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## **Strategies for Sustainable Urban Development and Urban-Rural Linkages**

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# Strategies for Sustainable Urban Development and Urban-Rural Linkages

Kjell Nilsson et al

## Authors

Kjell Nilsson<sup>1</sup>, Thomas Sick Nielsen<sup>2</sup>, Carmen Aalbers<sup>3</sup>, Simon Bell<sup>4</sup>, Baptiste Boitier<sup>5</sup>, Jean Pierre Chery<sup>6</sup>, Christian Fertner<sup>7</sup>, Miroslaw Groschowski<sup>8</sup>, Dagmar Haase<sup>9</sup>, Wolfgang Loibl<sup>10</sup>, Stephan Pauleit<sup>11</sup>, Marina Pintar<sup>12</sup>, Annette Piorr<sup>13</sup>, Joe Ravetz<sup>14</sup>, Mika Ristimäki<sup>15</sup>, Mark Rounsevell<sup>16</sup>, Ivan Tosics<sup>17</sup>, Judith Westerink<sup>18</sup>, Ingo Zasada<sup>19</sup>

## Abstract

An important driving force behind urban expansion is the growth of the urban population. But for Europe, this is not a sufficient explanation. The major trend is that European cities have become much less compact. Since the mid-1950s European cities have expanded on average by 78%, whereas the population has grown by only 33%. In the PLUREL project - an integrated project within the EU's 6th Research Framework Programme - more than 100 researchers from 15 countries analysed the impacts of urban land consumption at a pan-European level and, through six European and one Chinese case studies, identified how land use conflicts and the pressure towards peri-urban areas can be strategically managed in different development and regulatory contexts. To summarise, the following strategies were identified as important steps towards more sustainable urban-rural futures: (i) better coordination of transport, land use and open space planning; (ii) urban containment and densification – development of a green compact city; (iii) preservation of blue and green infrastructure; and (iv) preservation of agricultural land and the promotion of local production. The need also remains to strengthen governance at the regional level while at the pan-European level there is clearly a need for more policy attention to be given to urban-rural linkages.

**Keywords:** peri-urbanisation, urban sprawl, urban growth management, regional planning, compact city, green infrastructure

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<sup>1</sup> Nordregio; corresponding author: [kjell.nilsson@nordregio.se](mailto:kjell.nilsson@nordregio.se)

<sup>2</sup> Department of Transport, Technical University of Denmark

<sup>3</sup> Alterra, Wageningen UR, The Netherlands

<sup>4</sup> OPENspace Research Centre, Edinburgh College of Art, University of Edinburgh

<sup>5</sup> ERASME, Ecole Centrale Paris and University of Paris 1

<sup>6</sup> CEMAGREF Agricultural and Environmental Engineering Research Institute, Montpellier

<sup>7</sup> University of Copenhagen, Department of Geosciences and Nature Management

<sup>8</sup> Polish Academy of Science, Warsaw

<sup>9</sup> UFZ Helmholtz Zentrum für Umweltforschung, Leipzig

<sup>10</sup> Austrian Institute of Technology, Vienna

<sup>11</sup> Technische Universität München

<sup>12</sup> Department of Agronomy, University of Ljubljana

<sup>13</sup> Institute of Socio-Economics, Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

<sup>14</sup> Centre for Urban and Regional Ecology, University of Manchester

<sup>15</sup> SYKE, Finnish Environment Institute, Helsinki

<sup>16</sup> Geography and the Lived Environment Research Institute, University of Edinburgh

<sup>17</sup> Metropolitan Research Institute, Budapest

<sup>18</sup> Alterra, Wageningen UR, The Netherlands

<sup>19</sup> Institute of Socio-Economics, Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

## **Introduction**

Peri-urbanisation may become the dominant 21<sup>st</sup> century challenge for regional and city planning and design. The peri-urban is a zone of social and economic change and restructuring, a zone of intensive and sometimes even chaotic development. It is not just an in-between or edge space at the urban fringe; rather it is a new kind of hot-spot multi-functional landscape for urban renewal and development.

This paper presents an outline of the policy agenda and research approaches to peri-urbanisation, addressing a set of peri-urban development trajectories ranging from urban shrinkage to controlled polycentric growth with some emphasis on urban sprawl. The results refer to the PLUREL project, one of the largest recent research projects on peri-urban issues carried out in recent years, which included more than 35 organisations with over 100 actively involved researchers and stakeholders<sup>20</sup>.

The paper begins by outlining the current dynamics, possible future scenarios and the potential problems arising from peri-urban transition. Following this, urban development strategies and policy responses are addressed, including integrated planning approaches, compact cities, green and blue infrastructure, and agriculture/food supply. A final section discusses these issues in the light of experiences from six European and one Chinese case study region.

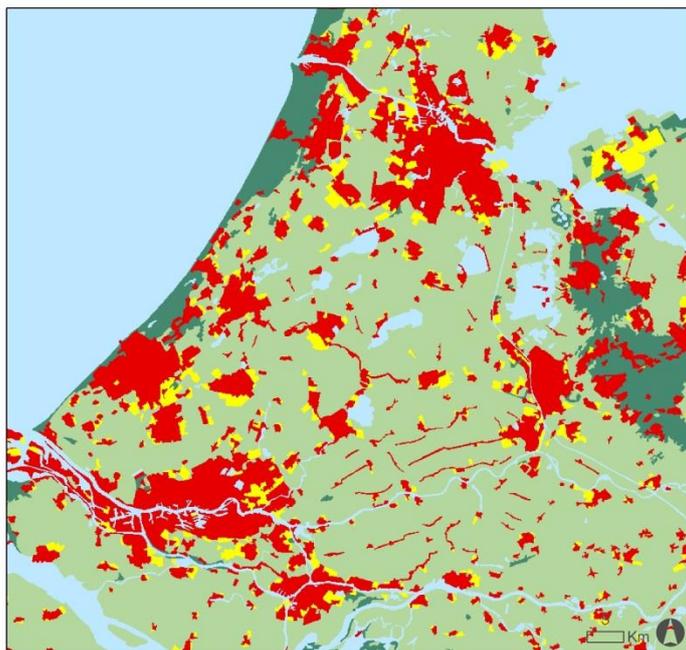
## **The dynamics of urban expansion and sprawl**

One of the most discernible trends when observing the current dynamics of cities and urban regions is urban sprawl. Urban sprawl can be defined as the low-density expansion or ‘leapfrog development’ of large urban areas into the surrounding rural landscape. Other definitions also include the fact that such development is often accompanied by weak regional land use planning and control (e.g. EEA & JRC 2006, Reckien & Karecha 2007). From 1990 to 2006 urban areas and associated infrastructure throughout Europe increased their territory at the rate of approximately 1000 km<sup>2</sup> per year, equivalent to the entire area of the city of Berlin.

One important driving force behind urban expansion is, of course, population growth, mainly caused by migration in the case of Europe. But this is only part of the explanation. Since the mid-1950s European cities have expanded on average by 78%, whereas the population has grown only by 33% (EEA & JRC 2006). A clear trend towards urban expansion is not surprising in regions with a dense and growing population such as the Randstad in the Netherlands, but even in regions with a declining population, the urbanised built up area (at least until the economic crisis) continues to grow, most notably in Spain, Portugal, Italy and eastern Germany or in central Europe, in Poland and the Czech Republic (Haase et al. 2013a).

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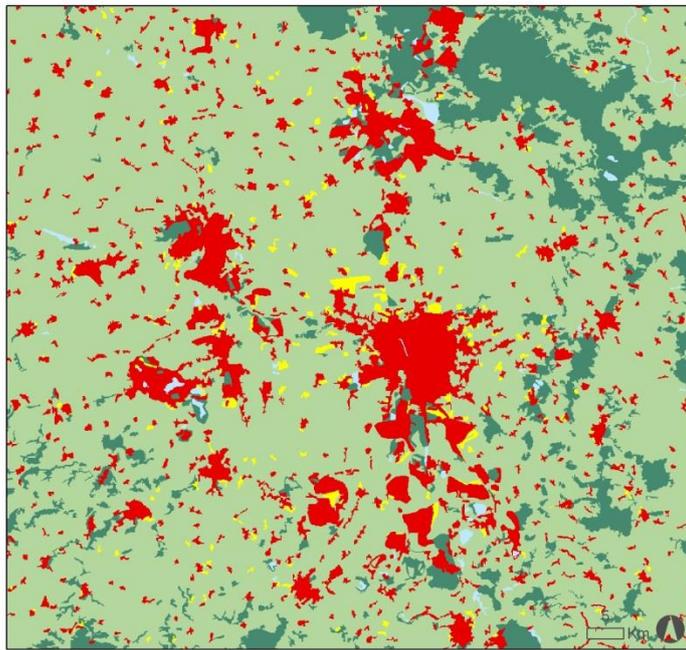
<sup>20</sup> PLUREL (Peri-urban Land Use Relationships – Strategies and Sustainability Assessment Tools for Urban-Rural Linkages) is an Integrated Project funded within the 6th Research Framework Programme of the European Union (EC FP6 036921). During its lifetime, 36 partners from 14 European countries and China have participated in the project. The project began in 2007 and terminated in March 2011. For further details, see [www.plurel.net](http://www.plurel.net)



Corine land cover 1990, 2000

- Urban, 1990
- Agriculture, 1990
- Forest and nature areas, 1990
- Water surfaces, 1990
- Additional urban land 1990-2000

PLUREL  
Institut



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Figure 1. Urban expansion on the edges of existing agglomerations in the regions of Randstad (above) and Leipzig-Halle (below). Source: Corine Land Cover Databases 1990 and 2000.

The city region of Leipzig-Halle in eastern Germany is a good example of a region that suffers from the problems of both a shrinking core city and urban sprawl into the peri-urban (Figure 1; Bauer et al. 2013). A similar trend – that urban areas expand approximately two times faster than the population – can also be observed in both the United States and China (Figure 2). Increasing economic welfare and living standards, together with smaller household sizes but increasing household numbers, are important drivers behind this development.

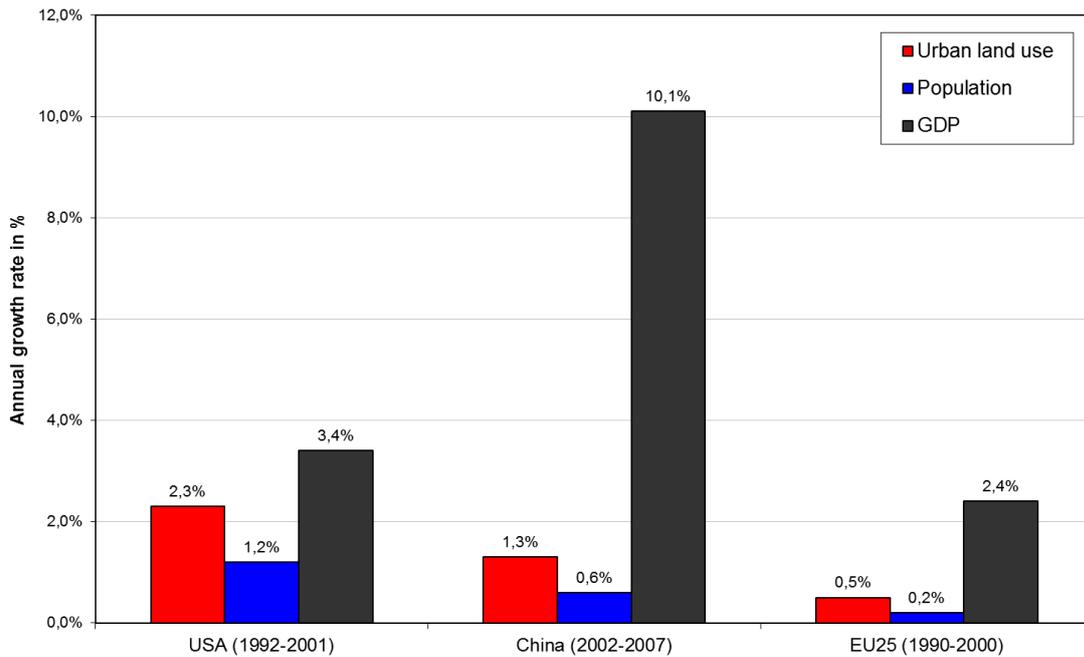


Figure 2. Growth rates for urban land use, population and GDP in the EU, the United States and China. Sources: Zhu et. al 2004; Ministry of Land and Resources P.R.C. 2007; U.S. Department of Agriculture, 2003; European Environment Agency 2005; and United Nations databases, 2009, accessed at <http://data.un.org/>.

How might the future develop? In the PLUREL project, four plausible scenarios for the future development of urban areas in Europe were created, based on the global scenarios of the Intergovernmental Panel on Climate Change (IPCC), as presented in the “Special Report on Emissions Scenarios” (Nakicenovic & Swart 2000, Ravetz & Rounsevell 2008). These PLUREL scenarios were defined in line with two conceptual axes: (i) an axis plotting global and regional versus local dynamics, and (ii) an axis plotting a focus on public, social and environmental values versus private enterprise/economic values (Figure 3). The scenarios were used as the basis for subsequent ‘top-down’ modelling work at a pan-European level on economic, demographic, environmental and land use changes, and as a starting point for the exploration of regional ‘bottom-up’ scenarios within each case study.

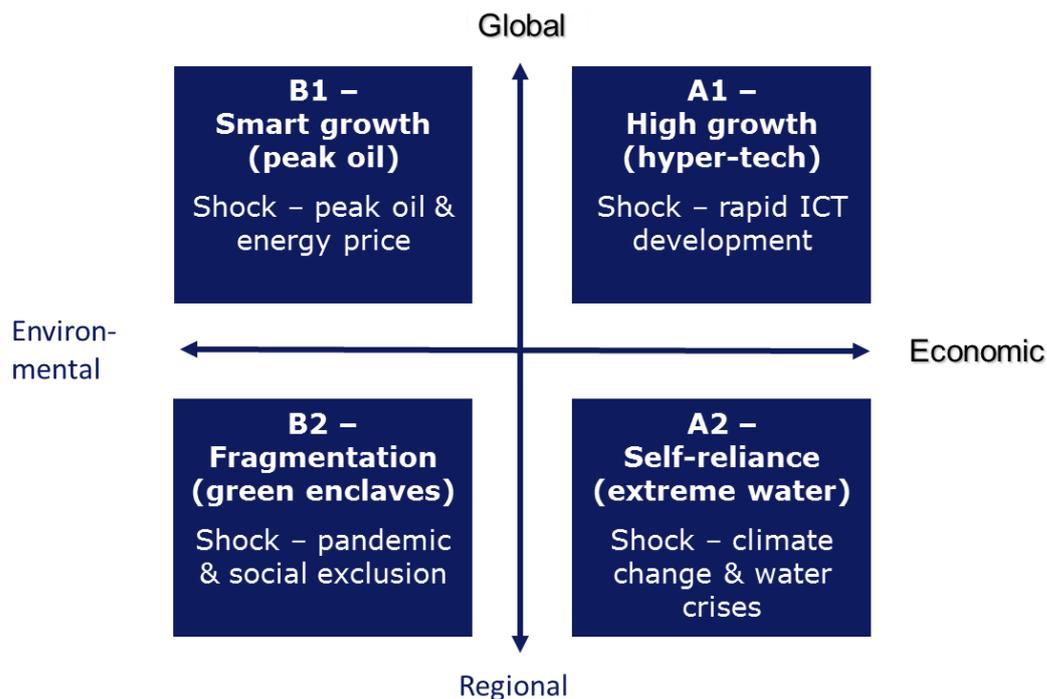


Figure 3. PLUREL scenario framework and images (Ravetz & Rounsevell 2008).

A1 “Hypertech” describes a future world of rapid economic growth, the rapid spread of new technologies and declining energy prices.

A2 “Self-reliance” describes a ruralised world, economic development is primarily regionally-oriented, and per capita economic growth and technological change are fragmented and slow.

B1 “Peak oil” describes a future resilient society of environmental and social consciousness – a global approach to sustainable development, and a dramatic increase in fossil fuel energy prices.

B2 “Fragmentation” describes a world of slow economic growth and a divided society in terms of age, ethnicity and increased international distrust.

Based on the assumption that the different demographic, economic, technological and environmental trends entail consequences for growth dynamics and the way growth occurs spatially, the scenarios show substantial variations in urban development. The Hypertech scenario is likely to see small towns in polycentric urban regions becoming even more popular and it may lead to the increased peri-urbanisation of rural areas, while in Peak Oil; most people attempt to return to larger towns and cities since high transport costs will limit commuting distances. In Self-Reliance huge sums are spent on adaptation to climate change and people gravitate towards living in small, self-supporting communities, while in Fragmentation cities become more dispersed and segregated as younger migrants inhabit city centres while the older natives escape to the

outskirts and to enclaves outside the city. Regardless of which future scenario we explore however, urban expansion will, according to the model simulations, continue at a rate of 0.4 – 0.7% per year, which is more than 10 times higher than the development of any other comparable type of land use, such as agriculture and forestry (Figure 4; Boitier et al. 2008).

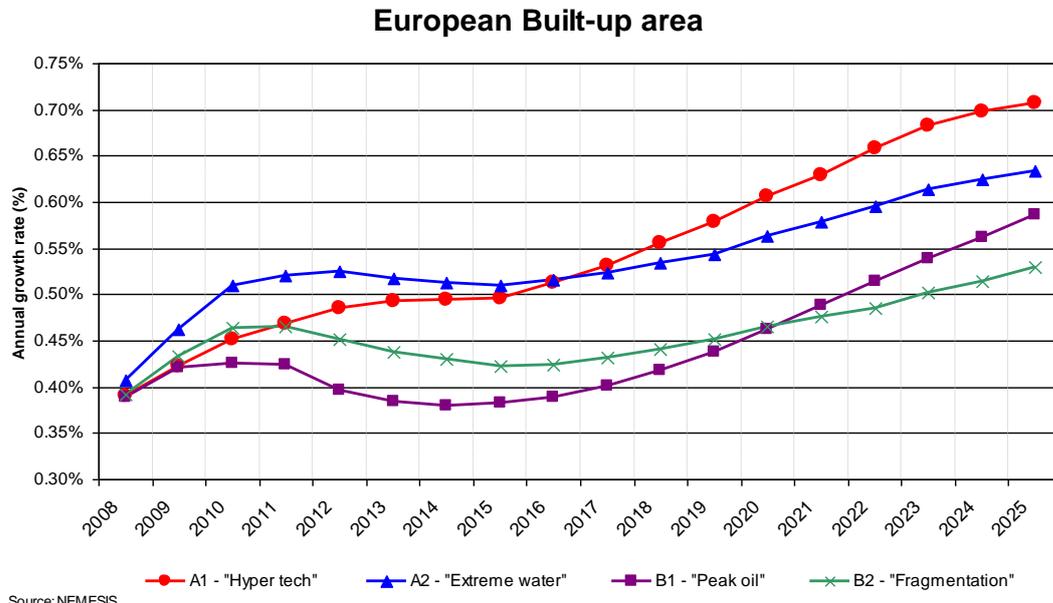


Figure 4. Development of built-up areas based on the four PLUREL scenarios. The figures are calculated from the NEMESIS econometric model developed by the Research Laboratory ERASME in Paris (Boitier et al. 2008).

The pattern of urban growth in Europe was assessed by applying a ‘regional urban growth model’ (RUG) allocating the urbanisation pressures to every 1 km grid cell in Europe based on the method utilised by Reginster & Rounsevell (2006). The model links the proportion of artificial surfaces to the population and gross domestic product per capita, urban type and country. Most of the development projected by this model will take place in peri-urban areas; high density peri-urban areas are defined as “discontinuous built development” areas with an average population density of at least 75 persons per km<sup>2</sup> and local centres larger than 10,000 inhabitants, while low density peri-urban areas are adjacent to high density peri-urban areas and show an average population density of at least 40 persons per km<sup>2</sup> (Loibl & Köstl 2008, Zasada et al. 2013). Such areas are growing four times faster than urban areas, and at a rate which would double their total area of 48,000 km<sup>2</sup> in 30-50 years (Piorr et al. 2011). The highest share of peri-urban areas in Europe can be found inside the ‘pentagon’ delimiting the area between London – Paris – Hamburg – Munich – Milan, with the highest concentrations in Greater London and the Benelux countries, but also outside the pentagon, for instance in large parts of Poland and in the Copenhagen region (Figure 5).

# Change of peri-urban artificial surface share 2005 - 2025

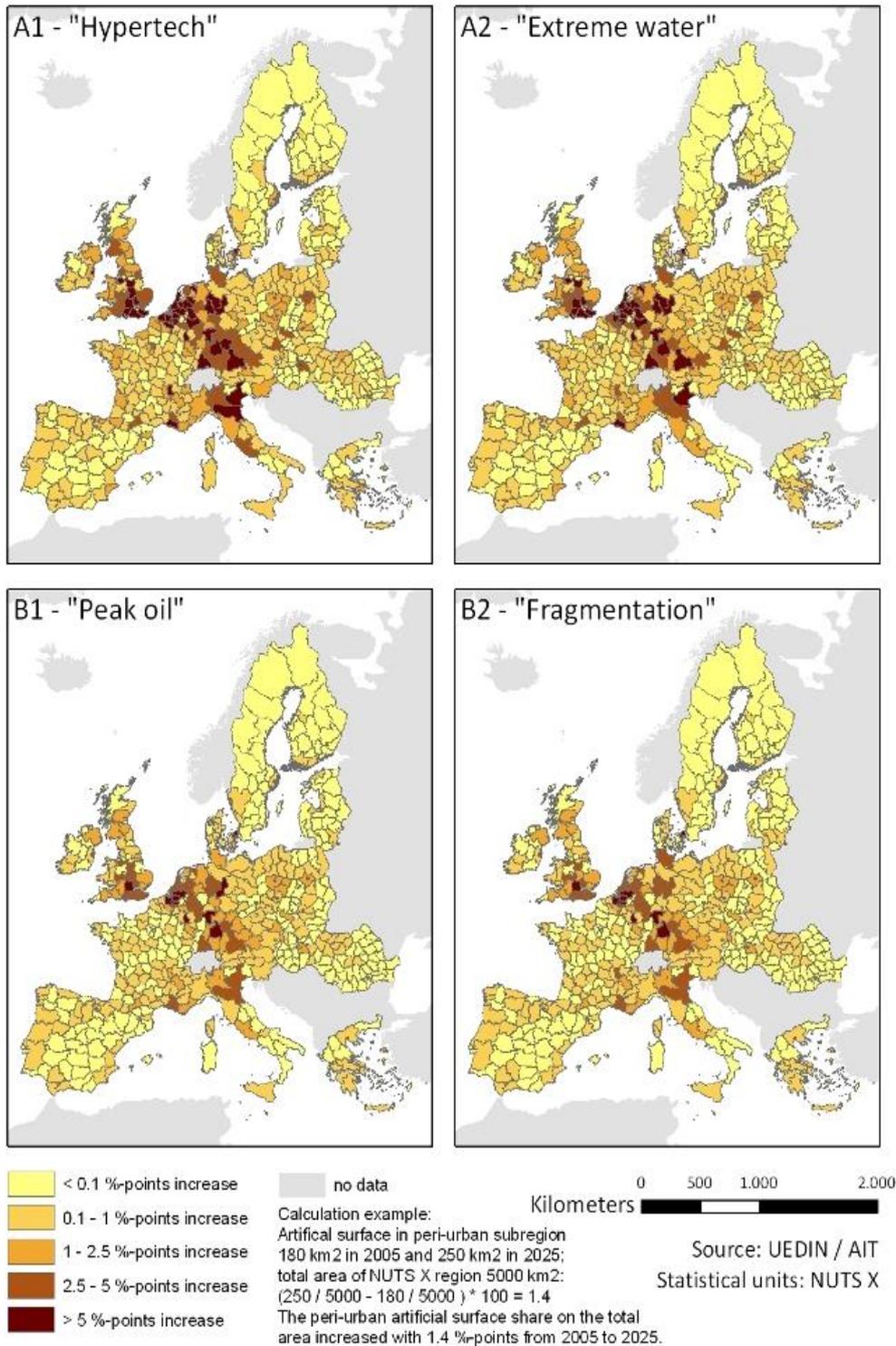


Figure 5. Peri-urbanisation in Europe. Share of artificial surface per region (Piorr et al. 2011).

## **The impacts of urban sprawl**

The rapid expansion of urban land use has many impacts. In the EC document “Towards a strategy for the urban environment” (CEC 2004) urban sprawl is recognised as the most urgent of the current urban planning and design issues. The EU project SCATTER (2004) divided the effects of urban sprawl into five groups, namely (i) public and private capital and operating costs, (ii) transportation and travel costs, (iii) land/natural habitat preservation, (iv) quality of life, and (v) social issues. Sieverts (2003) identifies three main shortcomings of the peri-urban or Zwischenstadt areas namely that they are inefficient in transportation terms, short on aesthetic appeal, and fragmented in political and administrative terms. Nuissl et al. (2009) argue that urban land consumption is usually detrimental to the environment in various ways. Its impact reduces the ability of nature to fulfil human requirements and thus impairs the provision of ecosystem services.

As part of PLUREL and for the whole of Europe on NUTS2/3 level, future land use changes as identified by the RUG model were simulated with regression models for different indicators for agricultural production, habitats and ecological diversity, and recreation – so called response functions (Zasada et al. 2010). The PLUREL project identified the most important negative impacts as:

- Consumption of land, loss of highly productive agricultural land
- Destruction of biotopes and habitats with fragmentation of landscape structure and decline of ecosystem services
- Less open space, longer distances to attractive recreational areas
- Increased dependency on private car use, traffic congestion, longer commuting times and distances, climate change emissions, noise and air pollution

The results indicate that the consumption of agricultural land will continue in all parts of Europe (Figure 6). In large parts of Scandinavia, the UK, Central Europe, and the Mediterranean coastal areas, but also in parts of Romania, more than 5% of the current agricultural area will be converted to sealed surfaces (Piorr et al. 2011).

Amongst the areas of major agricultural importance, the Netherlands, Belgium and the Mediterranean coast of France are likely to suffer the greatest loss of agricultural land, while in northern Germany, Poland and Hungary the degree of land consumption occurs in a more scattered pattern. In addition, the high productivity soils connected with intensive use and larger farm structure will be affected as well as areas with lower economic performance and a high proportion of part-time farming (Piorr et al. 2011).

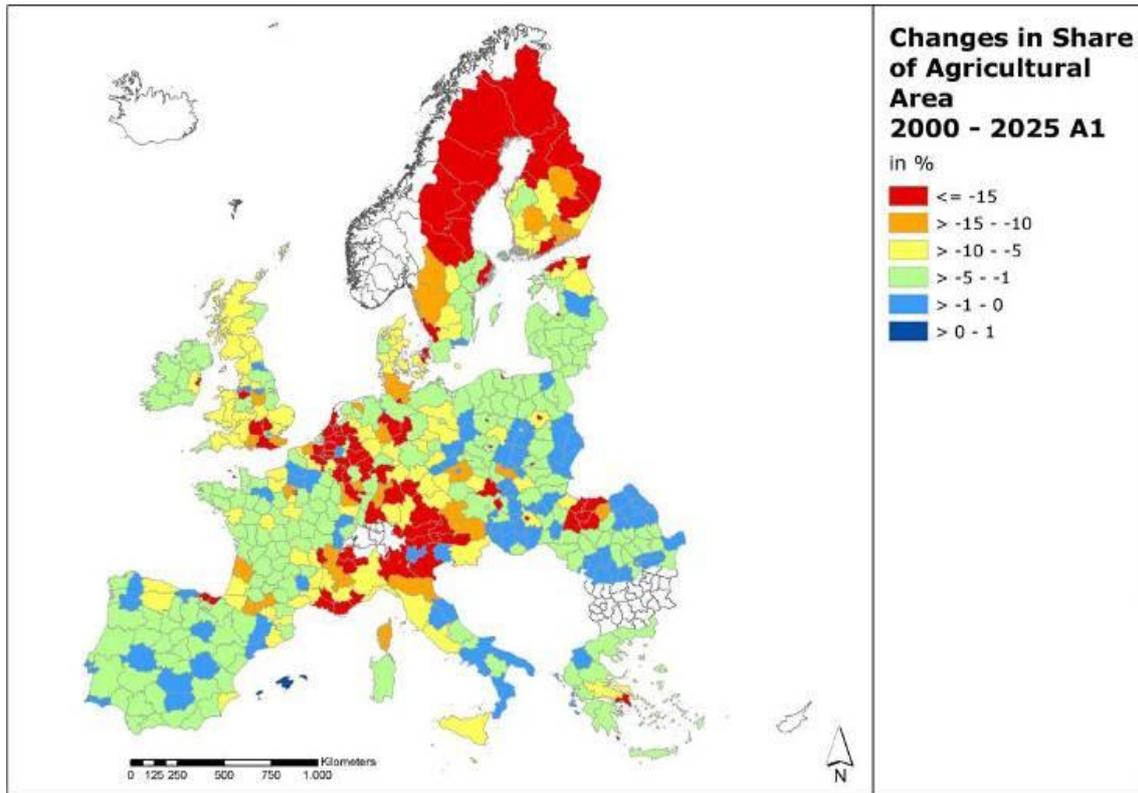


Figure 6. Consumption of agricultural land in Europe 2000-2025 (N.B. in northern Scandinavia the loss of agricultural land is mainly caused by afforestation and not peri-urbanisation). Source: Zasada, Piorr, Berges (ZALF) 2010

Effective Mesh Size is an indicator that quantifies landscape continuity, indicating the probability of two organisms finding each other in a landscape fragmented by infrastructure and human settlements (Figure 7; Jaeger 2000). Landscape fragmentation is likely to be concentrated in central Western Europe, where only small patches of open landscapes remain (Zasada et al. 2010). With increasing wealth, changing lifestyle and consumption patterns, urban growth is likely to continue, especially in the convergence regions of Southern and Central Eastern Europe and in the Iberian Peninsula. However, the full consequences of the economic crisis upon Europe's economic geography and urban growth patterns still remain to be seen, such that some of these trends may not occur exactly as suggested by the models due to slower rates of change.

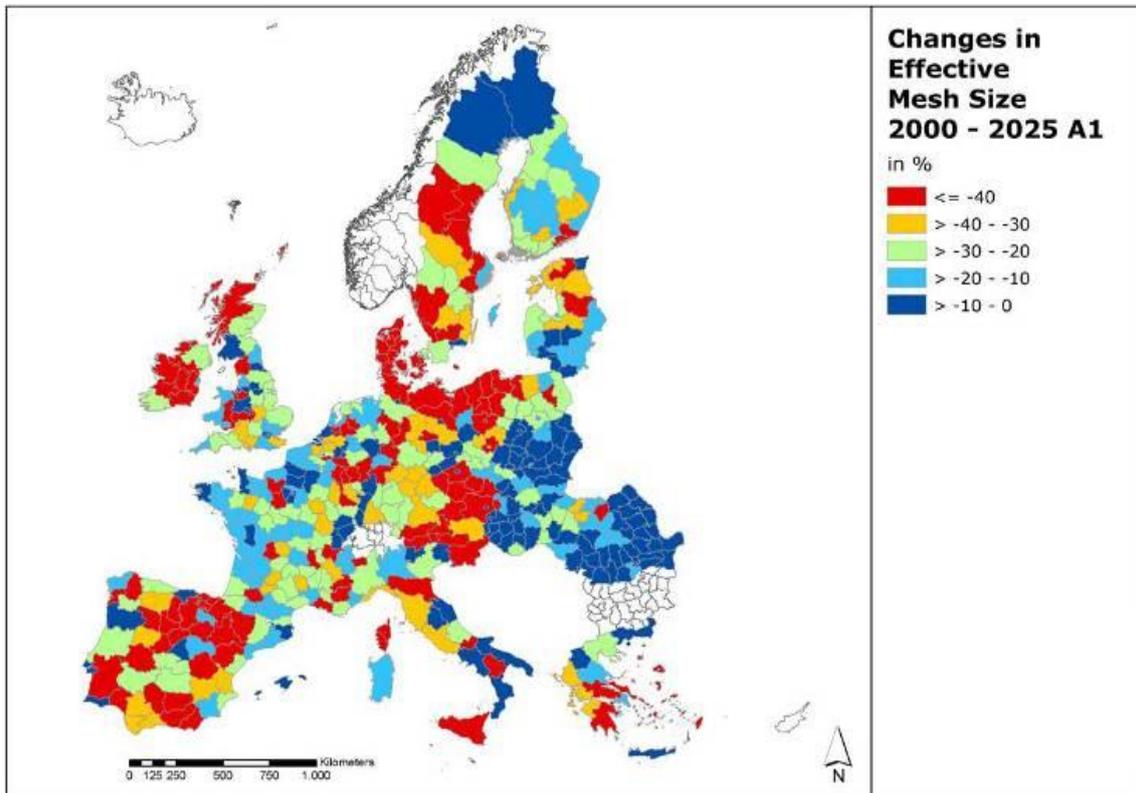


Figure 7. Landscape fragmentation in Europe 2000-2025. Source: Zasada, Piorr, Berges (ZALF) 2010

A similar pattern of decline has been projected for the Green Background Index (GBI), representing the availability of ecologically sensitive areas such as pasture and other semi-natural biotopes, agricultural mosaics, forests, wetlands and inland waters, which are valuable as habitats and for outdoor recreation (Figure 8; Zasada et al. 2010). Here the peri-urban areas of metropolitan regions, like London and Warsaw, but also intensive agricultural regions, such as the Paris basin or parts of northern Germany and Denmark face serious reductions in terms of the GBI. This could have serious implications for species abundance and biodiversity as well as for people's health and well-being, since society today is faced with the increasing incidence of various forms of poor health related to modern lifestyles. Natural outdoors and green space such as forests, parks, trees and gardens provide opportunities to enhance public health (Nilsson et al. 2011). When more people have to travel longer distances between their homes and green areas for outdoor recreation and exercise, the recreational use of these areas will decrease, which may have a critical effect on people's health and well-being. The availability of green areas for recreation also depends on their ownership and on the ease of accessibility, which is expected to be reduced in peri-urban areas.

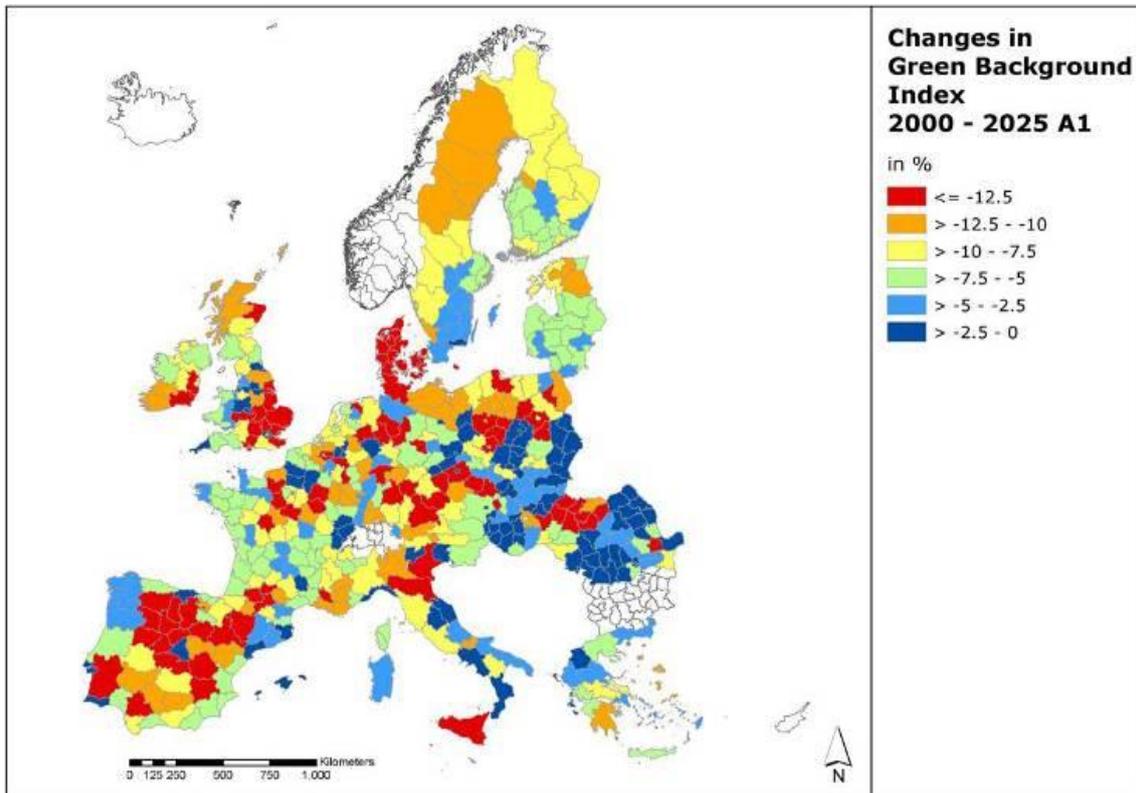


Figure 8. Recreational capacity in Europe 2000-2025. Source: Zasada, Piorr, Berges (ZALF) 2010

The ultimate goal of the transportation system is good general accessibility – to land uses, services, goods, people, workplaces, all distributed in a multifunctional landscape. The highest levels of accessibility and thus little travel time are usually achieved in densely built areas where workplaces, shops, services and activity centres are in close proximity and the transportation infrastructure (road network, public transport) is most developed. Urban sprawl and low-density peri-urbanisation leads to longer commuting distances, to less accessibility by public transport requiring more use of private cars, which tends to exclude poor and car-less people, as well as promoting less healthy lifestyles and increasing land consumption (Frumkin et al. 2004, Helminen et al. 2009). One should also expect higher emissions of particulate matter and CO<sub>2</sub>, while NO<sub>x</sub> emissions from road transport are expected to decline despite an increase in traffic, due to an increased take up of catalytic converters (Loibl et al. 2010). Despite lower emissions per vehicle, the impact of traffic congestion may generate additional costs due to the time and fuel wasted (Levy et al. 2010). Further, transport-related noise has a highly negative impact on human health in both core cities and peri-urban areas.

Peri-urbanisation does however also have some positive effects. One of the main reasons, especially for young families, for moving from urban to peri-urban areas is the availability of (semi)detached houses with a private garden, fresh air, clean water, green surroundings and a safe environment for children to grow up (Zasada et al. 2011). The

development of fast and affordable communication technologies provides a ubiquitous environment for long distance working, virtually connected with the employing companies located in urban cores. With improved public transport systems people tend to accept longer distances between the home and the workplace.

All these aspects plus decreasing real estate prices combined with the growing distance to urban cores allow – depending on the preferred lifestyle – families to live in detached houses in a green environment. Life in peri-urban and rural communities provides the inhabitants with further opportunities for more environmentally friendly lifestyles, e.g. by growing vegetables, buying meat from local farmers, composting organic wastes, etc. At the same time newcomers can bring new spirit, youth and liveliness to declining villages. By adapting to demands for healthy food, recreational services and attractive landscapes, agriculture can take advantage of its peri-urban location to increase its competitiveness (Zasada 2011).

## **Strategies for growth management**

Development in peri-urban areas causes conflicts between urban, agricultural and nature-based values. It also challenges the distinctions between urban and rural areas as they are usually applied in policy and regulatory terms. The six European and one Chinese PLUREL case study regions represent excellent showcase examples of how these conflicts and the pressures in respect of peri-urban areas can be strategically managed in different development and regulatory contexts (Nilsson et al. 2013).

The six European case studies reflect the variability of the geographic, economic and social conditions prevailing in Europe but are also characterised by having different cultures of governance. Population trends differ markedly in the case study regions, ranging from growing monocentric or polycentric areas (e.g. Warsaw and Haaglanden) to regions with ongoing population decline, resulting in different rural-urban development patterns (Leipzig). They include, in economic terms, strongly performing regions (Haaglanden and Montpellier), regions characterised by economic regeneration (Manchester and Leipzig) and those characterised by a transition economy (Warsaw and Koper). Geographically, they cover transects from west to east for central (Manchester – Haaglanden – Leipzig – Warsaw) and southern Europe (Montpellier – Koper). Finally, a Chinese reference study (Hangzhou) was chosen in order to explore the relevance of the results to the very rapidly urbanising areas in Asia.

In the PLUREL project the assessment of growth patterns at the European level was supplemented by more detailed modelling at the case study level developed in cooperation with partners from the regions involved. The modelling approach at the case study level involves an adaption of the general scenarios to the context of the individual case study region where important and plausible aspects of the future as well as planning responses within the scenario storylines were elaborated in dialogue between researchers, local stakeholders and planners. The modelling was carried out

with MOLAND, a cellular automata model which simulates urban development as a growth process, where the location of each grid cell, the suitability of the land and zoning regulations, as well as the status of neighbouring cells determine the probability of land use change. Regional storylines were elaborated for modelling scenarios of land use change in the case study regions up to 2025.

The assessment of sustainability relies on a wide set of sustainability indicators as well as a detailed response function approach based e.g. on changes in land use along the rural-urban continuum (Haase et al. 2013b). The consequences of peri-urbanisation can only be fully explored and/or understood in cooperation with practitioners and stakeholders from the urban regions who can compare sustainability indicators with desired outcomes and subsequently revise their strategies to aim for desired outcomes in a future that is uncertain but may be approached by means of assessing the scenarios.

The following sub-sections present examples of possible strategies for managing peri-urban development as identified in the case study regions. The strategies were studied based on a joint analytical and assessment approach of governance and spatial planning in the regions, including the described scenario (annex 1; Aalbers & Van Dijk 2008). The following four main land use issues were used as criteria for the assessment of the strategies:

- to reduce the pressure on housing in urban fringe;
- to strengthen agriculture in the urban fringe;
- to sustainably integrate tourism and recreation with regional development;
- to preserve high value nature areas in the urban fringe.

### ***1. Territorial cohesion***

The Regional Structure Plan of the Hague Region and the Scheme of Territorial Coherence of Montpellier Agglomération are examples of modern advanced strategies for the better coordination of transport and land use planning. The Regional Structure Plan of the Hague Region presents the region's main strategies in terms of strengthening the relationship between spatial planning and traffic/transportation, coordinating sectoral ambitions and goals and forming the basis for long-term politically endorsed agreements between the participating municipalities (Westerink & Aalbers 2013). In the Scheme of Territorial Coherence of Montpellier Agglomeration (SCOT: Schéma de Cohérence Territoriale), which concerns a highly attractive region, there is clearly a level of political willingness to develop the region through a sustainable dispersion of green open landscape and urban development based on quality of life and attractiveness measures as well as on the protection of agriculture and green space in the urban fringe (Buyck et al. 2008).

A key issue here is that urban regions are usually split up into many local municipalities with a certain degree of planning autonomy, while integrated territorial policy

approaches above the local level are required to steer urban development in the interests of the wider region. In most European countries however the formal governmental power and the ability to control and coordinate the entire urban region, with respect to spatial development, remains limited.

Good governance, i.e. the sphere of public debate, partnerships, interaction and dialogue between citizens, organisations and local governments, is a precondition for achieving sustainable development (Evans et al. 2005). As examples of successful governance attempts to set an overall strategy for protecting agriculture and green space in the urban fringe the Regional Structure Plan of the Hague Region and the Scheme of Territorial Cohesion of Montpellier Agglomération have already been mentioned. In contrast to these schemes the situation in Warsaw is characterised by intense pressure on high-value nature and agricultural areas due to high economic and population growth rates and uncontrolled peri-urbanisation both in the area directly surrounding the city (Warsaw Metropolitan Area) and in the wider Mazovian region. The attempts by the regional authorities to exercise a measure of control over this, as identified in existing strategies and plans, has not yet provided a sufficient bases for sustainable development to take hold. The policies are focused on specific problems, mainly of an economic nature, with the local interests dimension taking precedence over overall coordination and cooperation with neighbouring communities (Groschowski et al. 2013). It is not only planning and environmental policies that are contributing to urban sprawl here, financial and sectoral policies are also having a negative impact.

Coordination of the separate priorities of 72 independent municipalities in the Warsaw Metropolitan Area is of course considerably more difficult than the 9 of the Hague Region, but, on the other hand, the Hague Region is part of larger agglomerations in the province of South Holland and the Randstad while Montpellier has succeeded, thanks to the SCOT planning approach, in bringing together the ambitions of some 31 municipalities in a strategy designed to promote a more equally distributed development.

## ***2. Urban containment and densification – the development of a green compact city***

Urban containment, managed through a distinct boundary zone between urban and rural land use, is a common strategy for urban growth management and for attaining sustainable development focusing on efficient land use and the preservation of rural functions like ecosystem services. Strong planning legislation (government) as well as an open dialogue with different stakeholder groups (governance) are key factors in the success of such an approach. The Green Belt Policy of the UK and the Green Heart in the Netherlands are both policies that have proven to be successful in quantitative terms, but we can also find negative consequences as for instance can be observed in the Greater Manchester Area (Ravetz 2008, Westerink et al. 2013). A certain proportion of the development, which would have taken place in the Green Belt of Manchester, is merely pushed further out, leapfrogging the belt itself, and leading to a greater impact

on the countryside and longer travel distances for commuters. This problem may become more acute as people are increasingly prepared to accept longer commuting distances witnessed by the growth in tele-working as noted previously (Ravetz 2008).

Smart urban densification, structured into a pattern of multifunctional neighbourhoods is another common strategy for avoiding urban sprawl. The EC Thematic Strategy on the Urban Environment (CEC 2006) recommends more compact settlements in addition to better coordination between urban transport and land use planning. This has been taken seriously by the Hague Region where the aim is that 80% of all urban development should take place within the existing urban fabric. However, quality of life in the city can be a limiting factor for urban densification. For example, densification at the cost of reducing the area of parks and other public open spaces might be a good strategy at the regional level but may have serious negative consequences at the local level. Therefore, in the Regional Structure Plan of The Hague Region, multiple functions and high quality public space, as well as integrated polycentric development, e.g. limited sprawl in an organised way, are identified as useful strategies to maintain quality of life in dense areas (Westerink & Aalbers 2013, Westerink et al. 2013).

The issue of urban density vs. green space is an example of the potential conflict between climate change mitigation and adaptation concerns (Carter 2008). If increasing density, in order to reduce energy by lowering travel demand and heating requirements, leads to the loss of green space, one consequence will be the loss of a vital adaptation resource. For example, an increasing number of heavy rainstorms could cause more frequent problems with flooding, which presents a higher risk where there is insufficient permeable open space areas providing water infiltration. Also, if average temperatures change in the future the Urban Heat Island effect is likely to exacerbate more frequent temperature extremes in urban environments. The results of model simulations for the city of Manchester suggest that a 10% green space increase in residential areas would compensate for even the worst case temperature scenario by 2080 (Gill et al. 2007).

A critical discussion of the view promoted by European Commission policy on urban planning and sustainability is thus essential (Porter & De Roo 2007). To prevent residents from leaving compact cities in search of better living environments in the urban fringe new concepts have to be developed to make the compact city more attractive. The concept of a green metropolis by the seaside in The Hague and a variety of urban renewal and social regeneration projects in Leipzig are examples of such ambitions. In Leipzig, due to outmigration and suburbanisation, there are a variety of vacant buildings and brownfield sites available for use, so the urban core can be described as perforated rather than compact. The main strategy is to counter suburbanisation processes by the enhancement of the city and improving quality of life in order to retain residents in the city centre (Sinn et al. 2008, Westerink et al. 2013).

### ***3. Preservation of blue and green infrastructure***

Another strategy for peri-urban development is to develop green and blue corridors suitable for energy-saving means of transport such as walking and cycling, for biodiversity and for human health and well-being. The Green Ring of Leipzig, involving 13 municipalities in a spatial, environmental and recreational strategy (Bauer et al. 2013), and the Red Rose Forest covering the 6 western districts of Greater Manchester are examples of this approach. The Red Rose Forest, one of a national set of community forests created in the early 1990s, forms, together with the adjacent Mersey Forest and the Pennine Edge Forest, an extended network of community woodland, often established on former mining spoil and landfill sites, where much of the previous contamination and dereliction has been greened and made safe and usable (Ravetz & Warhurst 2013).

Occasionally the peri-urban zone contains areas of specific natural value which, thanks to their localisation, give the urban population easy access to areas of high natural quality. One such example here is the Skocjanski Zatok Nature Reserve – the largest brackish wetland in Slovenia in the urban fringe of Koper. The key attribute of the nature reserve is its rich flora and fauna including a number of endangered species. The area was severely damaged in the 1980s, when the local authorities planned to fill the lagoon in order to develop the area as an industrial and commercial zone. In 1993, the NGO BirdLife Slovenia initiated a public campaign to protect the area, and after five years of persistent work the area was officially designated as a nature reserve by the Slovenian government. BirdLife Slovenia has obtained a license to manage the area, which is now open to the public enabling them to observe birds and other wildlife (Pintar et al. 2008).

The Xixi Wetland area, situated northwest of the West Lake District in Hangzhou, used to be a plain with a large blue network of ponds and rivers. The area, known for its beauty and rich ecology, was dominated by farmland and fishing with only few dispersed settlements. Despite the proximity to central Hangzhou hardly any urbanisation took place before 1990, but in 1996 Jiangcun Village was incorporated in the West Lake District of Hangzhou and a large-scale urbanisation process began. In less than ten years, the area had become one of the largest residential districts in Hangzhou, while the wetland area had decreased from 60 to 10 km<sup>2</sup>. At the same time, the city authorities experienced growing demand for new recreational areas due to the expansion of the city westwards. They reacted promptly and in November 2001 they passed the planning programme for Xixi Wetland Cultural and Ecological Tourism Area and in 2004 the Xixi Wetland Reserve Master Plan was approved. The long-term importance of the Xixi National Wetland Park project for the restoration of natural areas and as a tourist attraction in the Hangzhou region thus cannot be overstated. Conversely, from a European governance perspective, it is almost inconceivable that an area of this

size – the core protection area has a size of 10.08 km<sup>2</sup>, would be restored in such a radical way by removing entire settlements and in such a short time (Spiekermann et al. 2013).

#### ***4. Preservation of agricultural land and the promotion of local production***

In the pre-industrial age shorter cycles existed in the flow of resources between towns and the surrounding countryside. In a more sustainable future for urban-rural relationships recycling and circular resource flows need to be re-established in water and waste management, food and energy production and in the supply of raw materials etc. Strategies will also be required to enable agriculture to cope with the peri-urban conditions and to serve the demands of the nearby urban society (Zasada 2011). The PLUREL case studies present examples of how this goal can be achieved by means of various methods to support local food production. High land prices not only in the urban but increasingly also in the peri-urban zone are however a major obstacle here.

The Koper strategy to protect the best agricultural soils appears to be the most advanced sectoral strategy of all those studied. Historically, agriculture was one of the most important activities in the Koper region; today however it has lost much of its economic importance. A major problem contributing to the decline in the importance of agriculture here is the pattern of small and increasingly poor land parcels and combined with the ageing farmer population. Another threat is urban sprawl. However, analyses show that good opportunities remain for the further development of agriculture in the region, mostly in connection with tourism and recreation, but also in the provision of food for local consumption. Therefore, spatial planning measures which include a new approach to the classification of agricultural land are currently under development, an approach which includes targeting soil characteristics, exposure rates to sun and irrigation, creating opportunities to promote economically and environmentally sound production, and isolation from pollution sources (Pintar et al. 2013).

Montpellier Agglomération also has an active policy for the protection of agricultural land use in the urban fringe. Besides land use zoning, land price regulation and the stimulation of shorter product chains from farmer to consumer, an agri-park has been developed in the North Lez area. The agri-park concept relies on multifunctional land use where recreational and other social functions are integrated with the agricultural production process and farming is used as a cost-efficient way of protecting and maintaining open spaces in the urban fringe (Jarrige et al. 2013).

Another ambitious local initiative was found in the market town of Todmorden, 20 km north of Manchester. Here the aim was to make the town self-sufficient in food by 2018. The initiative, named Incredible Edible Todmorden, has a true bottom-up perspective, encouraging public and private bodies; small-scale gardening and agriculture are stimulated through the supply of potential land, removing legal constraints, and supporting local action (see <http://incredible-edible-todmorden.co.uk/> for details).

The need to make financial compensation available to farmers who provide ecosystem services in peri-urban areas is seen as an important component of this approach. In The Hague Region farmers are rewarded for improving the landscape, by providing so-called “Green and Blue Services” (Westerink & Aalbers 2013). The Green Blue Service strategy provides an alternative to land purchase by the government for the development of natural and recreational areas, since the farmers combine food production with improved biodiversity, landscape amenity and public footpaths on their land. The strategy contributes not only to maintaining agriculture but also to biodiversity, recreation and tourism. There is clearly interest here, both from farmers and the authorities, to develop the model further as well as to maintain the green funds, but the strategy needs complementary measures, such as land banking to make a real difference in containing urban sprawl (Westerink & Aalbers 2013). The freezing of land use status for 15 years combined with support to farming businesses as implemented in the territorial coherence scheme supported by Montpellier Agglomération are good examples of such land control measures.

## **Discussion and future perspectives**

Batty (2008) argues that cities mainly grow from the bottom up, where economic and transportation behaviours are the key elements, while spatial planning and urban design play a sub-ordinate role. In the PLUREL case studies, we have seen several successful bottom-up initiatives for the urban rural interface, e.g. the preservation of Skocjanski Zatok Nature Reserve in Koper and the Incredible Edible movement in Todmorden. We have also found a number of exemplary models for good governance such as the Regional Structure Plan of The Hague Region and the Scheme of Territorial Coherence of Montpellier Agglomération. These examples show the need for strong government in the shape of legislation, the size of its jurisdiction area in relation to the size of the urban agglomeration and an efficient spatial planning system. In this sense the regional authority and the perspective of the rural-urban region are the most strategic levels, but the need also remains for EU-level initiatives at the pan-European level, such as an urban-rural development framework directive or a community initiative. In their absence we can expect the gaps between different parts of Europe – north/south, east/west, rich/poor and, last but not least, urban/rural – to grow even wider, making a more sustainable and inclusive Europe ever harder to envisage.

The ability of the public authorities to resist the push by market actors to create ever more urban sprawl depends on two things; the strength of either the administrative or governance-based planning instruments and the governmental level at which land use decisions are taken. The more decentralised the system and laissez-faire the policy, the weaker is the steering potential in favour of the wider urban agglomeration. However, land use change also depends on other kinds of dynamics such as economic and taxation systems, transport, housing and other sectoral policies. A comparison of the case study regions’ potential ability to control peri-urban development highlights the existence of

significant differences between them in this respect (Tosics & Gertheis 2010). The Hague Region has the greatest potential to control urban development, if it were not for its limited jurisdiction area in relation to the far bigger size of the functional urban region, followed by Manchester and Montpellier, while city regions in former Communist countries such as Warsaw and Koper have changed from a centralised planning system during the Communist era to a more liberal regime where the market has a much stronger role. We have also identified the need for an integration of spatial planning and territorial cohesion policies with financial and taxation mechanisms, which often create direct or indirect incentives for urban sprawl. To counterbalance this, more tools should be given to the public sector to capture values more efficiently.

	Haag-landen	Man-chester	Mont-pellier	Leip-zig	Koper	War-saw
Financial transfer system	0.67	1.00	0.67	0.67	0.00	0.33
The local taxation system	0.67	0.67	0.67	0.33	1.00	0.67
<b>Local government financing systems</b>	<b>0.67</b>	<b>0.83</b>	<b>0.67</b>	<b>0.50</b>	<b>0.50</b>	<b>0.50</b>
Economic development and infrastructure	1.00	0.50	0.50	1.00	0.50	1.00
Transport	0.83	0.67	0.50	0.50	0.17	0.33
Housing	1.00	0.67	0.67	0.33	0.33	0.33
<b>Sectoral policies</b>	<b>0.94</b>	<b>0.61</b>	<b>0.56</b>	<b>0.61</b>	<b>0.33</b>	<b>0.56</b>
<b>Tools to steer development</b>	<b>0.75</b>	<b>0.50</b>	<b>0.50</b>	<b>0.75</b>	<b>1.00</b>	<b>0.25</b>
<b>Summary</b>	<b>6.53</b>	<b>5.45</b>	<b>4.74</b>	<b>4.69</b>	<b>3.83</b>	<b>3.97</b>

Table 1. *Strength of the public sector to control urban development (Tosics & Gertheis 2010).*

More recently however, the tendency has been for power to flow in the opposite direction - towards more decentralised growth management and deregulation. In countries such as France, the Netherlands and the UK the regional level has been weakened when it comes to control of spatial development. In all six European case studies, the urban area increased from 2000 to 2006 - even in Leipzig-Halle, which during this period experienced a considerable decline in its population, although the consumption of urban land per new inhabitant was very different. Manchester and Montpellier became denser, while the Hague Region, Warsaw, Leipzig and Koper used more urban land per inhabitant in 2006 than in 2000. Remarkably, the Hague Region, despite being estimated to have the greatest potential to control urban growth, experienced the second largest additional urban area per new inhabitant, 786 square metres, which was exceeded only by Warsaw with 904 square metres (Fertner 2012). In 2000, The Hague Region had the lowest urban area per inhabitant of the regions

compared, though the large planned urban expansions of The Hague were realised during this period.

Better balanced, sustainably developed urban growth and shrinkage requires more policy attention be given to urban-rural linkages at the regional level, although there is also a clear need here for a new agenda in respect of EU policies and funds linked to spatial development. When it comes to policy-making, the time has come to challenge the historic distinction between urban and rural issues. Instead, what is required is a more holistic, territorially-oriented perspective designed to shape future EU agricultural and structural policies. Integrated urban-rural development should be accepted as a general requirement and made a condition for any EU support from the Structural and Cohesion Funds or indeed from the Common Agricultural Policy.

Research has an important role to play in supporting sustainable urban-rural relationships. In the context of the current research effort a number of important knowledge gaps have been identified. First of all, the type and the effects of the various decision-making mechanisms currently in use need more attention. Uncertainty clearly remains as to how effective different kinds of steering mechanisms, e.g. planning legislation, taxation rules, housing policies, multi-level governance etc., are when it comes to land use management and land use change. Secondly, our knowledge in respect of the efficiency of different transport systems in relation to the shape and morphology of urban structures – compact or dispersed, mono- or polycentric – remains, at best, inconclusive. Thirdly, the vision of the Green Compact City needs the support of a better knowledge base when it comes to achieving a better balance between urban densification and the preservation of green infrastructure at various scale levels. Forestry and agriculture will have a new and important role to play in the future urbanised society. Research should therefore generate knowledge that will improve the planning and management of natural and planted forests as well as how better to integrate local food production into urban settings. And finally, ecosystem functions and services provided by the green and blue infrastructure, and their potential for adaptation to climate change, is a topic that needs to be further developed. An important way to bridge these knowledge gaps is to develop better methods in respect of regional landscape planning which integrate scales and disciplines and bridge cultural differences between communities, businesses, policy and science. PLUREL offers a rich knowledge base to help bring these issues further, including experience of conducting relevant research in collaboration with stakeholders, something which is necessary for research to make an impact in terms of promoting sustainability (see [www.plurel.net](http://www.plurel.net) for further information).

## References

- Aalbers, C. & Van Dijk, T. (2008). *Framework for the assessment of regional strategies*. PLUREL deliverable D3.2.1 extra. Retrieved August 6, 2013, from [http://www.plurel.net/images/D321\\_xtra.pdf](http://www.plurel.net/images/D321_xtra.pdf)
- Batty, M. (2008). The size, scale and shape of cities. *Science* 319, 769-771.
- Bauer, A., Röhl, D., Haase, D. & Schwarz N. (2013). Leipzig-Halle: Ecosystem services in a stagnating urban region in eastern Germany. In: Nilsson, K. et al. (eds.), *Peri-urban futures; Scenarios and models for land use change in Europe* (pp. 209-240). New York/Dordrecht/Heidelberg/London: Springer.
- Boitier, B., Da Costa, P., Le Mouel, P. & Zagame, P. (2008). *Calculation of land use price and land use claims for agriculture, transport and urban land use at national level*. PLUREL Deliverable D1.1.2. Retrieved August 6, 2013, from <http://www.plurel.net/images/D112.pdf>
- Buyck, J., Chery, J.P. & Jarrige, F. (2008). *Montpellier case study*. Analysis of regional and decision making strategies and their impact on land use in the urban fringe. PLUREL Deliverable 3.3.2. Retrieved August 6, 2013, from <http://www.plurel.net/images/D332.pdf>
- Carter, J. (2008). Climate change: a rural-urban region perspective. *PLUREL Newsletter No 3*, April 2008, Copenhagen, pp. 4-5. Retrieved August 6, 2013, from [www.plurel.net/images/PLUREL\\_%20Newsletter\\_No%203\\_screen.pdf](http://www.plurel.net/images/PLUREL_%20Newsletter_No%203_screen.pdf)
- CEC, Commission of the European Communities (2004). *Towards a thematic strategy on the urban environment*; Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, Commission of the European Communities, Brussels.
- CEC, Commission of the European Communities (2006). *Thematic strategy on the urban environment*; Communication from the Commission to the Council and the European Parliament on. Commission of the European Communities, Brussels: CEC.
- EEA, European Environment Agency (2005). *Land cover accounts (LEAC) based on Corine land cover changes database (1990-2000)*. Accessed at <http://www.eea.europa.eu/>
- EEA, European Environment Agency & JRC, Joint Research Centre (2006). *Urban sprawl in Europe*. EEA Report No 10/2006, Copenhagen: EEA.
- Evans, B., Joas, M., Sundback, S. & Theobald, K. (2005). *Governing sustainable cities*. London/Sterling: Earthscan.
- Fertner, C. (2012). *Urbanisation, urban growth and planning in the Copenhagen Metropolitan Region with reference studies from Europe and the USA*. Forest & Landscape Research 54. Frederiksberg: Forest & Landscape Denmark, University of Copenhagen.
- Frumkin, H., Frank, L. & Jackson, R. (2004). *Urban sprawl and public health*. Washington: Island Press.
- Gill, S., Handley, J., Ennos, R. & Pauleit, S. (2007). Adapting cities for climate change: the role of the green infrastructure. *Built Environment*. 30(1), 97-115.
- Groschowski, M., Korcelli, P., Kozubek, E., Slawinski, T. & Werner, P. (2013). Warsaw: Spatial growth with limited control. In: Nilsson, K. et al. (eds.), *Peri-urban futures; Scenarios and models for land use change in Europe* (pp. 131-168). New York/Dordrecht/Heidelberg/London: Springer.

- Haase, D., Kabisch, N. & Haase, A. (2013a). Endless urban growth? On the mismatch of population, household and urban land area growth and its effects on the urban debate. *PLoS ONE* 8(6): e66531. doi:10.1371/journal.pone.006653.
- Haase, D., Piorr, A., Schwarz, N., Rickebusch, S., Kroll, F., van Delden, H., Zuin, A., Taylor, T., Boeri, M., Zasada, I., Lavallo, C., Vanhout, R., Sarretta, A., Müller, F., Rounsevell, M., & Bell, S. (2013b). Tools for modelling and assessing peri-urban land use futures. In: Nilsson, K. et al. (eds.), *Peri-urban futures; Scenarios and models for land use change in Europe* (pp. 69-90). New York/Dordrecht/Heidelberg/London: Springer.
- Helminen, V., Ristimäki, M., Kontio, P., Rita, H., & Vuori M. (2009). *Response function for commuting*. PLUREL deliverable D2.3.7. Retrieved August 6, 2013, from <http://www.plurel.net/images/D237.pdf>
- Jaeger, J. (2000). Landscape division, splitting index, and effective mesh size: new measures of landscape fragmentation. *Landscape Ecology* 15, 115-130.
- Jarrige, F., Chery, J.P., Buyck, J. & Gambier, J.P. (2013). The Montpellier Agglomeration: New approaches for territorial coordination in the periurban. In: Nilsson, K. et al. (eds.), *Peri-urban futures; Scenarios and models for land use change in Europe* (pp. 241-274). New York/Dordrecht/Heidelberg/London: Springer.
- Levy, J.I., Buonocore, J.J. & von Stackelberg, K. (2010). Evaluation of the public health impacts of traffic congestion: a health risk assessment. *Environmental health* 9:65, doi:10.1186/1476-069X-9-65 .
- Loibl, W. & Köstl, M. (2008). *Report on a methodology to delineate RUR sub-regions*. PLUREL deliverable D2.1.4. Retrieved August 6, 2013, from <http://www.plurel.net/images/D515.pdf>.
- Loibl, W., Orthofer, R. & Köstl, M. (2010). *Response functions on energy consumption and air pollution*. PLUREL deliverable D2.3.8. Retrieved August 6, 2013, from <http://www.plurel.net/images/D238.pdf>
- Ministry of Land and Resources Peoples Republic of China (2007). *Communiqué on land and resources of China 2007*. Retrieved March 10, 2014, from <http://www.mlr.gov.cn/mlrenglish/communique/2007/>
- Nakicenovic, N. & Swart, R. (2000). *Special report on emissions scenarios*. Cambridge: Cambridge University Press.
- Nilsson, K., Sangster, M., Gallis, C., Hartig, T., de Vries, S., Seeland, K. & Schipperijn, J. (eds.) (2011). *Forests, trees and human health*. New York/Dordrecht/Heidelberg/London: Springer.
- Nilsson, K., Pauleit, S., Bell, S., Aalbers, C. & Nielsen, T.S. (eds.) (2013). *Peri-urban futures; Scenarios and models for land use change in Europe*. New York/Dordrecht/Heidelberg/London: Springer.
- Nuissl, H., Haase, D., Wittmer, H., & Lanzendorf, M. (2009). Environmental impact assessment of urban land use transitions—A context-sensitive approach. *Land Use Policy* 26 (2), 414-424.
- Pintar, M., Udovic, A., Istenic, M.C., Zupan, M., Prus, T., Pirnat, J., Hladnik, D., & Glavan, M. (2008). *Analysis of regional spatial planning and decision-making strategies and their impact on land use in the urban fringe – case study Koper*. PLUREL Deliverable 3.3.5. Retrieved August 6, 2013, from <http://www.plurel.net/images/D335.pdf><http://www.plurel.net/images/D335.pdf>
- Pintar, M., Perpar, A., Udovc, A., Zupan, M., Cernic-Istenic, M., Milicic, V., Babic, T., Deranja, D., Bangiev, G. & Mlakar, A. (2013). *Koper: Beyond the rural and urban*

- paradigm. In: Nilsson, K. et al. (eds.), *Peri-urban futures*; Scenarios and models for land use change in Europe (pp. 275-306). New York/Dordrecht/Heidelberg/London: Springer.
- Piorr, A., Ravetz, J. & Tosics, I. (eds.) (2011). *Peri-urbanisation in Europe*; Towards a European Policy to Sustain Urban-Rural Futures; Synthesis Report. Frederiksberg: University of Copenhagen/Academic Books Life Sciences.
- Porter, G. & De Roo, G. (2007). The end has no merit. In: De Roo, G. & Porter, G. (eds.), *Fuzzy planning*; The role of actors in a fuzzy governance environment (pp. 1-18). Hampshire: Ashgate.
- Ravetz, J. (2008). *The City Region in time and space*. Analysis of regional spatial planning and decision-making strategies, and their impact on land use in the urban fringe. PLUREL Deliverable D3.3.6. Retrieved September 8, 2013, from <http://www.sed.manchester.ac.uk/research/cure/research/plurel/project/documents/Man-city-region-spatialgovernancereportD336-18-11-08.pdf>
- Ravetz, J. & Warhurst, P. (2013). Manchester: Re-inventing the local-global in the peri-urban city-region. In: Nilsson, K. et al. (eds.), *Peri-urban futures*; Scenarios and models for land use change in Europe (pp. 169-208). New York/Dordrecht/Heidelberg/London: Springer.
- Ravetz, J. & Rounsevell, M. (2008) Scenarios – crystal balls for the urban fringe. *PLUREL Newsletter No 3*, April 2008, Copenhagen, pp. 1-2. Retrieved August 6, 2013, from [www.plurel.net/images/PLUREL\\_%20Newsletter\\_No%203\\_screen.pdf](http://www.plurel.net/images/PLUREL_%20Newsletter_No%203_screen.pdf)
- Reckien, D. & Karecha, J. (2007). Sprawl in European cities – the comparative background, In: Couch, C., Leontidou, L. & Petschel-Held, G. (eds), *Urban Sprawl in Europe: landscapes, land-use change & policy* (pp. 39-68). Oxford: Blackwell.
- Reginster, I. & Rounsevell, M.D.A. (2006). Future scenarios of urban land use in Europe. *Environment and Planning B: Planning and Design*, 33(4), 619–636.
- SCATTER project – sprawling cities and transport: from evaluation to recommendations. Retrieved August 6, 2013, from [www.casa.ucl.ac.uk/scatter/download/ETC\\_scatter\\_gayda.pdf](http://www.casa.ucl.ac.uk/scatter/download/ETC_scatter_gayda.pdf)
- Sieverts, T. (2003). *Cities without cities*; An interpretation of the Zwischenstadt. London/New York: Spon Press.
- Sinn, A., Haase, D. & Walde, A. (2008). *Analysis of regional spatial planning and decision making strategies and their impact on land use in the urban fringe*. PLUREL Deliverable 3.3.6. Retrieved August 6, 2013, from <http://www.plurel.net/images/D336.pdf>
- Spiekermann, M., He, Y., Yang, J., Burkhardt, I., Yan, F., Yi, X. & Pauleit, S. (2013). Hangzhou: Fast urbanisation and high population growth. In: Nilsson, K. et al. (eds.), *Peri-urban futures*; Scenarios and models for land use change in Europe (pp. 307-340). New York/Dordrecht/Heidelberg/London: Springer.
- Tosics, I. & Gertheis, A. (2010) *Review of further instruments with indirect effect on regulation of peri-urban land uses*. PLUREL Deliverable 2.2.2. Retrieved August 6, 2013, from <http://www.plurel.net/images/D222.pdf>
- U.S. Department of Agriculture (2003). *Annual National Resources Inventory*.
- Westerink, J. & Aalbers, C. (2013). The Hague region. Negotiating the common ground in peri-urban landscapes. In: Nilsson, K. et al. (eds.), *Peri-urban futures*; Scenarios and models for land use change in Europe (pp. 99-130). New York/Dordrecht/Heidelberg/London: Springer.

- Westerink, J., Haase, D., Bauer, A., Ravetz, J., Jarrige, F., & Aalbers, C.B.E.M., (2013). Dealing with sustainability trade-offs of the compact city in peri-urban planning across European city regions. *European Planning Studies* 21(4), 473-497.
- Zasada, I. (2011). Multifunctional peri-urban areas – A Review of societal demands and agricultural provision of goods and services. *Land Use Policy* 28(4), 639-648.
- Zasada, I., Berges, R., Piorr, A., Schläfke, N., Werner, A., Toussaint, V., & Müller, K. (2010). *Modelling approach for response functions on agricultural production, ecological regulation and recreation function*. PLUREL Deliverable D2.3.9-10. Retrieved August 6, 2013, from [http://www.plurel.net/images/D239\\_2310.pdf](http://www.plurel.net/images/D239_2310.pdf)
- Zasada, I., Fertner, C., Piorr, A., & Nielsen, T.A.S. (2011). Peri-urbanisation and multifunctional agriculture around Copenhagen, Denmark. *Danish Journal of Geography* 111(1), 59-72.
- Zasada, I., Loibl, W., Berges, R., Steinnocher, K., Köstl, M, Piorr, A., & Werner, A. (2013) Rural-Urban-Regions. A spatial approach to represent urban-rural relationships in Europe. In: Nilsson, K. et al. (eds.), *Peri-urban futures; Scenarios and models for land use change in Europe* (pp. 45-63). New York/Dordrecht/Heidelberg/London: Springer.
- Zhu Huiyi, Lu Changhe, & Li Xiubin (2004). Land use studies in China, *Journal of Geographical Sciences* 14, supplement, pp 69-73.

### Annex 1. Overview of main strategies implemented by the case study regions

	Leipzig	Haaglanden	Montpellier	Manchester	Warsaw	Koper	Hangzhou
1. Better coordination of transport and land use planning		Regional Structure Plan - network governance	Schema de Coherence Territoriale of Montpellier Agglomeration		Warsaw Metropolitan Area Spatial Development Plan		Binjiang Development – combined housing with an effective transport network
2. Urban containment and densification - green compact cities	A variety of “Innerstadt” projects	Green Heart Strategy - 80% “infill policy”	Density Building Strategy	Green Belt Policy			
3. Nature conservation and development of a green and blue infrastructure	Green Ring of Leipzig – Saxon Green Corridors	Green and blue services		Green infrastructure – Community Forestry		Skocjanski Zatok Nature Reserve	Xixi National Wetland Park
4. Preservation of agricultural land and local production		Green and blue services	Agri-parks – farming as a natural way to manage urban-rural limits	Incredible Edible - Todmorden		Koper strategy for the protection of agricultural land	