PLUREL

Instruments and tools

Module 5

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PERI-URBAN LAND USE RELATIONSHIPS – STRATEGIES AND SUSTAINABILITY ASSESSMENT TOOLS FOR URBAN-RURAL LINKAGES, INTEGRATED PROJECT, CONTRACT NO. 036921

D5.2.2

Interactive Impact Analysis Tool

based on Multi Criteria Assessment for key indicators at EU 27 and case study level

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SIXTH FRAMEWORK PROGRAMME

Contents

PLUREL

Abstract

Objectives: The new integrated Impact Analysis Tool (iIAT) synthesises the modelling results from the impact analysis of land use changes of the EU-project PLUREL on peri-urban land use relationships and the effects of peri-urban land use change; www.plurel.net) into one stand-alone tool. It facilitates the integration of manifold aspects of problems of land use (change) and its functions and services related to urbanisation. It further considers conflicts of interest of different stakeholders such as residents, planners or developers within a planning process. The iIAT covers all dimensions of sustainability, namely the economic, the social and the environmental. Based on land use change maps, economic, social and environmental impacts are evaluated in terms of their sustainability impact using a range of indicators.

Methodology: The iIAT is an internet-accessible tool that displays results in form of sustainability spidergrams, which provide a surface that enables an easy and holistic perception of multilevel information on land use change impacts. The PLUREL iIAT consists of two modules: the iIAT-EU and the iIAT-Region. Hence, it covers two spatial levels: the EU27 and the regional (urban region) level.

Results: Being user determined, e.g. by displaying comparative spidergrams for different land use scenarios or for urban regions across Europe, the tool facilitates discussions for heterogeneous user groups ranging from an EU policy assistant to a regional or local planner. The paper presents the prototype version of the iIAT.

Popular science description: The iIAT-EU and Region is a computerised assessment tool for evaluating social, economic and environmental impacts of land use change by displaying sustainability spidergrams. It is web-based and can be run using Java at each computer, notebook, work station.

Keywords: Impact assessment tool; urban region; spidergrams

Classification of results / outputs:
For the purpose of integrating the results of this deliverable into the PLUREL Explorer dissemination platform as fact sheets and associated documentation please classify the results in relation to spatial scale; DPSIR framework; land use issues; output indicators and knowledge type.

Spatial scale for results: Regional, national, European	Regional, national, European
DPSIR framework: Driver, Pressure, State, Impact, Response	Pressure, State, Impact
Land use issues covered: Housing, Traffic, Agriculture, Natural area, Water, Tourism/recreation	All
Scenario sensitivity: Are the products/outputs sensitive to Module 1 scenarios?	Yes
Output indicators: Aggregated (EU27) and spatially explicit indicators (EU-Region); see Figures 2 and 4 in the document.	Yes
Knowledge type: Quantitative indicator values and respective models for calculation iIAT tool with Graphical User Interface (GUI)	Data, Tool

How many fact sheets will be derived from this deliverable:	**1**

1. Introduction

1.1 Peri-urbanisation in Europe

Urbanisation has arguably been the most significant process of land use change in Europe since the Second World War. Over 70 % of Europe's population now lives in urban areas, which in turn have grown in area by almost 80% over the last fifty years (EEA, 2006). The most obvious signs of this shift towards urbanisation are urban sprawl and the emergence of peri-urban areas, characterised by scattered built-up residential, industrial or commercial areas and dense transport networks, but also by the establishment in some places of green belts, recreational facilities, urban woodlands and golf courses, the conversion of farmstead complexes into housing and changes from conventional agricultural land uses into hobby farms and rural areas within easy reach of the city.

1.2 The PLUREL approach

The EU-project PLUREL (www.plurel.net) on peri-urban land use relationships and respective land use changes in rural-urban regions aims to achieve a deeper understanding of the changing relationships between urban and rural land use with an emphasis on the most dynamic portion, that of peri-urban areas. It develops methods and tools to assess the environmental, social and economic impacts of land use changes. Potential strategies and good practice examples will be identified in order to promote the sustainable development of land use systems in Rural-Urban Regions, especially the peri-urban. A multi-level approach is essential, both to identify driving forces and pressures, and to explore policy responses and opportunities. Thus the results will be targeted to the pan-EU level as well as for several case studies (Nilsson et al., 2009).

For the pan-European level, PLUREL develops typologies for Rural-Urban Regions, as well as future scenarios for spatial development (Ravetz and Rounsevell, 2008). These scenarios are assessed regarding their effects on land-use change, peri-urban land use relationships, as well as wider sustainability impacts, delivering outputs at NUTS2/3 level across the EU. For the case study level, PLUREL combines detailed collaborative case studies and stakeholder scenarios for peri-urban development pressures, planning and governance systems – with the development of quantitative land use scenarios, for the assessment of peri-urban land use relationships and sustainability impacts, both from regional policies and external driving forces.

What policy questions PLUREL is supposed to answer? It is expected to support end users towards a better and more integrated understanding of urban-rural interlinkages, of trends and processes specifically occurring in peri-urban areas, and of the possibilities to steer them. "End users" refers to policy makers at EU level as well as national policy makers and stakeholders in the case study regions.

1.3 The need for an integrative presentation of modelling results

Within the project, a huge number of modelling results in terms of land use change scenarios and impact analysis has been created. Discussions of scientists and (regional as well as EU-level) stakeholders showed the need for a summarising and comparative tool to provide an overview over all these results. Thus, the integrated Impact Analysis Tool (iIAT) was developed in discussion with stakeholders to synthesise the modelling results from the impact analysis of modelled land use changes into one tool. It is a tool for an integrated result presentation. The tool is multi-purpose and interactive in nature. It allows the integration of manifold aspects of problems of land use (change) and its functions and services related to urbanisation or land consumption. It considers conflicts of interest between different stakeholders within a land development, planning or governance process (Nijkamp et al., 2002; Nijkamp and Vreeker, 2000). The iIAT covers

all dimensions of sustainability, namely the economic, the social and the environmental, as required for integrative tools (Schetke and Haase, 2008).

2. The tool

Physically, the PLUREL iIAT is an internet-accessible tool that displays results in form of spidergrams. Those spidergrams provide a surface that enables an easy and holistic perception of multilevel information. These spidergrams allow for a visualisation of changes in indicators, as positive or negative trends according to different scenarios are immediately visible as shifts in the lines of the spidergrams. Different directions of shifts for two or more indicators thus show trade-offs between different dimensions of sustainability.

The interactive nature lies in the possibility for an in-depth view into different thematic scopes and different scales, chosen according to individual user interest. The tool accesses the impact assessment result database of PLUREL and generates the demanded outputs in the graphical user interface (GUI). Via the GUI it is possible to explore the effects of global drivers, national planning policies and local governance on land use change in rural-urban regions and, consequently, their impacts on sustainability. The iIAT is Java based. To use it, no installation etc. is necessary, but a connection to the internet has to be established.

The PLUREL iIAT consists of two modules: the iIAT-EU and the iIAT-Region. Hence, it covers two spatial levels: the EU27 in form of NUTSX regions (size-harmonized NUTS 2/3 regions) and the regional (urban region) level. Being user determined, e.g. by displaying comparative spidergrams, the tool facilitates discussions for heterogeneous end user groups ranging from an EU policy assistant to a local planner. What is more, collaboratively working with the iIAT provokes learning processes about different view on land use development (Haase et al., 2009).

2.1 The iIAT-EU

The iIAT-EU shows how the impacts of urbanisation under future scenario conditions will differ from the current situation (Nielsen et al., 2009). The initial situation 2000 (baseline) can be compared to up to four scenarios of future development (Ravetz and Rounsevell, 2008) for the two time slices 2015 and 2025. The main purpose of the iIAT-EU is to create awareness on how sustainability trends develop at different scales for different types of regions and where policy action might be necessary, thematically and spatially. It also allows distinguishing the impacts of trends in predominantly urban, peri-urban and rural regions. Underlying data are derived from modelling results at the spatial NUTS3 (administrative unit across the EU comparable with districts or counties) or NUTSX scale (Fig.1).

The major indicators the iIAT provides at the EU27-scale address the three pillars of sustainability (Level 1). Level 2 of the iIAT-EU allows gaining a deeper insight on the processes that we expect for different scenario settings. The indicators at level 3 specify the environmental categories of level 2 ‚habitat and biodiversity', ‚recreational value' and ‚regulation function' or the economic indicator ‚agricultural production'. For example, trends show an increase of horticultural areas and of small farms, but a decrease of forests and semi-natural areas (Figures 2).

In order to carry out comparisons, the user can choose different scales of outputs, e.g. the average EU-27 or in the predominantly peri-urban regions of Europe. The user may also choose different typologies for comparisons, so, for example a rural-urban and a mono- and polycentrism typology both developed in PLUREL (Loibl et al., 2008) or a European planning regime typology also developed in PLUREL but also typologies frequently used

by the EC such this of the coastal areas. Each NUTSX region has a characteristic profile, resulting from attributes that are derived from the different typologies. In the iIAT functionality they act as filter for the generation of grouped average values of one or more attributes (characteristics). So doing, it allows for comparisons with

- the national average,
- the same or other RUR type regions,
- other coastal areas,
- spatial planning types,
- innovation regions,
- low accessibility regions or
- high natural hazard regions.

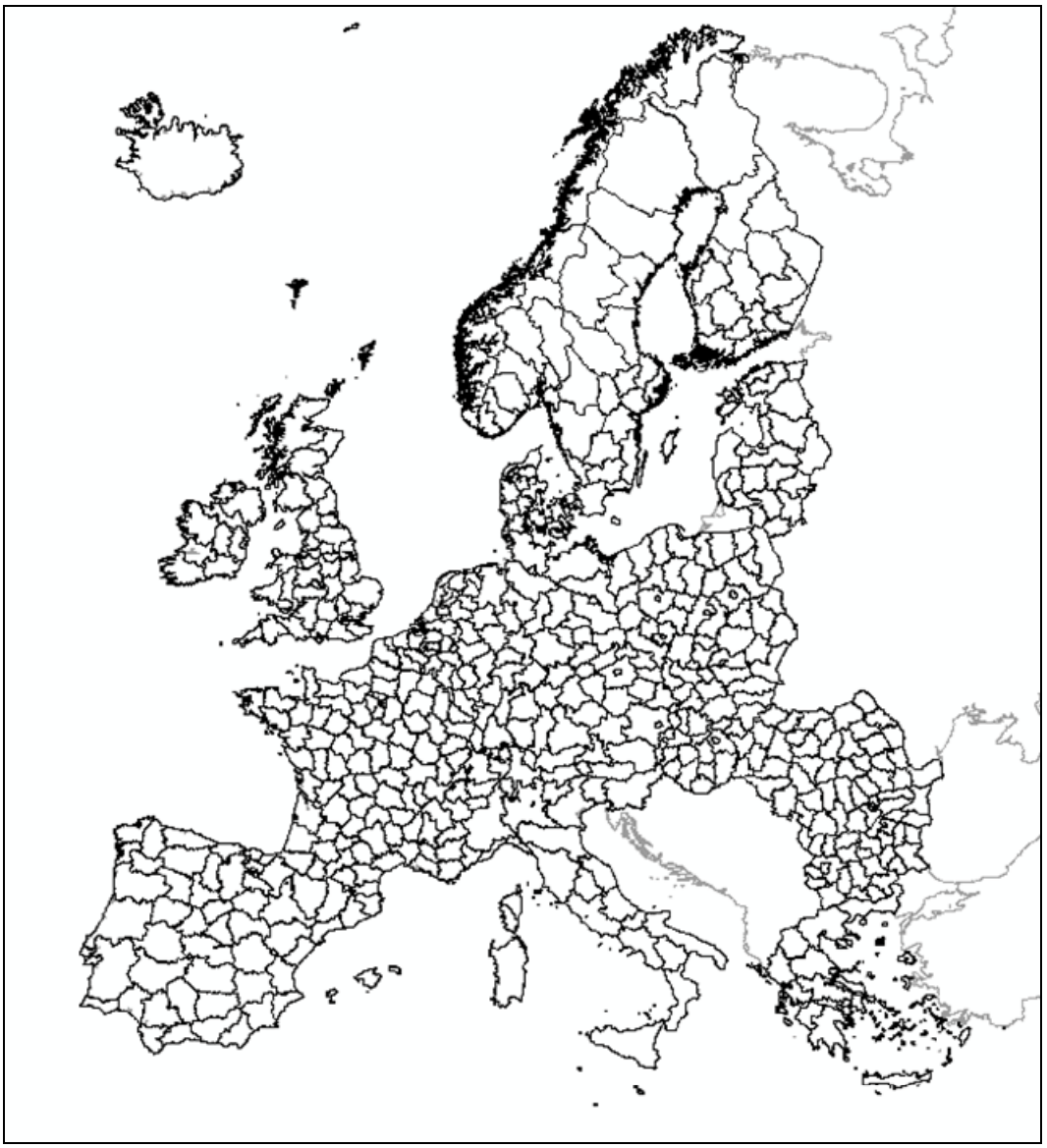
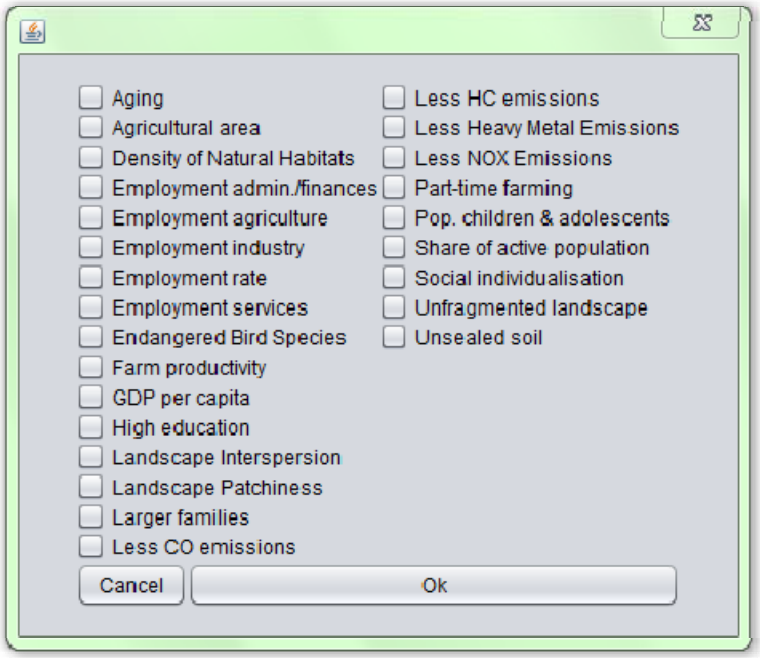


Figure 1: NUTS X regions of the EU27 (NUTS = Nomenclature des unités territoriales statistiques, Eurostat).



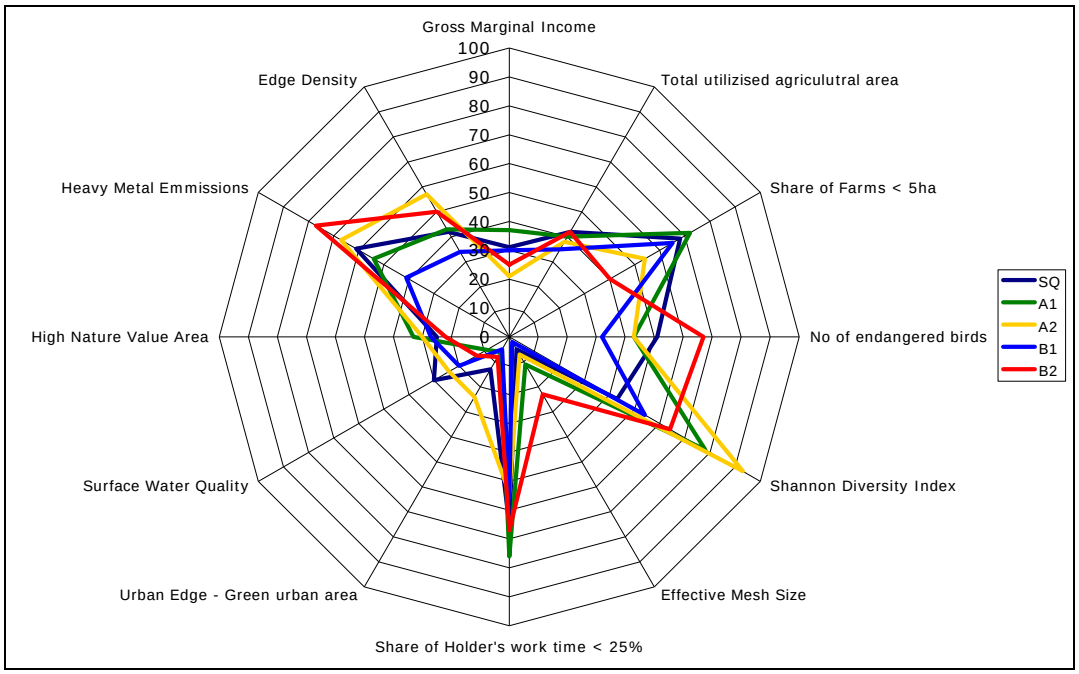


Figure 2: Spidergram displaying the integrated analysis of urbanisation impacts on sustainability (Level 2 indicators) using percentage values; the example average of predominantly peri-urban areas in the EU27.

By making use of the typologies the user will be enabled to carry out comparisons between a single NUTSX region and an average of other NUTSX groups or between groups (types). The data themselves will be transformed into standardized values in order to unify the scale of output data values between indicators. In the conduction of the standardization, at first we removed the outliers. Therefore all variables with a value above the 97.5 percentile were reduced to that value and all variables with a value below the 2.5 percentile were raised to this level. After that a z-standardization was made. For the z-standardization, the standard deviation was taken into account. We used the OECD

Statistics Working Paper in which the method is explained (Nardo et al., 2005). The data input into the iIAT is realised using an open source database format (PostgreSQL) which can be easily and freely updated by the user. Figure 3 shows the preliminary version of the GUI of the iIAT-EU in a stylised form.

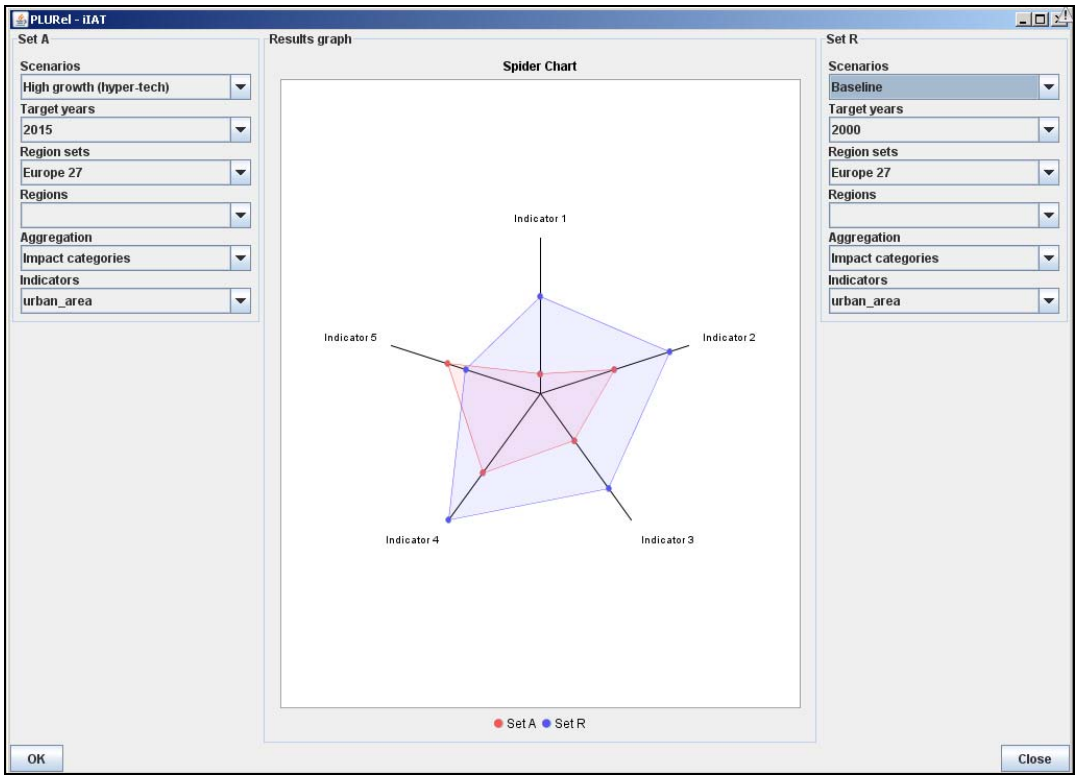


Figure 3: GUI of the first prototype of the iIAT.

2.2 The iIAT-Region

The iIAT-Region approach, technically similar to the iIAT-EU, allows selecting regional land use related impact indicators, the case studies to be compared, and the scenarios that should form the basis of the comparison, as well as thresholds or target values for single indicators. Currently, the six European PLUREL case studies are included: Haaglanden, Koper, Leipzig-Halle, Manchester, Montpellier, and Warsaw.

All values entering the iIAT-region database are change-values compared to the baseline of 2000 and/or a respective target value. They are given as relative changes in %. As output the iIAT computes interactively composed integrated spidergrams for a) different scenarios for one selected urban region or b) a range of indicators comparing different urban regions (cf. Figure 4).

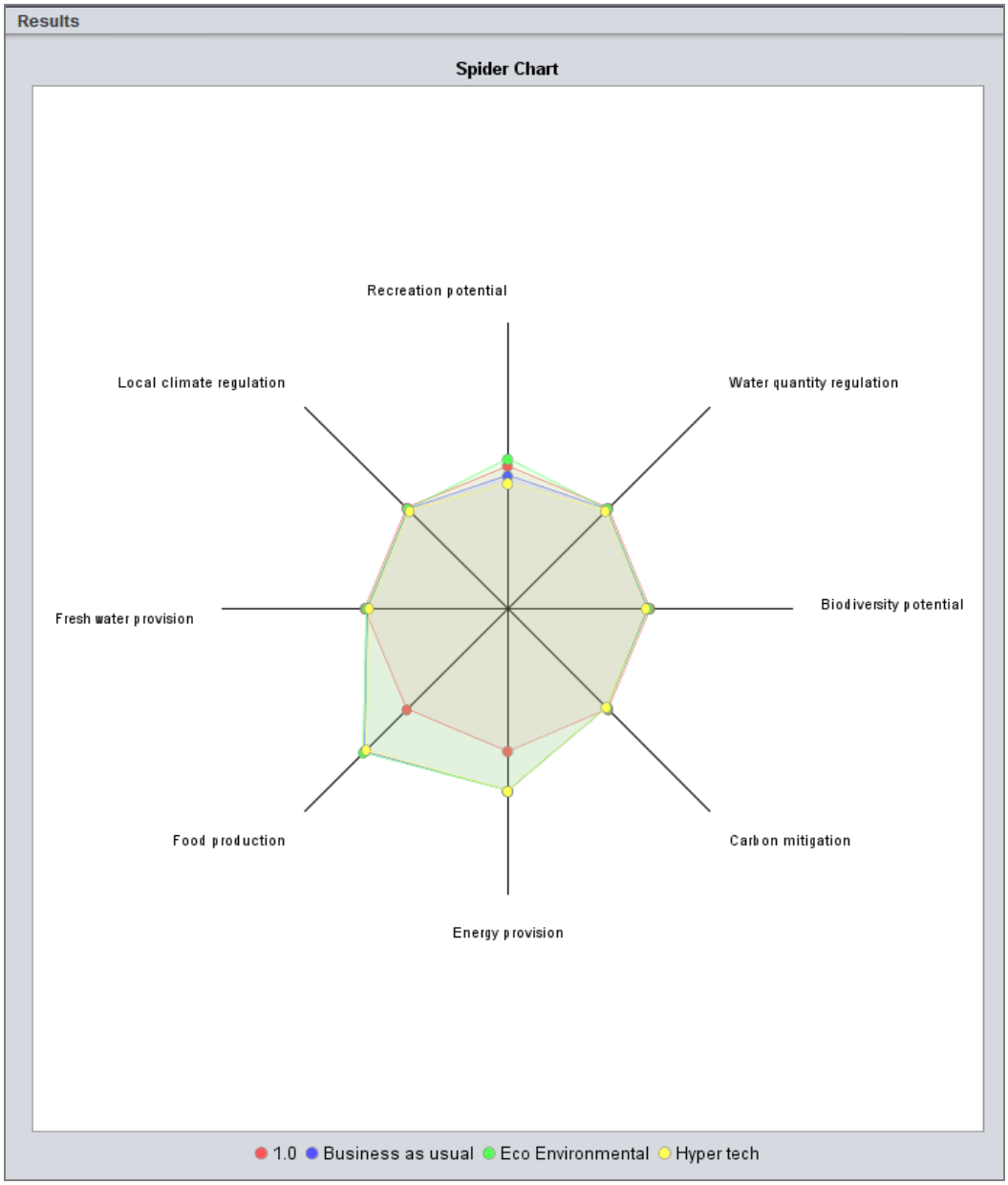


Figure 4: Sustainability spiders provided by the iIAT Region: A comparing assessment is possible between different scenarios for a selected case study or several case studies with only a single scenario.

Although relative numbers are visible, absolute numbers are available and stored in the database (as reference values and for additional or alternative computations). Compared to the iIAT-EU, the iIAT-Region additionally provides the possibility to enter target values for indicators by the user. Although it not a full participatory model, the iIAT-Region facilitates participatory decision processes of practitioners or policy makers.

3. Input data

3.1 Scenarios for land use change

The scenarios used for the iIAT consist of narrative letters related to the AB-scenarios of IPCC SRES and of quantitative demographic (Skirbekk, 2008) and economic trends (NEMESIS model). For the pan-European level, these scenarios were translated into input parameters for the RUG model (see below). For the case study level, planning and governance strategies are additionally incorporated based on regional stakeholder workshops and a joint "regionalization" of the pan-European scenarios to be used as input for the MO LAND model (see below). Thus, planning is translated into land use neighbourhood attraction curves and suitability maps that stand for planners' decision-making. These scenarios are comparable in terms of their storylines, but not in terms of model specifications as different models are used for different spatial levels and the scenarios for the case studies are locally adapted. Additionally to these scenarios, for each level of analysis a "baseline" in terms of land cover in the year 2000 is available.

3.2 Land use change models

The scenarios of future land use development of rural-urban regions across Europe are computed using the European-wide RUG-model (Rickebusch and Rounsevell, 2009) or the regional MOLAND cellular automaton. The RUG model for all urban regions across Europe uses regression functions, gravity and cost-distance functions to simulate land use change from non-urban to urban and vice versa at a 1km-grid (covering nearly 4.2 million pixels). The main input to RUG is a projection of the quantity of artificial surfaces per NUTS 2 region for 2025. This is derived from projected population and GDP (Gross Domestic Product) per capita, both outputs of the NEMESIS model. To allocate these artificial surfaces within each region, the model also uses data such as travel times to the nearest cities (medium or large), distance from the coast and the presence of flood risk zones (Rickebusch and Rounsevell, 2009). The cellular automaton MOLAND and MOLAND light, respectively, work at the case study scale. MOLAND simulates land use change patterns for 100x100m grid cells stratified into about 15-30 land use classes for the time slices of 2005 and 2025. Growth rates (land use pressures) are determined by expert based regional estimates using targets for the future, e.g. residential land use based on population growth scenarios where additional demands for residential land per capita are based on the new (future) population projections. Particularly MOLAND light is a specific development within the PLUREL project: it is a tool that makes integrated dynamic modelling available to stakeholders (Petrov et al., 2009).

3.3 Indicator analysis

Based on the resulting land use change maps, economic, social and environmental impacts were evaluated for both the pan-European and the case study level. Due to data and model availability, the indicator sets for the two levels are not identical, although both cover the three sustainability dimensions.

The indicators the iIAT provides at the EU 27-scale address, as already mentioned the three pillars of sustainability (level 1). It is possible to select more specific impact categories and indicators for each dimension. The level 2 impact categories of the iIAT-EU allow gaining a deeper insight on the processes that we expect for each scenario: economic performance, food production, income, living environment, regulation, demography and housing. At level 3, the respective indicators specify e.g. the environmental impact categories such as habitat and biodiversity, recreational value and ecological regulation function (Figure 5). All indicators are computed in form of land use (change) response functions and represent mathematically bivariate regression functions.

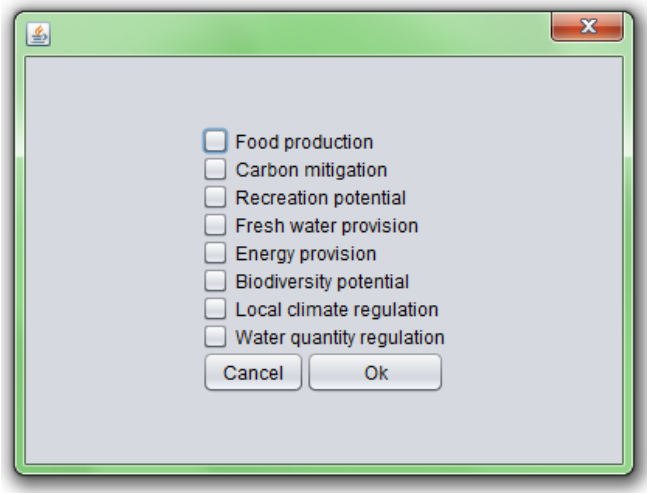


Figure 4: Indicators implemented in the iIAT-Region.

For the case study level, a range of indicators such as share of impervious surface, climate regulation potential, carbon storage, recreation area, biodiversity, employment in the industry or agrarian sector and population density was used (e.g. as proposed in Schetke and Haase, 2008, Haase and Schetke, 2009; Burkhardt et al., 2009). Land use impact models which use the land use change maps as input data are either statistical models (regression functions or machine learning algorithms), empirical models (in form of look-up tables), additive models or physically -based differential equation models (for calculating water supply or filtering functions for example).

4. Conclusions

To summarize, the relevance and practical use of the PLUREL iIAT is first of all the comparative and summarising presentation of impact modelling results. Additional values are the fostering of discussion processes on various levels of decision making: (1) The iIAT facilitates the exploration of possible future situations under the perspective of sustainable development. (2) The iIAT -EU helps to identify future policy issues and territorial action agendas for European policy-makers. (3) It provides an information basis and encourages European stakeholders within the different policy fields to search for a more sustainable land use development in urban regions with particular focus on the peri-urban space. (4) The iIAT-Region facilitates the inter-regional comparison and the identification of hot-spot regions with particular need to policy/planning intervention.

The iIAT will be available for public use. This publication raises the question of risks associated with this tool. Generally speaking, those results could be misinterpreted by the public, and this risk cannot be fully eliminated. However, the PLUREL scientists will provide accompanying documentation of all methods in a publicly available tool, the XPLORER (which will actually be the access point for the iIAT). In the XPLORER; descriptions of all methods, including scenario development, land use change modelling, and impact analysis related to all indicators, can be found and are especially targeted at practitioners and not a scientific audience.

The PLUREL iIAT is expected to be online available by the end of 2010. It will be introduced to the public in the International Conference "Managing the Urban Rural Interface", 19–22 October, 2010, in Copenhagen, Denmark (www.plurel.net/conference).

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