanisation and economic growth (impact on natural-area forests).
- Map IId: Land-use Pressure due to urbanisation and economic growth (impact on wetlands and water surfaces).
- Map III: Land use pressure due to nitrogen in deeper groundwater (based on modelling)

Map Ia: Agricultural Intensification Indicator.

Map Ib: Agricultural Abandonment Indicator.

Map IIa: Land-use Pressure due to urbanisation and economic growth.

MapIIb: Land-use Pressure due to urbanisation and economic growth (impact on semi natural areas).

Map IIc: Land-use Pressure due to urbanisation and economic growth (impact on natural-area forests).

Map II: Land-use Pressure due to urbanisation and economic growth (impact on wetlands and water surfaces).

Map III: Land use pressure due to nitrogen in deeper groundwater (based on modelling)

## APPENDIX 1

### *Categorisation of Land-use and Land-cover*

Taking into consideration the need to view the categorisation of land cover in the European Land thoroughly, the most accessible solution is CORINE land cover nomenclature, which may be used on two levels accordingly to the analysis scale (see Table 1). Level 1 (5 categories) can be used for the spatial analysis levels NUTS 1 and NUTS 2, whereas Level 2 (15 categories) is used for the spatial analysis levels NUTS 2 as well as NUTS 3. Our personal estimation is that LEVEL 3 (43 categories) should be avoided because it is too analytical and does not provide additional information.

*Table A1: CORINE land cover nomenclatures*

LEVEL 1 ( scale 3,000,000)		LEVEL 2 ( scale 100,000 – 500,000 )	
1	Artificial surfaces	1.1	Urban fabric
		1.2	Industrial commercial and transport units
		1.3	Mine, dump and construction sites
		1.4	Artificial non-agricultural vegetation areas
2	Agricultural areas	2.1	Arable land
		2.2	Permanent crops
		2.3	Pastures
		2.4	Heterogeneous agricultural areas
3	Forests and semi-natural areas	3.1	Forests
		3.2	Shrub and/or herbaceous vegetation associations
		3.3	Open spaces with little or no vegetation
4	Wetlands	4.1	Inland wetlands
		4.2	Coastal wetlands
5	Water bodies	5.1	Inland waters
		5.2	Marine waters

The categorisation suggested in Spatial and Ecological assessment of the TEN could be alternatively preferred to the above categorisation. This categorisation can be derived by CORINE land cover nomenclature and by this particular order characterises an increasing environmental sensibility.

The above categories have resulted from the analysis and interpretation of satellite images (remote sensing) and in this sense they mainly refer to land cover. However, it was attempted to include in some degree an interpretation of land use, considering human interference (artificial environment). An example is the discrimination between natural vegetation, forests, cultivation and urban vegetation areas.

An alternative nomenclature that we could use is the following Cluster Classification for Land Use Statistics of Eurostat Remote Sensing Program limited to the three first levels (see Table A2).

An important development is the initiative of EUROSTAT to develop land cover and land-use information systems for European Union Policy needs (EUROSTAT, 1999). This initiative highly supports the development of indicators on land-use pressure in Europe.

*Table A2: Cluster classification for Land-use statistics of EUROSTAT Remote Sensing Programme*

LEVEL I		LEVEL II		LEVEL III					
A	Man-made areas	A1	Residential areas and public services	A11	Residential areas				
				A12	Public services, local authorities				
		A2	Industrial or commercial activities	A20	Industrial or commercial activities				
				A3	Technical and transport infrastructures	A31	Technical infrastructures		
		A32	Transport						
		A4	Extraction industries, building sites, tips and wasteland	A41	Extractive industries				
				A42	Building sites, tips, and wasteland				
		A5	Land developed for recreational purposes	A50	Land developed for recreational purposes				
B	Utilised agricultural areas	B1	Tilled and fallow land	B11	Cereals				
				B12	Root and industrial crops				
				B13	Vegetables and flowers				
				B14	Fallow land, inc. green manure				
		B2	Areas under grass used for agricultural purposes	B21	Temporary and artificial grazing				
				B22	Permanent pastures and grazing				
				B23	Rough grazing				
				B3	Permanent crops	B31	Fruit trees and berries		
						B32	Citrus fruit		
						B33	Olive trees		
						B34	Vines		
						B35	Nurseries		
						B36	Permanent industrial crops		
						C	Forests	C1	Wooded forest areas
C12	Sclerophyllous trees								
C13	Conifers								
				C14	Intensively managed plantations				
				C2	Non-wooded forest areas	C21	Clear-cut zones		
C22	Other unproductive forestry areas								
D	Bush or herbaceous vegetation	D1	Bushes	D10	Bushes				
		D2	Herbaceous vegetation	D20	Herbaceous vegetation				
E	Surfaces with little or no vegetation	E0	Surfaces with little or no vegetation	E01	Bare soils				
				E02	Glaciers and eternal snow				
				E03	Burned areas				
F	Wet surfaces and surfaces under water	F1	Wet surfaces	F10	Wet surfaces				
		F2	Inland waters	F20	Inland waters				
		F3	Coastal waters	F30	Coastal waters				

*Table 3: Nomenclatures of land-use and landscapes*

<b>European Landscapes</b>	<b>CORINE Land (use/cover)</b>
<ol style="list-style-type: none"> <li>1. Forest tundra</li> <li>2. Boreal swamp</li> <li>3. Northern taiga</li> <li>4. Southern taiga</li> <li>5. Highlands</li> <li>6. Mountains</li> <li>7. Atlantic bocage</li> <li>8. Semi-bocage</li> <li>9. Mediterranean semi-bocage</li> <li>10. Atlantic open fields</li> <li>11. Continental open fields</li> <li>12. Aquitaine open fields</li> <li>13. Former open fields</li> <li>14. Central collective open fields</li> <li>15. Mediterranean open fields</li> <li>16. Coltura promiscua</li> <li>17. Montados/dehesa</li> <li>18. Kampen</li> <li>19. Delta</li> <li>19. Huerta</li> <li>20. Polder</li> </ol>	<ol style="list-style-type: none"> <li>1. Artificial territories</li> <li>2. Strongly artificial vegetated areas</li> <li>3. Less artificial vegetated areas</li> <li>4. Forests</li> <li>5. Non-wooded semi-natural areas</li> <li>6. Wetlands</li> <li>7. Water surfaces</li> </ol>

## APPENDIX 2

### *Agricultural intensification and abandonment*

At NUTS 3: Four variables with two or three values each, plus missing value:

- agricultural accounts 1996 / agricultural accounts 1989 from REGIO
- area of agricultural holdings / total area (source: EUROSTAT level III?)  
(Remark: non-presence of agricultural area indicates mostly the presence of urban or nature areas.)

for intensification subdivided into:

- extensive: (agriaria + permcrop + arabland) / total area  
(Remark: very extensive grazing/B23 and forestry/C1 separate categories).  
intensive: (vineyard/B34 + olive plantation/B33) / total area  
(Remark: irrelevant for northern countries in contrast to e.g. glasshouses and stables/A20 and bulb fields/B13.)
- agricultural holdings > 50 ha. / all agricultural holdings, from ... ?  
(Remark: will give percentage of holdings with continuity of extensive use, not necessarily intensification, which can take place in small holdings. On the other hand, small holdings are more prone to abandonment or selling)

Remark: price levels for agricultural land (and recent changes) could improve the indicator.

Abandonment:

Proposed data on decline of population density was ignored because of large numbers of regions with missing values. Location outside a buffer of 50 km from urban settlements was also ignored because it was very restrictive. Remoteness from towns may contribute to abandonment and population decline may be a consequence of abandonment, but they don't describe the abandonment process as such.

We would like to have a map of Europe with five categories, plus non-agricultural land:

- 1 high level of intensification
- 2 moderate level of intensification
- 3 stability or extensification
- 4 moderate level of abandonment
- 5 high level of abandonment

At least for a recent year (1996), if possible for a recent period (1989 – 1996) and for a prognosis too. Since the map of abandonment is almost a negative of the intensification map, this should be possible.

### APPENDIX 3

#### *Urbanisation*

Pressure of urbanisation is considered to be a function of economic growth of land-use categories in surrounding areas. Economic growth creates jobs, influencing migration flows and movement patterns. The proportionate change of the gross domestic product (GDP) in 1996 compared with 1989 is available per NUTS 2. The form of urbanisation is determined by the proximity of diffused settlements connected with a dense road system.

$$P_j = (S_i * N_{ij})$$

P pressure of urbanisation on resource area (j)

S combined indicator of  $GPD_{1996} / GPD_{1989}$  (REGIO), length of road network (from TEN) and built-up area (from CORINE) in surrounding source area (i)

N nearness of resource area (j) to surrounding areas (i)

Pressure is calculated for 1x1 km grids. The radius of presumed impact from the presence of human activities was positioned at 10 km. To obtain more interpretable and meaningful results the inferential presumed spatial interaction of human activities, evaluated from the presence of urban agglomerations, transport network and GDP growth, was referenced on the land cover information.

With this aim we have proceeded to the evaluation of three derived indicators. The relevant CORINE land cover categories were regrouped into three meaningful categories.

Code	CORINE	New category
3	Less artificial vegetated areas	Semi-natural areas
5	Non-wooded semi-natural areas	
4	Forests	Natural areas
6	Wetlands	Wetlands and water surfaces
7	Water surfaces	

The proposed order of these three categories reflects the level of environmental sensibility' and the nature of suggested policy measures.

We accepted that the presence of high mean values of indicator, evaluated for each of these areas (the mean value of all the cells included in each new category), normalised by the administrative area (NUTS2), represents an equivalent potential land-use pressure. The numerical values obtained can be interpreted as a weighted percentage evolution of economic activities (GDP), and regrouped into four classes, with the following characterisation:

- Insignificant pressure
- Very low pressure
- Low pressure

- High pressure

The results are reported on four maps. The first map illustrates the values of this indicator without any modification (Fig A2-1), while the following three illustrate the value with the weighted values according to the three new land-use category, semi-natural areas (Fig A2-2), natural area-forests (Fig A2-3) and wetlands and water surfaces (Fig A2-4).

The pressure might be the probability of building up the location but should be interpreted in a wider sense as short-distance urbanisation pressure in general. In the case of missing values (like in the UK), we obtain low values for the indicator.

## APPENDIX 4

### *Environmental stresses on land use.*

An example of an integrated method for the numerical assessment of the impact of both actual and potential environmental stresses on land use at European scale is the so-called Natural Capital Index Framework (Van Vliet et al., 1999). This framework enables to describe status (past, present and future) and establish relations to various socio-economic and environmental developments in an integrated, policy-oriented manner.

The framework is specifically developed to combine information on remaining natural areas in Europe (i.e. quantity of ecosystems) and changes of some pressures relevant to biodiversity (i.e. quality of ecosystems). Because, no detailed geographic explicit data on ecosystem quality for the whole of Europe is available, pressures to ecosystems are applied as substitute for ecosystem state (quality) variables. Moreover, pressure variables are easy to link with socio-economic factors. It is assumed that the lower the pressure, the higher the *chance* on high ecosystem quality and vice versa (see table 1)

*Table 1: Pressures to biodiversity and scaling values.*

Pressures	High chance on high ecosystem quality Pressure class = 0	Low chance on high ecosystem quality Pressure class = 1000
1. Rate of climate (temperature) change	< 0.2°C change in 20 years	> 2.0°C change in 20 years
2. Human population density	< 10 persons/km <sup>2</sup>	> 150 persons/km <sup>2</sup>
3. Consumption and production (GDP)	US\$ 0 per km <sup>2</sup>	> US\$ 6,000,000 per km <sup>2</sup>
4. Isolation/fragmentation	% natural area within 10 km > 64%	% natural area within 10 km < 1%
5. Acidification	Deposition < critical load	Deposition > 5 x critical load
6. Eutrofication	Deposition < critical load	Deposition > 5 x critical load
7. Exposure to high ozone conc.	AOT40 < critical level	AOT40 > 5 x critical level

To be able to use the above approach in a context of land use pressure indices the existing approach had been modified in order to include other land uses types (e.g. agricultural uses). For this purpose, we separated four specific environmental pressures from the whole set of seven identified pressures into one new pressure index. The pressure that is due to developments in demography and economic activities and the pressure that represents the fragmentation of natural areas are not incorporated in the set of indicators. Each pressure is preliminary graded on a linear scale from pressure class 0 (no pressure) to pressure class 1000 (very high pressure). To give an indication of the chance on high ecosystem quality or total threat to biodiversity or land use, for each grid cell (1 x 1 km) the pressure classes of the individual pressure indicators are added which results in one single pressure index per grid cell.

Additionally, the individual pressures require some fine-tuning both in classification and in their relative weighing, this because of the differences in impact of the identified individual environmental pressures on the different land uses. In this stage, the pressure indices for all uses, are calculated according to the weighing that was done for the natural land uses.

The result of the above approach shows that the environmental land use pressure is the highest in Germany, the Netherlands, and in parts of Denmark, France and Italy. The lowest pressure occurred in Sweden, Ireland, and Spain. For other EU- countries to above approach lead to moderate pressures.

The above approach requires some additional comments. An advantage of the presented approach is to possibility to combine both spatial and temporal information on single and multiple stresses in a context of their impact on certain uses. A difficulty remains the weighing of the individual stresses in a multiple stress indicator.

*Table 2: Pressures and scaling values.*

<b>Environmental pressure index</b>	<b>High chance on high ecosystem quality Pressure class = 0</b>	<b>Low chance on high ecosystem quality Pressure class = 1000</b>
1. Rate of climate (temperature) change	< 0.2°C change in 20 years	> 2.0°C change in 20 years
2. Acidification	Deposition < critical load	Deposition > 5 x critical load
3. Eutrofication	Deposition < critical load	Deposition > 5 x critical load
4. Exposure to high ozone conc.	AOT40 < critical level	AOT40 > 5 x critical level

Policy implication: The impact of multiple stresses on land is strongly dependent of the sensitivity of the actual land use. The framework to which is referred in this paper addresses in particular the natural areas/biodiversity. Fine-tuning of the indicator in order to get it more specific for different types of land use is required. However the restrictions and the difficulties of the approach, it is likely that it will contribute to consider the consequences of major environmental changes for land use planning in Europe.

## APPENDIX 5

### Summary of questionnaire responses

During the 'SPESP National Focal Points' meeting in Nijmegen the question was raised to get more input from Member States regarding 'Land use pressure'. To satisfy the need of this working group for more information it was decided to conduct a questionnaire in order to get your comments as experts on specific national and sub-national 'land use pressure' issues. The questionnaire has the following goals:

- 1) to collect examples of major land use pressures at national and sub-national level in the Member States
- 2) to find out at what scale(s) or level(s) preferably needs to be addressed in order to be appropriate for the analysis of land use pressure in a European context.
- 3) to find the significance of the proposed indicators and to find out whether these do sufficiently cover the examples of land use pressure that are supplied by the Member States.
- 4) to support the working with the identification of indicators that are needed to support the analysis of land use pressure as part of the framework for European spatial planning.
- 5) to receive information about the availability of data

The questions are grouped in two lists. The first list refers to the proposed indicators (see the background paper on "Land Use Pressure" presented at the SPESP-meeting in Nijmegen and the proposals and discussions that followed the presentation. The second list covers the general questions about land use pressure in Member States.

Below a summary and analysis is given of the questionnaire responses. Due to the differences in the level of details of the responses, and in some cases the lack of response, it was difficult to present the results in another format than in plain text.

#### **First set of questions:**

**1) Indicator: Urban land demand probability, based on economic features, population density and related mobility/transport pressure. Do you agree that this indicator might be of use in your country? Do you think that the required spatial and temporal data is available in your country and at what scale is the proposed information available? Should other aspects be included as well?**

The proposed indicator is suitable for identifying those regions or subregions in which increased settlement pressure can be expected in the medium to long term. It is regarded as a meaningful addition to the status quo oriented indicators (Germany). In Austria, Finland, Sweden and Belgium the proposed indicator is or might be useful. In Denmark the indicator seems less valuable at the national level because the pressure from urban expansion is marginal to the transition of land use patterns caused by environmentally

programs (forestry, extension of meadow). At local and regional level it may support the identification of urban pressures (planned new locations of industrial sites along highways and urban expansion and "hidden urbanisation" in metropolitan regions). In the Netherlands comparable indicators are already used for scenario based analysis of future land demands (not only urban demand). In the Netherlands more details of pressure are included (e.g. detailed linkages between demographic and sociological features). In the most recent publication on land use pressure especially attention is given to spatial interactions (e.g. interaction between agriculture and nature, living and work and living and recreation). The followed approach is to certain extend scale-independent

Observation by Germany: comparative analysis of economic development and land-use-dynamics did not reveal any significant correlation. From this was concluded that knowledge of the demographic and economic development of a region may allow initial pronouncements to be made concerning future settlement growth in that region but that such pronouncements are not conclusive. Alternative: systematic observation of planning activities at all scales, but above all the local level. Such observations are done in the Federal Republic every four-years, and is know under the heading of 'type of intended use'. Austria more straightforward approach is to estimate future area utilisation requirements. According to the Belgium comments the suggested indicator covers the main processes in Belgium: sub-urbanisation, shift of production and services from the centre to the periphery, and diversification of activities in the rural zones. Additionally, was made the remark that above all the variation in land or real estate prices is the most relevant indicator of urban pressure. Belgium suggested to take into account that the settlement pattern inside a geographical entity may be similar in density, but that the pressure exerted by the population may differ. In the Netherlands are, next to urban demand, also indicators developed that address other types of demand probabilities (e.g. nature, recreation)

Data: according to the respondents the data availability is, except for some countries, not a limitation. May be some general problems with inventories in East Germany before 1992/93. In Germany the available CORINE Land Cover data set is used to develop an indicator concept. Showing appointment related indicators (degree of urbanisation, continuous inner-city greenery, share of close to nature lands) and structure related indicators (fragmentation of open land, division of land, open-space provision). In Spain there are no systematic studies on urban land demand probability and there are no data sets available except for cases. Basic data sets (population, housing, industry etc.) are available but rarely processed at statistic or cartographic level. In Belgium most data seems to be available (also sub-municipality), except for some temporal data sets. Information on development in the periphery is only available at local scale. Information related to mobility and transport only exists in a fragmentary form. In Portugal census data on population and housing are available, about applications of these data has not been reported.

A remark was made in the German response about the serious problems that may arise because of the use of rather old land cover data that is used for CORINE and the fact that an update is not foreseen to be made in the near future.

**2) Indicator: ‘Agricultural intensification’\*. Do you agree that this indicator, which is based on temporal changes in agricultural accounts, and specific ratios between use and total agricultural area, might be of use in your country? Do you think that the required spatial and temporal data is available and at what scale is the proposed information available? Should other aspects be included as well?**

In Germany this indicator is of great significance for dealing with issues of land use. In Austria and Sweden it is valued as an indicator of little or no interest. In Spain, Luxembourg and the Netherlands this indicator is seen as a valid indicator which shows the dynamics in land use in the rural space. In France this indicator is used by different agricultural administrations. In France the indices used are based on temporal changes in production and productivity, or specific inputs (e.g. use of chemical fertiliser). In Finland intensification of agriculture has taken place in the southern and western part of the country. Besides, due to area-based subsidies the area also increased. The level of intensification is relative to other countries in Western Europe still low. In the Netherlands the tendency in agricultural land use is towards a decline in area. This change is the result of directives based on environmental policy (e.g. pig husbandry). The land demands are not really an issue in the Netherlands, except for land in specific regions where due to specialisation the demand is increasing (new warehouse areas).

Observation: following the suggestion of Spain indicators regarding agricultural performances in the southern European countries should sufficiently consider the technology that is applied. Especially in Mediterranean area it is fundamental to make the differentiation between irrigated and dry areas and between areas irrigated with surface and underground waters. D. suggests to use agricultural yields and other inputs economic. The use of ratios (agricultural land versus total) is not valuable in Denmark because the process of enlarging has stopped there long ago. It is suggested to consider not only the changes but also the absolute levels. Denmark proposed to consider more the agricultural specialisation instead of intensification.

Denmark made an observation from an economic point of view. They suggest to use a measure of the regional demographic and economic current state and potentials, due to the rationalisation of agriculture. Therefore is needed the extent to which there is a surplus population in rural regions, and if the rural regions are prosperous or marginal. They proposed an indicator of land use pressure, due to the rationalisation of agriculture, e.g. a measure of the number of people per ha occupied within the agricultural sector and their earnings. In the Netherlands there seem to be a strong decrease in agricultural area in the high density areas, whereas in the north and south-west the changes in agricultural area are marginal.

Indicators for agricultural intensification	Earnings	
	LOW	HIGH
Occupation within agricultural sector pr HA		
LOW	Insufficient marginal and non-competitive farms Land use pressure: low	Highly productive farms (economy of scale) Land use pressure: high
HIGH	Potentials for specialisation or rationalisation Land use pressure: low	Highly specialised farming (e.g.brand-production) Land use pressure: medium

*Figure: Indicator scheme proposed by Denmark.*

Belgium suggest to construct an indicator on intensification which is based on three objectives: firstly the historical development of agricultural production (rather detailed level, using agricultural statistics – yields, areas, number of animals, productivity, land price, labour input. Secondly the impact of intensification on the environment (animals/ha, inputs/ha). And finally the economic figures on inputs, equipment, investments, and services, expressed in monetary terms as well as labour (e.g. ‘agriculture value added’ as indicator for intensification).

In Finland forest is the most important form of land use. The currently proposed indicators do not take into account the effects of forestry as a pressure. Forestry does cause pressure to original ecosystems and biodiversity (e.g. more roads causing fragmentation, type of forest management) and has effect on other land uses (e.g. agriculture). In Finland initiatives are undertaken to take above pressures into account in the methods of forestry (e.g. implementing certificates). The availability of a CORINE data set for Finland (available at the end of this year) may support further analysis of a suitable indicator for pressures due to forestry.

Data: quantitative data on agriculture derived from census, agricultural statistics, and maps are available in most of the EU-countries. Regarding the qualitative aspects there might be some lack of data. Cartographic association and time comparison is expect to be problematic. In Austria data at NUTS 2 and 3 level would probably be available. In Portugal census data are available, but difficulties may arise in comparing census data, because of changes over time of criteria and definitions

**3) Indicator: ‘Land Abandonment’\*. Do you agree that this indicator which is based on decline in agricultural accounts, in population, in services, and the distance to urban settlements might be of use in your country? Do you think that the required spatial and temporal data is available and at what scale is the proposed information available? Should other aspects be included as well?**

In Germany this indicator is of great significance for dealing with issues of land use. Also in Spain the indicator is certainly of use to measure marginality and spatial trends and suitable to represent process of change and the ‘crisis’ of given spaces. In Sweden and Austria the indicator is of little or no value. In Finland the land abandonment indicator is relevant, especially when concerning the services and distances. In Finland the land

abandonment takes place in the northern and eastern part of the country. Here the rural population is declining and the unused agricultural land the areas are reforested. Besides, these changes in land use and land cover, the cultural assets are subject of degeneration. In Finland relevant datasets are available. According the respondents of Belgium the issue of land abandonment seem not important. In Austria, Denmark and the Netherlands the indicator is not very relevant, as abandonment of land does not occur.

Observation: Spain suggested to indicate the typology of crops which are abandoned and the new uses of land (ecological, forestry, extensive cattle breeding, etc.), and the causes explaining land abandonment processes. France suggest to use CORINE Land Cover to show land abandonment. A suggestion was made by Belgium to construct an indicator for example by using the ratio of used versus total agricultural area, the number of exploitations in relation to total population, forested areas versus total agricultural area. Denmark suggest not to represent the abandonment as discussed here. Denmark proposes an alternative, which represent the 'controlled abandonment' of agricultural land into forestry, meadows and energy crops. Denmark valued this alternative indicator as highly relevant. In Portugal census data are available, but difficulties may arise in comparing census data, because of changes over time of criteria and definitions. Luxembourg made the remark that the indicator may identify the broad development, but the question is whether an alternative land use is foreseen or not.

In Austria and in Denmark this indicator is of little interest because land abandonment does not exist.

**4) Do you think that the land price and/or its added value in the rural areas is a good reflection of the 'land use pressure' in the rural areas of your country (keep in mind that rural includes also nature, services etc.)? Is information about these prices and values available and at what scale is this available?**

Greece evaluated the indicator of uncontested importance. For Spain the suggested indicator is certainly relevant to measure pressure on the land use. In Denmark land prices are relevant indicators of hidden urbanisation in the metropolitan regions and as well as indicator of shortage of land in highly specialised agricultural regions (pig farming). In Finland the land price is of significance close to densely populated areas, an at coastal and lake areas, under the condition of building rights. Price of forest land does not vary to the degree that it could be an indicator. The value of agricultural does vary according to the intensity of agriculture in the region. According to Sweden the indicator reflects the pressure from new settlements and second or summer houses, but no the demand from future infrastructure in sensitive areas. In the Netherlands land prices are good indicators of pressure. The weak point is that the price itself or the change in price is not reflecting what is the underlying process that caused the change. In the Netherlands also specific regulations (often EU) affect the value (e.g. slurry rights, and milk quota). Luxembourg stressed the importance of the impact of the juridical aspects on the price of land (restrictions on land use: nature park).

Observation: Spain observed the importance of take into account that the price of land is affected by various factors: agrarian economy, space functionality, urban planning, protection measures; and in the rural areas there are also psychological factors affecting land markets, particularly in areas with small estates. The French comments are in line with the Spanish observation. France valued the indicator as very critical. Additionally was mentioned the impact of the policy inside each territorial division. France made the observation that the differences from country to country may be rather large. According to Belgium the indicator is not a representation of land use pressure but an indicator of potential use, both rural and urban, as defined in their land use plans.

Data: In Germany the prices of land are published down to district level. In Greece the data on land prices are not available. In Spain information of land prices are available at the national and regional level. At more detailed levels the availability of such data is very difficult and would require monographic studies. In Denmark information on prices are available on NUTS3 level.

In Austria data sets with land prices are available at NUTS 3 level (remark: not very reliable for uses in absolute numbers). In Belgium relative prices are available at local level. In combination with land use the prices are available at the arrondissements level only.

In the Netherlands the markets for urban and rural are separate markets, which do not interfere. Except zoning plans prevent the expansion of one type at the account of the other. In Portugal no data published about land prices

**5) In many Member States the shifts in agriculture is, more than in the past a result of the Common Agricultural Policy. Its impact at longer term will be rather diverse. In some areas it caused the shift to diversification (at farm level – pluriactivity – or regional economic level), extensification or marginalisation, while other areas remain competitive through increased intensification. Which indicators are used in your country to show the impact of the shifts in agricultural policy? Are there examples of changes in land use pressure and changes in cover because of the shifts in policy?**

In Germany a common indicator for shifts in agriculture is the share of agricultural land currently out of production relative to the total inventory of agriculturally used lands.

In Denmark trend-measures of ratios in land use are available, as well as trends in employment. In Austria the CAP did not change much. Belgium<sup>2</sup>: on going research on the impact of CAP. The change in land cover/use is the main indicator that is addressed in the mentioned research. In one part of Belgium agriculture becomes more intensive because of technology-economy driven developments causing more and more environmental pressure on the land (e.g. manure surplus). In another part the opposite process occurs leading to diversification and the production of quality products.

Observation: In Spain certainly there is a strong relationship between CAP, land use and land use pressure. The main indicators are related with the evolution of crops (and many

other agricultural statistics), community support, woodland etc. In Belgium it not just the CAP that affects agriculture, but also ecological and environmental issues, and issues regarding the quality of the products (e.g. ESB, hormones, dioxins).

**6) Compared to economic indicators, indicators that concern ecological and environmental features (biodiversity, water quality, noise, fragmentation) are less applied in spatial planning. Because of the attention for natural assets (theme 1.6) and cultural assets (theme 1.7) it is the intention to find a modes to address these topics in a context of land use pressure. Do you think that such a more integrated indicator has additional value? Besides we would like to be informed about ecological/environmental indicators that are used in spatial analysis in your country? Would you think that land use pressure also could encompass the pressure from a potential claims on land (e.g. land that is part of an ecological structures)**

*The inclusion of further environmental features definitely makes a lot of sense according the response of Germany. Care nevertheless needs to be taken to avoid excessive aggregation. It would be feasible, however, to augment the “main indicators” selected with a few “accompanying” indicators. According to Spain, land is certainly a fundamental part of ecological structures and therefore in problems related to land pressures it will be necessary to consider the potential demands. Denmark suggests to focus on very specific indicators for changes of land-use and overlaps of conflicting kinds of land-use, e.g. overlap between arable land and groundwater resources, overlap between urban development and groundwater resources. Specific measures should be given higher priority than synthetic indicators. According to Finland the ecological and environmental indicators are not in a wide use in spatial planning, but the approach towards that direction is under way. Several of such indicators (biodiversity, forest features, number of species etc.) are tested for potential applications in spatial planning. In the Netherlands ecological and environmental features determine more and more the way land is managed and used. Juridical acts are basis instruments for the authorities to prevent the development of unwanted land use. According to Belgium ecological and environmental factors are not much be used, but are beginning to be integrated in policy.*

Observation:

France: landscape field of research can provide good indicators to evaluate land use pressure. According the opinion of Austria this requires a lot of theoretical and conceptual work in advance. (‘Integrating indicators are not really solving conflicts between different interests’). Sweden does not agree that an increasing interest for these issues should be described as land use pressure. It is the interest for the environment/ecosystems that it is harder to meet the land demands from others interests. In their view land use pressure is driven by the growing demands for built-up areas and not from the existing green areas.

A remark was made to integrate the environmental dimension within a set of indicators relating to types of occupation and land use. These should be part of town and country planning process at different scales (e.g. protection of drinking water). Based on the experience in Belgium to set up the NATURA 2000 ecological network, the remark was made to integrate the environmental dimension in a set of indicators to the extent that it is

likely to facilitate the arbitrages associated with conflicts of land use.

Data: In Spain the future 'ecological' demands can be evaluated, to some extent, based on planning inventories developed by the Autonomous Communities (at municipal level) and particularly from the urban planning designation of "building/developing land". In Portugal there are not yet sufficiently long statistical series of indicators concerning ecological features. Data collected are scarce and spatially incomplete.

## **Second set of questions**

**1) Do you think that the indicators that are currently used for the analysis of the land use pressure in your country reflect the existing land use pressures or are additional indicators required? If any please give a short description. Do these indicators also support long-term analysis of land use pressures?**

In Denmark there are no regularly indicators introduced on the subject. In Germany very few established indicators are used. They mainly address land use / settlement development issues. One of the applied indicators is the share of land in a territorial entity given over to settlement and transport spaces plus the change in that share over time. For forecast purposes in Germany are used a settlement pressure indicator and an 'open-site shortage through demand for building land'. Germany referred to an assessment framework for ascertaining the overall burden on settlement structures, especially for application at local-authority level. Spain suggested to use indicators of integrated nature that especially address the long term dynamics. Some topics that attracts particular attention are trends in land use and consumption ('ecological consumption', leisure and tourism). More emphasize should be given to handle indicators in a more quantitative way instead of only a qualitative. In Austria is land use pressure not an issue of importance and therefor have not been developed specific indicators. In the Netherlands the currently uses sets of indicators sufficiently support the short and long-term analysis of pressure. In Finland an indicator for densely built-up areas (200 inh./km<sup>2</sup>) is used and has been proven very useful. In Sweden for local planning there is no need for additional indicators, but on regional and national level there is of easily available data.

**2) Could you supply us with information on indicators or indices that are used in your country to support spatial planning at sub-national as well as national policy level?**

In Denmark the 'need for areas for urban activities' is the only land used pressure that is evaluated by the central planning authorities for urban growth in regional-county plans. The information nowadays available is based on non-codified statistics. Currently, a codified national land use statistics based on GIS is under preparation. Spain uses a set of indicators addresses issue related to demography, economy, urban processes, environment and spatial ones. Some of these reflect the land use pressure: planning designation of land, infrastructure en land use. In Austria statistics are used by the

regional authorities (Länder) to compute current and future urban land demand. Recently a pilot started to monitor the prices and availability of building land at the national level. In the Netherlands a range of indicators has been assessed and applied in various planning activities and at various scales. In Finland an GIS based approach is about to come into use for the monitoring of spatial structures (e.g. accessibility patterns, functional structures, and physical structures).

**3) Could you indicate who and how these indicators are used in the national and/or regional spatial planning process in your country?**

In Spain there is no systematic database or GIS. Planning teams give different priorities and background, and concerns. For planning purpose these are mainly used at local (Municipal Urban Planning) and regional scale (Spatial Planning). The use of GIS is progressive, and making possible a greater harmonization in the use of indicators. In Finland the above system is used by the Finnish Environment Institute, the Ministry of Environment, and several regional centres. In Sweden spatial planning is the task of the local authorities, supervised by the regional authorities

**4) Could you list and describe examples of current 'land use pressure' in your country. Please include whether it is a regional or national pressure, its major driving forces, its short and long term consequences for land cover/use and the policy responses.**

In Germany and also in Denmark the recent development suggest a trend where households and companies opt for more peripheral sites, causing pressure on neighbouring communities. Of regional interest is the settlement pressure brought about by transport macro-infrastructures (airport/motorways). In specific problem in Germany is the re-utilisation of military properties, which are not always suitable for settlement purposes. In Denmark the pressure stems from the transition of land-use in the countryside, due to action plans for forestry, meadows, lakes and streams. Regionally there is a overlap in agricultural production and groundwater resources. Due to regulations about spreading of slurry the demand for agricultural land is increasing in certain regions. Mentioned action plans aiming at transformation of agricultural land into woodlands are likely causing an even bigger problem. In Finland there is an ongoing migration to the largest urban regions from other parts of the country. Together with urban sprawl, this makes the settlement structure more compact, causing pressures to built-up areas and recreational areas. In Sweden the pressure is the largest in the vicinity of Stockholm, and in the region near the bridge between Malmö and Copenhagen, and in recreational areas near the west coast.

In Spain there are very diversified regional trends. Some examples are: the pressure from tourism (especially in coastal areas and on islands) and urban areas on areas with natural value. The pressure from agriculture on wetlands and forestry, the pressure from urban areas on agriculture, and those pressures that are the result of policy regarding water quality and quantity. In Austria land use pressure is mainly occurring in the bigger urban areas and in some tourism sites. The shortages in building land in the past were solved

due to the introduction of regulations and also due to lower economic performances  
In Greece two main critical spatial mutations occur: the proliferation of settlements on the coastal areas (because of the lack of efficient normative legislation concerning tourist development, high profits compared to the traditional ones) and secondary residences near urban areas. In the Netherlands the pressure is partly from urbanisation and from nature conservation / recreation. The ration is about 1 to 3.

### **5) Are there examples of changes in land use pressure and changes in cover because of the Common Agricultural Policy.**

In Germany there are definite signs in some areas that an intensification of arable land being taken out of products (some states over 5% of such land). In Denmark there is a general belief that the reform has lead to a general ease in land use pressure. In Spain the CAP has caused significant changes in the use of land: increase of sunflower, maize, feeding plants and olives, and a decrease in vineyards, cereals and cattle breeding. Besides shifts in commodities also intensification took place The overall picture is the abandonment of cultivated land. The abandoned land is subject of reforestation. In Finland CAP is partly responsible for the fast decline in number of farmers and farms since the '90s. Other reasons for this decline is the environment subsidies. In Sweden a strong decline has been noticed.

### **OVERVIEW of comments by respondents**

**1: scale:** local regional, national, european: When addressing issues of land use pressure almost exclusively leads to an analysis of indicators that are used at the local/regional level and rarely the application of an indicator at the national level. According to Luxembourg the cited indicators could theoretically be of use in Luxembourg. But it seems doubtful that the theoretically usefull indicators coincide with the practically used indicators in spatial planning in Luxembourg.

**2: heterogeneity:** there seems to exist a significant heterogeneity in kind and level of land use pressure within Europe. This is mainly due to the differences in agriculture within Europe (especially in technology, inputs, labour), the demographic composition and development, and the economic level and developments. For example, land abandonment is only occurring in the southern region, where there seem to be no active authority interfering in the ongoing process. Also the demand for nature conservation is existing only in a few countries.

**3 homogeneity:** urbanisation and sub-urbanisation, do occur in the whole of Europe.

**4: priority in issues:** there is no uniformity in the priority setting of the main issues. In some countries/regions is urban expansion a relevant issue, where others do address this is issue as not significant if compared to other transitions in land use (e.g. caused by

environmentally programs).

### **5 way of dealing with indicators and indicator frames**

It seems that not many countries have a well-developed system to generate model- and scenario based outputs in the field of land use pressure.

### **6 future:**

It seems that the scale independent scenario approach of the Netherlands, is a very well developed approach that can be applied to many countries in Europe. The level of detail will always be a matter of local/regional/national interests.

The process in at least one country is directed towards further integration of land use functions at the local/regional/national scale. This integration of information on behalf of the integration of functions and multiple land use likely do require the development of indicators