PLUREL

Instruments and tools

Module 5

September 2010

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

D5.1.5

Land use change balance calculation at RUR level

Land use change simulation map "explorer"

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SIXTH FRAMEWORK PROGRAMME

Contents

Abstract

Objectives:

The Deliverable contains 2 different tasks, serving as preparation tasks for other deliverables:

Task 1 refers to the land use change balance at RUR level – which refers to the artificial surface area subdivided into the 3 sub-region classes of each of the RUR regions and NUTS3 regions: urban, peri-urban and rural.

Task 2 refers to the integration of the land use change simulation within the graphical user interface embedded in the SIAT interface which is embedded in the PLUREL Xplorer. The demand for a more detailed result presentation led to the development of an interactive PLUREL result MapViewer which should enable later users of the system to explore the PLUREL RUR calculations in greater detail and to make it possible to depict the impacts of the 4 different scenario assumptions in a comprehensible way.

Methodology

The disaggregation of the land use data had been carried out by spatial intersection of the 1km grid cells of the RUG model output with the RUR sub-regions. The RUG models' artificial surface fraction numbers were recalculated to absolute artificial surface numbers to aggregate them to artificial surface area totals for each of the RUR sub-region classes for the RURs and for NUTS3 regions.
The land use simulation map explorer has been carried out by establishing a web.map server and developing a map layout to present indicators for land use transition to be integrated into the IIAT.

Results / findings / conclusion

The data were applied in a set of response functions, among them the population-, and the population-pressure related ones (e.g. air emissions), documented in deliverables D.2.3.3 -response functions air pollution & households and D.2.3.8-response functions population households)

The results are also viewed in deliverables D.2.3.3. population maps, and emission maps and are finally applied via the xplorer in the IIAT.

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	European, spatial explicit – disaggregated for NUTS3 / RUR subregions
DPSIR framework: Driver, Pressure, State, Impact, Response	Pressure
Land use issues covered: Housing, Traffic, Agriculture, Natural area, Water, Tourism/recreation	Artificial surface
Scenario sensitivity: Are the products/outputs sensitive to Module 1 scenarios?	yes
Output indicators: Socio-economic & environmental external constraints; Land Use structure; RUR Metabolism; ECO-system integrity; Ecosystem Services; Socio-economic assessment Criteria; Decisions	Land use structure
Knowledge type: Narrative storylines; Response functions; GIS-based maps; Tables or charts; Handbooks	Tables, maps

How many fact sheets will be derived from this deliverable:	No – content integrated in others

Introduction

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PLUREL'S WP5.1
Links to other WPs:

According to the PLUREL DOW (31.05.2010) the objective of WP 5.1 is

1. "to develop and maintain a GEO-compatible database containing data sets of the case study regions and further urban reference regions and additional data sets referring to land use and land use relationships, through compilation and harmonization of the datasets delivered by the project partners"

2. "to establish an information and map portal serving as a web based platform for data provision, exchange and integration of information on land use relationships in urban regions in Europe during and beyond the lifetime of the project."

And –as an extension later in the project-:

3. "to show quantities and patterns of peri-urban land use changes under different scenario framework conditions for different types of Rural-Urban Regions which are used as "show cases". The maps can be downloaded from the warehouse."

WP 5.1.5 was responsible for this last topic (No. 3).

Contributions to PLURELs end-products
The data sets are preparation work to be applied in the response functions. Indicators derived out of the data are integrated in the IIAT

As a result dissemination website the MapViewer is an PLUREL end-product of its own but is also linked to the PLUREL Xplorer (D 5.3.2) by expanding its possibilities to visualise the outcomes of the project's investigations .

Objectives of the deliverable

This deliverable should expand the dissemination possibilities of the PLUREL end-products via developing an interactive website that is capable of visualising the PLUREL RUR calculation results in a way that would emphasise the differences between the 4 scenarios better than in static maps.

Structure of the deliverable

Task 1 describes the work related to the calculation of the Land use balance and shows some indicators.
Task 2 will first explain the data basis of the MapViewer, i.e. the RUR landuse class calculation procedure. After that we will explain the data base structure for the map representation. Finally there will be a description of the technical implementation of the MapViewer itself and of its functionalities, as well as its capabilities to be referenced by other PLUREL end-products and tools.

1.1 RUR land use balance calculations

Concept and Approach

Land consumption and population distribution in the entire EU27 show various patterns with distinct differences in the urban-, peri-urban and the rural sub-regions.
The objective of this task is to provide initial data about the development of the artificial surfaces in the RUR sub-regions. These data will applied in various other work-packages to explore the relationships between population as driver and the respective pressures and land use – currently and for future scenarios.
Here we concentrate on the land use – population relations:
For the PLUREL future development scenarios (Ravetz et al, 2008) land use change modeling has been derived. These exercises have been limited to land use 2 classes: artificial surface and non-artificial surface (Rickebusch, 2009). In order to explore the current and the future relationships only those data are appropriate which can be provided for both time ranges. Thus we have to apply change in artificial surface, as derived for the PLUREL scenarios general proxy indicator for land use change.

The rural-urban region (RUR) typology (Loibl et al 2008a) and the RUR sub-region delineation (based on population density and land use characteristics) into urban-, peri-urban and rural sub-regions (Loibl et al, 2008b) was extended with a sub-region delineation for NUTSx regions within this task.
A RUR sub-region allocation of population numbers was also carried out within this task based on the RUG artificial surface 1xkm results and the IIASA population projections provided for NUTS 2 regions.
The PLUREL scenarios are the framework for all further modeling and assessment tasks. The scenarios bare certain assumptions about future development. The following figure 1 gives a short overview:

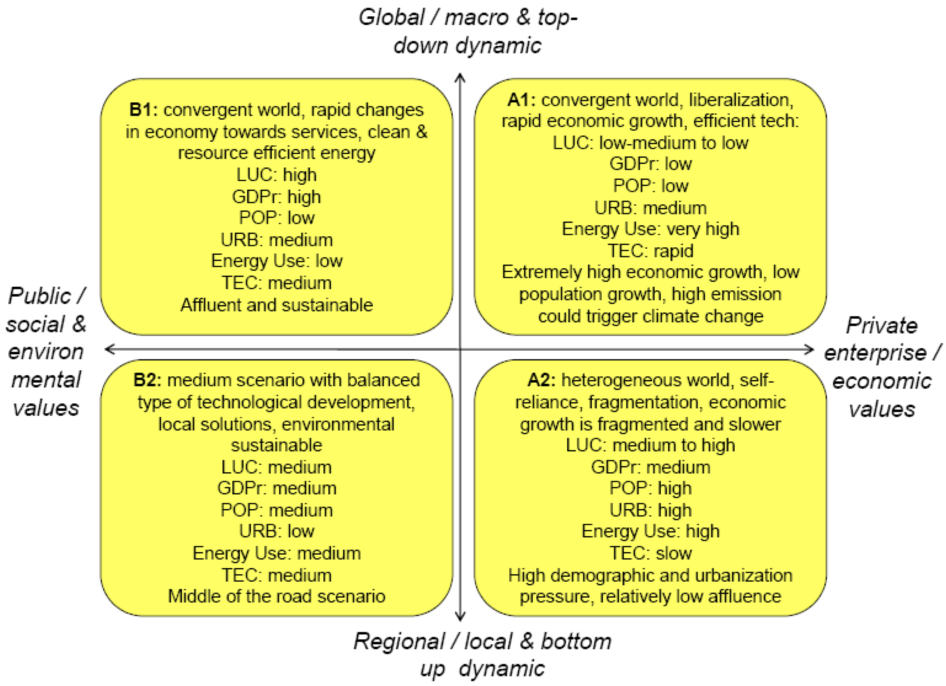


Fig. 1: PLUREL Scenario framework – overview (Raves et al, 2008)

The scenarios follow somehow the IPCC scenarios focusing on the urban and peri-urban issues.

- A1 “hyper tech” is the scenario with fast growth converging; rapid development without consideration of environmental or social issues.
- A2 “extreme water” is also fast growing but diverging: more fragmentation due to regional different initiatives.
- B1 “cleaner affluent” assumes sustainable usage of resources, suffering from decline because of lack of energy due to high oil prices
- B2 “social fragments world” let expect a competition of regions with green enclaves

Details can be found in the work packages addressed in the figure (WP1.1 to WP.1.4)

1.1 Data preparation - simplifying the RUR polygons und RUR sub-regions

The RUR region borders have been simplified (geometrically generalized be eliminating small patches and smoothing the borderlines) in order to allow more easy applications of GIS based analysis due to smaller file size. The file has been uploaded to the data warehouse as shape file for 3 sub-region classes (urban, peri-urban and rural). The original versions with 3 classes and 6 classes (2 population density classes for every sub-region type) showing the full fragmentation and edginess is still available as raster data sets in the data warehouse.

Figure 2 below shows this simplified delineation results for the 3 urban, peri-urban and rural sub-region types.

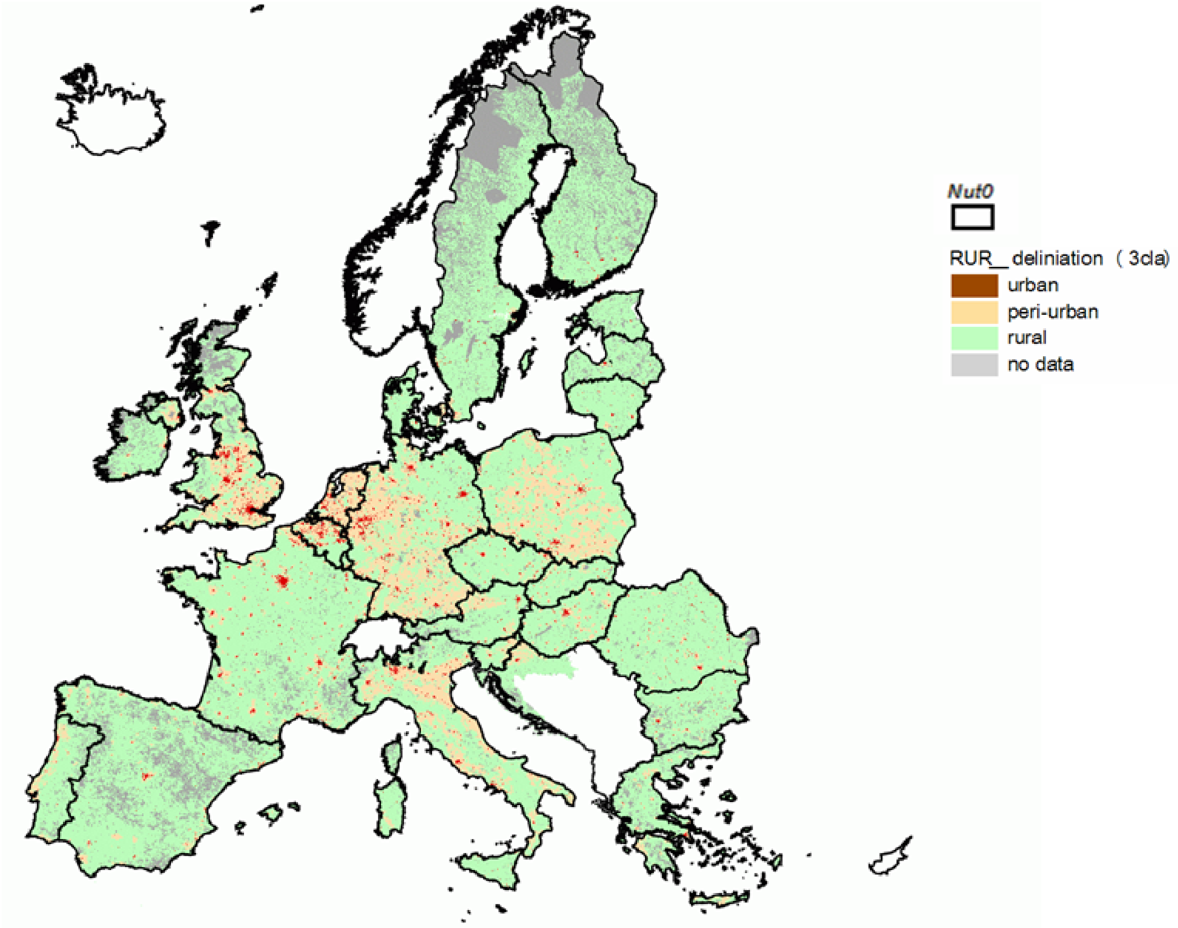


Fig. 2: Simplified RUR sub-region delineation into urban-, peri-urban and rural sub-regions (Loibl et al., 2008b)

1.2 RUG result processing – artificial surface

The RUG results aggregated for NUTSx regions by Rickebusch (2009) could not be applied for sub-region analysis as the information for the sub-regions were not extracted. To do so, the original 1x1km raster data sets had to be intersected by the RUR sub-regions, to identify for each raster cell to which sub-region type it belongs.
The original RUG results for 1x1 km cells for entire Europe have been provided as ASCII file with x/y coordinates and artificial surface fraction numbers. Those data have been re-transferred to a geo –spatial format to serve as GIS layer cells for further geometrical processing. We have decided not to apply a raster layer but a point file where only the cells, covered by artificial surface are considered and all other cells excluded to reduce the final point number (down to 7 millions) which allows an easier data handling.
To document population land use relationships for future scenarios allocation of population to the RUR sub-regions in a same way as the artificial surface is a crucial issue. As preparation for this step, the artificial surface fraction numbers provided from the RUG model was selected to recalculate the absolute artificial surface area for each1x1 km RUG model raster cell, covered (partly) by artificial surface and finally re-aggregated for the RUR sub-region entities, to be provided as NUTSx sub-region results. Here the 3D RUG model results, providing fraction values above 1, turn out to be a severe problem. The 3D version was initially the only one, delivered, which allows artificial surface increase above the fraction 1 (which is 100 % artificial surface coverage). A considerable number of raster cells show artificial surface fraction numbers of 3 or more - up to a fraction number of 21, which means a 2100 % artificial surface coverage, assuming a “total multiple storey artificial surface coverage” of a 1x1 km raster cell. These results are not appropriate to derive population growth numbers as growth in areas which were in 2000 occupied by artificial surface to - let’s say e.g. 70 % with a still considerable population density - there is not enough space to increase the population number for single 1x1km patches to explore future population – land use relationships.

We suggested spreading the growth fraction above 1 to the neighbouring cells (as done in cellular automata models (like Couclelis, 1985, White et al 1997, where MOLAND refers to), or in agent based models (like Portugali, 2000, Loibl et al, 2003, 2007), which was not considered by the RUG team. Instead it was suggested by them to cut off all exceedances above 1 or another threshold ignoring these “overshoots”. This has been done finally by the RUG authors delivering 3D- and a 2D-version, where all 3D-results higher than 100 percent artificial surface coverage had been set to 1.

These aspects had been explored during several tests for plausibility and data completeness and reported by mails and review papers to the authors, the module - and the project coordinator.

During the data final exploration tasks we have also recognized that in all scenarios the same 1x1 km cells are treated as artificial surface cells – the same raster cells which are covered by artificial surface shown by the RUG model input state for year 2000. The differences between these results are not different cells but differences in artificial surface fractions of the same cells. In other words urban sprawl was only simulated as increase of artificial surface fractions in those cells which already show settlement nuclei, but not in (adjacent) cells with other land uses.

The reason for this shortcoming lies in the model approach not to apply an agent based or cellular automata model, but a regression function based one, where only those entities which show values above 0 can increase and others not – also an artificial surface decrease was not possible and was not foreseen.

Thus, the RUG results for EU27 are rough estimations based on rough assumptions and may differ significantly from the MOLAND cellular automata model results delivered for the case study land use change simulations.

This preparation -, exploration - and aggregation steps have been done for 9 RUG data sets several times as various data versions had been delivered: the original year 2000 input and finally 16 scenario results - for 4 scenarios with 2 time targets 2015 and 2025 and 2 dimensions, finally for 2D and 3D.

The point file allows a fast spatial join of the delineation characteristics, provided as polygon file, with the RUG raster results. Every RUG point is covered by one certain RUR sub-region which allows a distinct information transfer. The following figure 3 depicts the process to merge the RUR sub-region types with the raster cell based RUG results.

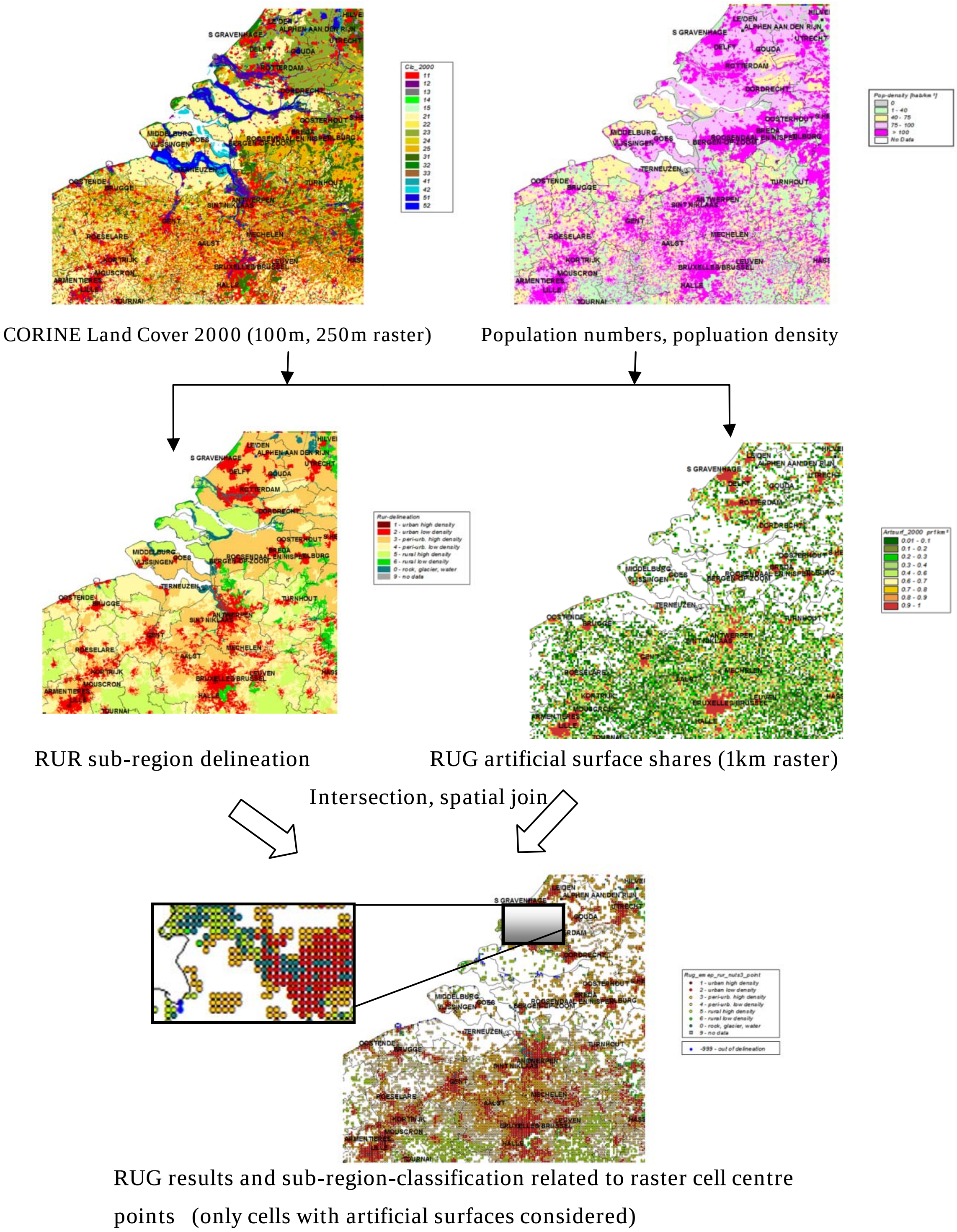


Fig. 3: Applied input data, the RUR delineation and RUG model results and the process to merge both. (Loibl W.)

1.3 RUG result processing - spatial distribution of population change

For the future possible changes regarding this relationships have to be explored. The only driver influencing land use which can be allocated to the 3 sub-regions with some certainty referring to currently available data is the population. This section describes the process to spatially distribute the projected population change to the urban, peri-urban and the rural sub-regions.

The initial allocation of the population numbers for year 2000 to the sub-regions is based to the municipality population numbers from EUROSTAT and the municipality density maps carried out by JRC applying CORINE land cover maps and the population numbers mentioned above (Gallego, 2007a,b)
The future population projections had been delivered by IIASA for NUTS2 regions (Skirbekk et al., 2007). To examine land use – population relationships for the future, a certain disaggregation of these changes had to be provided. As the RUG model results did not provide disaggregated population data, this disaggregation has to be carried out additionally in the current task.

The spatial distribution of population changes has been conducted at NUTSx sub-region level as requested by the M2 coordinator for further iIAT assessment. Our viewpoint was to use the RUR related sub-regions for further assessment of peri-urban issues, as we think that a general investigation of urban region issues at RUR level (containing entire functional rural urban regions) would be more appropriate than at NUTSx level (covering frequently only parts of rural urban regions, either more core city region parts or more peri-urban parts of a RUR). This result in sub-region shares within the NUTSx regions which may cause misleading interpretations: e.g. too little peri-urban share (because the peri-urban area is concentrated in a neighbouring NUTSx region), would lead to less growth in comparison with core city growth.

For the spatial distribution of future population changes, several versions to allocate the absolute NUTSx population change numbers had been tested. All approaches consider the change of the absolute artificial surface area and the relative fraction of change between the 3 sub-regions.
Finally two approaches had been applied, depending on the change characteristics – frequently a considerable population decline was projected by IIASA for the entire NUTS2 regions, which demanded the spatial distribution of population decline which has to be treated differently than distributing population growth as observed during former investigations (Loibl et al, 2007, Tötzer et al, 2009). (Growing population usually leads to population increase in the urban as well as the peri-urban regions, while population

decline frequently is concentrated on the core cities and the population numbers in the peri-urban surroundings remain stable.)

- Approach 1 – future population change in the rural and peri-urban sub-region is related to future artificial surface growth of the sub-region, weighted by the ratio (population-growth /artificial surface growth) of the corresponding NUTSx region:

$$\Delta P_{sub\text{-}region(i),t1} = \Delta AS_{sub\text{-}region(i),t1} * \Delta P_{NUTSx(j),t1} / \Delta AS_{NUTSx(j),t1}$$

  where:
  ΔP = change of population in person numbers
  ΔAS = change of artificial surface in km^2

  The urban sub-region receives the remaining ΔP:

$$\Delta P_{NUTSx(j),t1} - \Delta P_{sub\text{-}region\_peri(i),t1} - \Delta P_{sub\text{-}region\_rural(i),t1}$$

- Approach 2 – future population change is directly weighted by the current share of the population numbers in the sub-region:

$$\Delta P_{sub\text{-}region(i),t1} = \Delta P_{NUTSx(j),t1} * (P_{sub\text{-}region(i),t0} / P_{NUTSx(j),t0})$$

  The urban sub-region receives the remaining ΔP:

$$\Delta P_{NUTSx(j),t1} - \Delta P_{sub\text{-}region\_peri(i),t1} - \Delta P_{sub\text{-}region\_rural(i),t1}$$

The decision, which of the two approaches shall be applied, is based on the test, whether the population totals ($P_{sub\text{-}region(i)} + \Delta P_{sub\text{-}region(i)}$) of the rural and peri-urban sub-region couple show negative values.

The first approach provides most plausible results and had been often applied when population growth is expected and all sub-regions show artificial surface shares. Only when approach 1 had delivered negative population total numbers for the peri-urban or rural sub-regions, approach 2 had been applied. The latter occurred, when the population number decline was expected intensively and/or when the rural or peri-urban sub-regions show small population numbers where the share of the negative $\Delta P_{NUTSx(j),t1}$ was larger than the original population total of the sub-region. With the first approach population decline numbers would result in a disaggregation factor calculated as population shrinkage, divided by artificial surface growth, which is somehow odd. Then the 2nd approach seemed to be plausible for these cases, concentrating population shrinkage in sub-regions with larger population numbers which were usually the urban cores.

The application of population density as a spatial distribution factor seemed first to deliver appropriate results, avoiding any negative values, but this would lead to a constantly increasing concentration of population growth in the urban centres, what had not been observed in the case study sites and from further explorations (Loibl et al, 2003, Loibl et al, 2007, Loibl et al, 2008, Tötzer et al, 2009).

One has to stress that these disaggregation attempts delivered only rough results based on population projections and artificial surface growth model results which are all rather vague, bearing high uncertainties. The task has to be seen as a workaround due to lacking spatially explicit modelling of population change as conducted in agent based urban growth models (c.f. Portugali, 1997, Loibl et al., 2003, 2007). Nevertheless these data sets are the only one available and we have to continue with our explorations and response function estimations keeping in mind these uncertainties.

1.4 Results: artificial surface and population related to the RUR sub-regions

The artificial surface projection distribution and the population projection distribution to NUTSx regions and the respective RUR sub-regions is delivered as EXCEL-dataset containing the results for the current state 2000 and for every scenario A1, A2, B1, B2 and for both time ranges 2015 and 2025. The data will be uploaded to the data warehouse and are integrated in indicators to be delivered for the iIAT.
The table 1 below lists the metafile of one sheet of the table – the land use and population related data and further indicators delivered for each of the PLUREL scenarios A1,A2,B1,B2.

Table 1 List of the artificial surface and population data and indicators for the PLUREL scenarios - to be applied in various deliverables (among them the IIAT)

var_name	subregion	content	comment	unit	source
Num		sequence number	backward sorting help		
NUTSX		NUTSX code			
Scenario		A or B or Reference			
Time		2000 or 2015 or 2025			
capital		marker	marker c= captial		
N_0		Country code			
NAME		NUTSX name			
ASurface_urban	urban	artificial surface	1x1km2 Aggregates	km2	RUG/AIT
ASurface_peri	peri-urban	artificial surface	1x1km2 Aggregates	km2	RUG/AIT
ASuface_rural	rural	artificial surface	1x1km2 Aggregates	km2	RUG/AIT
ASurface_sum	total	artificial surface	1x1km2 Aggregates	km2	AIT
ASurf_urban_pct	urban	artificial surface	share of all NUTSx art.surf	pct	AIT
ASurf_peri_pct	peri-urban	artificial surface	share of all NUTSx art.surf	pct	AIT
ASurf_rural_pct	rural	artificial surface	share of all NUTSx art.surf	pct	AIT
ASurf_urban_rshare	urban	artificial surface	fraction of Subregion	pct	AIT
ASurf_peri_rshare	peri-urban	artificial surface	fraction of Subregion	pct	AIT
ASurf_rural_rshare	rural	artificial surface	fraction of Subregion	pct	AIT
ASurf_change_pct	entire area	artificial surface	change since 2000	pct	AIT
Pop_urban	urban	population	see Milestone report		AIT/RUG/JRC/IIASA
Pop_peri	peri-urban	population	see Milestone report		AIT/RUG/JRC/IIASA
Pop_rural	rural	population	see Milestone report		AIT/RUG/JRC/IIASA
Pop_sum	entire area	population	see Milestone report		AIT/RUG/JRC/IIASA
Pop_urban_pct	urban	population	fraction of Subregion	pct	AIT
Pop_peri_pct	peri-urban	population	fraction of Subregion	pct	AIT
Pop_rural_pct	rural	population	fraction of Subregion	pct	AIT
Pop_change_pct	entire area	population	change since 2000	pct	AIT
AS_cap_urban	urban	Artif. surface per capita	Land consumption	m2	AIT
AS_cap_peri	peri-urban	Artif. surface per capita	Land consumption	m2	AIT
AS_cap_rural	rural	Artif. surface per capita	Land consumption	m2	AIT
AS_ch_urban	urban	Land consumption %	change since 2000	pct	AIT
AS_ch_peri	peri-urban	Land consumption %	change since 2000	pct	AIT
AS_ch_rural	rural	Land consumption %	change since 2000	pct	AIT
openS_urpe_ha	ur&peri	open space - urban & peri-urban	total area - artif. surface	ha	AIT
openS_sum_ha	all	open space - entire subregion	total area - artif. surface	ha	AIT
openS_urpe_share	ur&peri	open space - urban & peri-urban	fraction of ur&peri area	pct	AIT
openS_share	all	open space - entire subregion	fraction of NUTSx area	pct	AIT
OS_cap_urpe_m2	ur&peri	open space per capita urban & periurban		m2	AIT
OS_cap_sum_m2	all	open space pe capita total NUTSx		m2	AIT
OS_cap_ratio	all	ratio urban&peri open space-cap / all open space-cap		ratio	AIT
ar_urban	urban	area -total	only reference !!	km2	AIT
ar_peri	peri-urban	area -total	only reference !!	km2	AIT
ar_rurral	rural	area -total	only reference !!	km2	AIT
ar_nodata	no data / no landuse		only reference !!	km2	AIT
area_total	NUTSx	area	only reference !!	km2	
GDP2001	all	GDP	only reference !!	mill eur.	NEMESIS

Source: Loibl W., 2010 – pop_aSurf_IIAT.xls - metadata listing

The file "pop_aSurf_IIAT.xls", containing population - and artificial surface data for the PLUREL scenarios, was delivered to some partners and uploaded to the data warehouse. The data have been provided for 2005 as current time and for all 4 scenarios for the years 2015 and 2025 . The maps showing absolute artificial surface numbers make no sense as they show strong relation to the size of these areas. So we present some indicators derived from these absolute numbers: proportion of artificial surface and population in peri-urban areas, change in these proportions for the 4 scenarios.

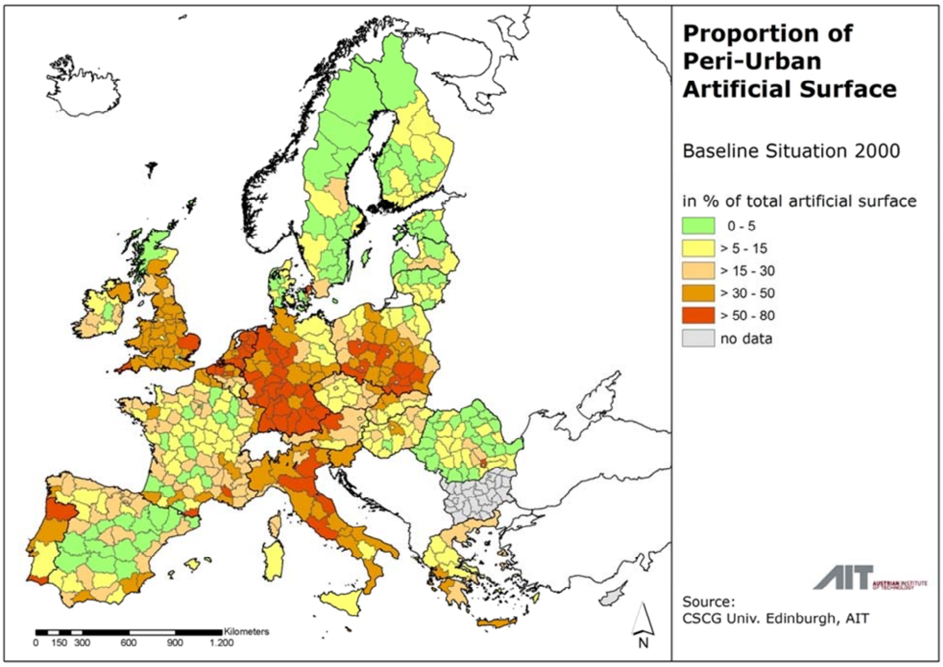


Fig. 4: Proportion of peri-urban artificial surface in % of total artificial surface 2000

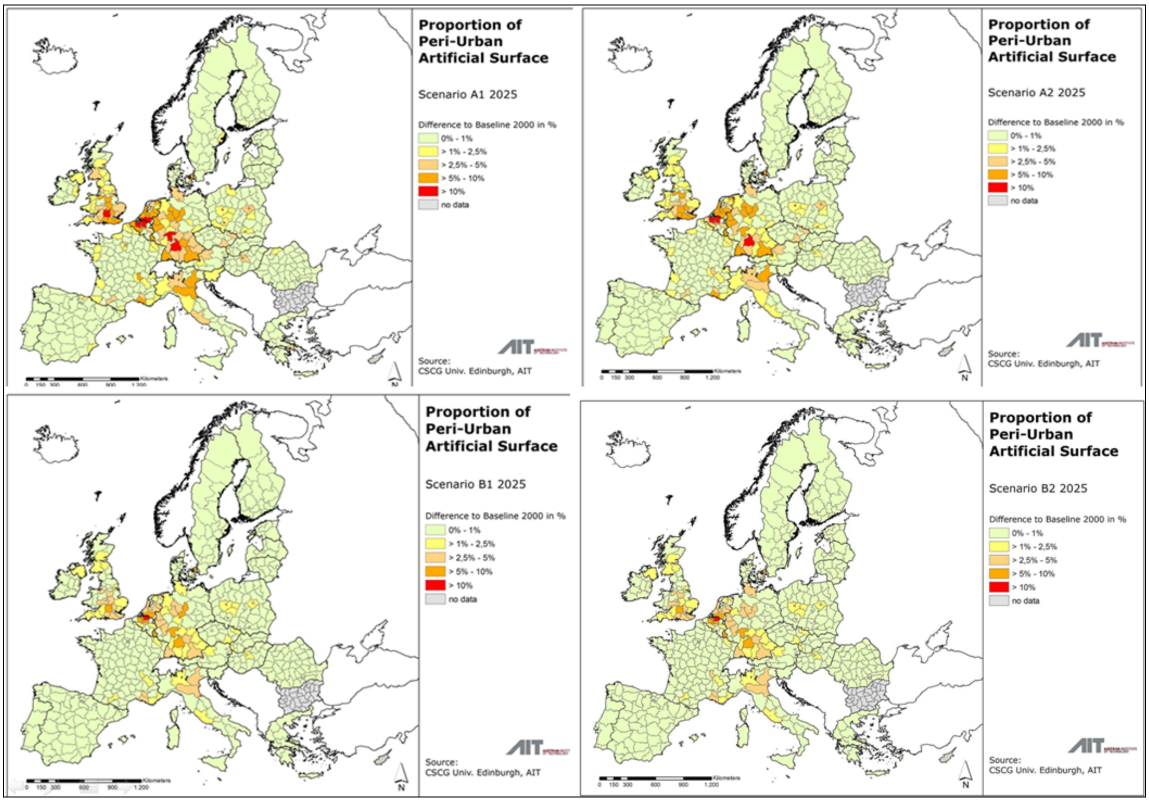


Fig 5: Change in the proportion of peri-urban artificial surface for the scenarios in 2025 (difference to baseline 2000 in %)

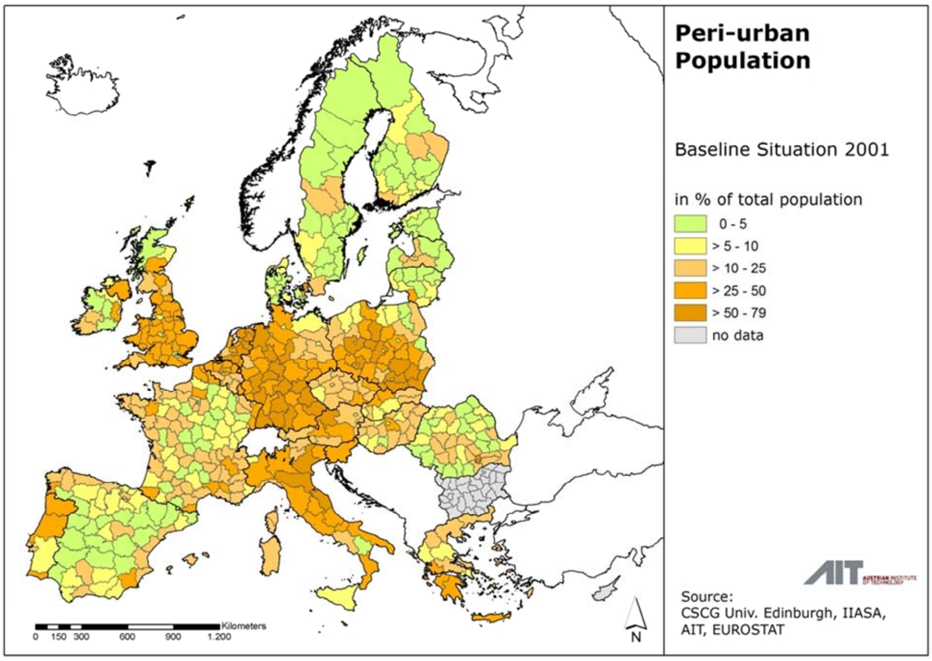


Fig. 6: Proportion of peri-urban population in % of total population 2000

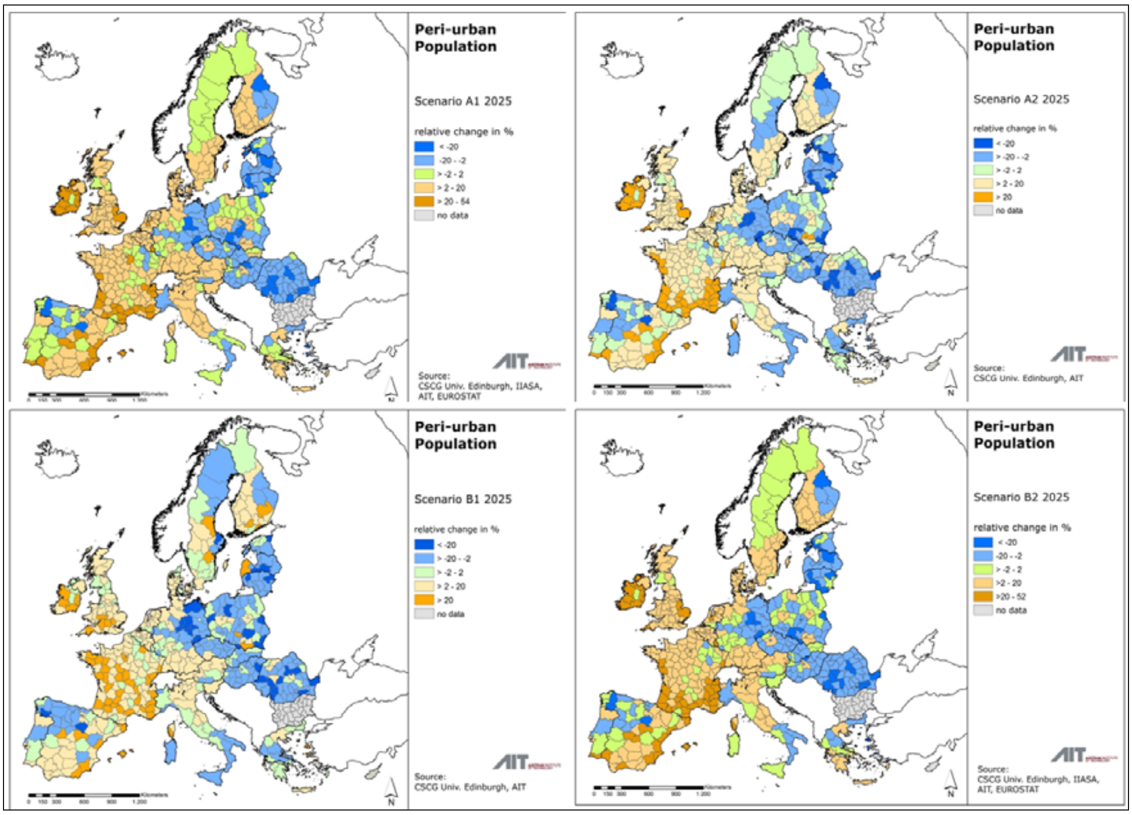


Fig 7: Change in the proportion of peri-urban population for the scenarios in 2025 (difference to baseline 2000 in %)

1. Map explorer development

2.1 Database structure for the MapViewer

The results from the land use class calculations existed as MS Excel sheets and had to be transferred to a data base in order to be visualised in a map (i.e. the MapViewer application). All data was based on NUTS3 regions and had been calculated for the four scenarios A1 (“Hypertech”), A2 (“Extreme Water”), B1 (“Peak Oil”) and B2 (“Fragmentation”) (for a detailed description of these scenarios see e.g. D 1.1.2). For easy retrieval via an SQL search the data for each scenario was merged into one table (Fig. 8).

Num	NUTSX	Scenario	Time	N_0	NAME	Pop_sum	area_total	NOx_02_kg	NOx07_kg
1	AT11	Reference	2000	AT	Burgenland	277.652	3.965,8	53.436	240.000
511	AT11	A1	2015	AT	Burgenland	284172	3965,776734	56.234	245.736
1021	AT11	A1	2025	AT	Burgenland	286397	3965,776734	60.893	247.926
1531	AT11	A2	2015	AT	Burgenland	284902	3965,776734	56.337	246.365
2041	AT11	A2	2025	AT	Burgenland	285133	3965,776734	59.465	246.759
2551	AT11	B1	2015	AT	Burgenland	284083	3965,776734	55.514	245.615
3061	AT11	B1	2025	AT	Burgenland	283781	3965,776734	57.869	245.511
3571	AT11	B2	2015	AT	Burgenland	283749	3965,776734	55.446	245.326
4081	AT11	B2	2025	AT	Burgenland	284654	3965,776734	57.581	246.232
2	AT12	Reference	2000	AT	Niederösterreich	1.545.754	19.194,4	480.000	1.834.000
512	AT12	A1	2015	AT	Niederösterreich	1.650.226	19.194,4	525.417	1.960.278
1022	AT12	A1	2025	AT	Niederösterreich	1.705.976	19.194,4	592.940	2.030.571
1532	AT12	A2	2015	AT	Niederösterreich	1.652.368	19.194,4	525.597	1.962.823
2042	AT12	A2	2025	AT	Niederösterreich	1.697.639	19.194,4	574.355	2.019.513
2552	AT12	B1	2015	AT	Niederösterreich	1.647.585	19.194,4	516.160	1.956.527
3062	AT12	B1	2025	AT	Niederösterreich	1.687.730	19.194,4	552.746	2.006.484
3572	AT12	B2	2015	AT	Niederösterreich	1.647.694	19.194,4	515.696	1.956.626
4082	AT12	B2	2025	AT	Niederösterreich	1.695.457	19.194,4	549.371	2.015.331

Fig. 8 Data base table – example

To visualise the data, a NUTSx polygon map was added to the database as well (see Fig. 9, for a details technical description see chpt. “Technical implementation”)

	nutsx character varying(5)	the_geom geometry	first_name character varying(60)
1	AT11	0101000020DB0B00007ACD111DBD5A5241DCA0B	Burgenland
2	AT12	0101000020DB0B00004ADFC891731C524140662E	Niederösterreich
3	AT13	0101000020DB0B00008E58C5374C4A5241EDDD7	Wien
4	AT21	0101000020DB0B000023B933BF24A05141BE6910	Kärnten
5	AT22	0101000020DB0B0000AE965E2646EE514107BD75	Steiermark
6	AT31	0101000020DB0B00000B42BAF0EC9B514123BDB6	Oberösterreich
7	AT32	0101000020DB0B0000CDDDD3BE485F51416F603	Salzburg
8	AT33	0101000020DB0B0000C15D8D0BF8EA50418B69A	Tirol
9	AT34	0101000020DB0B0000122F3FDC147450410BBD0D	Vorarlberg
10	BE10	0101000020DB0B000037C3C7AECAF14D410E453	Région de Bruxelles-Capit
11	BE21	0101000020DB0B00001C593B84C6274E41736E0E	Prov. Antwerpen
12	BE22	0101000020DB0B000096F47A3719854E41484A9F	Prov. Limburg (B)
13	BE23	0101000020DB0B0000BDF59C326CA94D413C6A6	Prov. Oost-Vlaanderen
14	BE24	0101000020DB0B000055B296FC7C104E410E9AC4	Prov. Vlaams-Brabant
15	BE25	0101000020DB0B000038014337341 4D417CF8D8	Prov. West-Vlaanderen
16	BE31	0101000020DB0B0000FD7185895B0C4E4119E38A	Prov. Brabant Wallon
17	BE32	0101000020DB0B0000E1B4F7F827B34D41DAC91E	Prov. Hainaut
18	BE33	0101000020DB0B00007EFE18A360A94E414C62A7	Prov. Liège

Fig. 9: NUTS3 polygon map in data base format

This NUTS3 base map was then used to “join” the data from the result tables to the respective NUTSx regions.

2.2 Map viewer implementation

The MapViewer has been designed as a stand alone website, that can be easily accesed via a browser (Adobe Flash® has to be installed) and an Internet connection.

The server side consists of the following components (all of which are open source software components):

1. UMN Mapserver to serve the maps via data retrievel from the PostGreSQL database
2. PostGreSQL database to hold the data for the maps
3. PostGIS – PostGreSQL extension to spatially enable database tables
4. Apache webserver to serve the HTML content

UMN Mapserver
The UMN Mapserver (http://mapserver.org/) is a widely used mapserver application that can be used to create images of geographic data situated on the same (or a remote) server according to user requests via Internet queries. These images are then served via the user’s browser. In the case of the PLUREL MapViewer the mapserver handles the map creation according to the “theme” and “subcategory” the user is interested in (see chpt. “Functionalities of the user interface”).

PostGreSQL database
PostGreSQL (http://www.postgresql.org/) as the “world’s most advanced open source database” (as the web site states) has been used to serve the result data tables from the RUR landuse class calculations and the corresponding NUTSx map data in tabular form. As a database system PostGreSQL offers a very reliable, robust and fast means of delivering tabular data and carrying out sophisticated SQL requests on the fly.

PostGIS
PostGIS (http://postgis.refractions.net/) is an extension to PostGreSQL and enables the database to serve spatially enabled data, i.e. adds the geographic location to a dataset. In the case of the PLUREL MapViewer PostGIS handles the join of the different result data to the respective NUTSx polygons -represented as a table in the database- through “connecting” them to the corresponding polygons via their ID.

Apache webserver
Apache is an open-source HTTP server that is also widely used on the internet. It is a robust and highly configurable HTTP server and is used to serve the map data for the PLUREL MapViewer.

On the client side the MapViewer uses
1. HTML, Javascript, CSS and Adobe Flash as programming languages and
2. Flamingo Viewer (http://flamingo.gbo-provincies.nl/) as a highly configurable map client

```
<fmc:Container borderwidth="0" bordercolor="#b8b8b8" right="xcenter -22" bottom="ycenter -6" left="left" top="top">
<fmc:Text left="10" top="10" width="200" height="20">
<style id=".tx3" font-family="verdana" font-size="11px" color="#666666" display="block" font-weight="normal"/>
<string id="text">
<en><![CDATA[<span class='tx3'>Scenario A1 - "Hypertech"</span>]]></en>
</string>
</fmc:Text>
<fmc:BorderNavigation width="100%" height="100%" listento="map_a1,map_a2, map_b1,map_b2" />
<fmc:MonitorLayer id="monitormap1" left="10" top="30" listento="map_a1"/>
<fmc:Map id="map_a1" holdonidentify="true" fadesteps="5" movetime="200" movesteps="5" holdonupdate="false" right="right" bottom="bottom"
left="left" top="top" fullextent="-45309,226784,7676833,6021773" nrprevextents="10" extent="650000,1500000,6600000,4300000">
<fmc:LayerOGWMS id="wms_a1_nox_total_00to25_idx" visible="true" format="image/png"
maptip_layers="#ALL#"
url="http://plurel.ait.ac.at/cgi-bin/mapserv5?map=/var/www/plureldata/map_app/emissions_scen.map&scenario=a1_2025"
VERSION="1.1.1" SERVICE="WMS" SRS="EPSG:3035"
LAYERS="nox_total_00to25_idx,mjwater,nutsx,eurasia_countries_small_scale,eurasia_countries_borders,eurasia_countries_borders_thin" >
</fmc:LayerOGWMS>
<fmc:LayerOGWMS id="wms_a1" visible="true" format="image/png" maptip_layers="#ALL#"
url="http://plurel.ait.ac.at/cgi-bin/mapserv5?map=/var/www/plureldata/map_app/map_app_neu.map"
VERSION="1.1.1" SERVICE="WMS" SRS="EPSG:3035"
LAYERS="open_sea_eurasia,eurasia_countries,copyright">
</fmc:LayerOGWMS>
```

Fig. 10: Example of Flamingo Viewer ‘s configuration file (clipping)

The MapViewer works as follows:

1. The user accesses the web page via his or her web browser either by entering the website directly or by being linked from another site/application (e.g. PLUREL Xplorer, PLUREL iIAT)
2. The user has then the possibility to explore the map or the switch through different “themes” and their “subcategories” (see next chpt. “Functionalities of the interface”

2.3 Functionalities for the user interface

The user interface of the MapViewer consists of a HTML web page with an embedded Flamingo Viewer (Fig. 11)

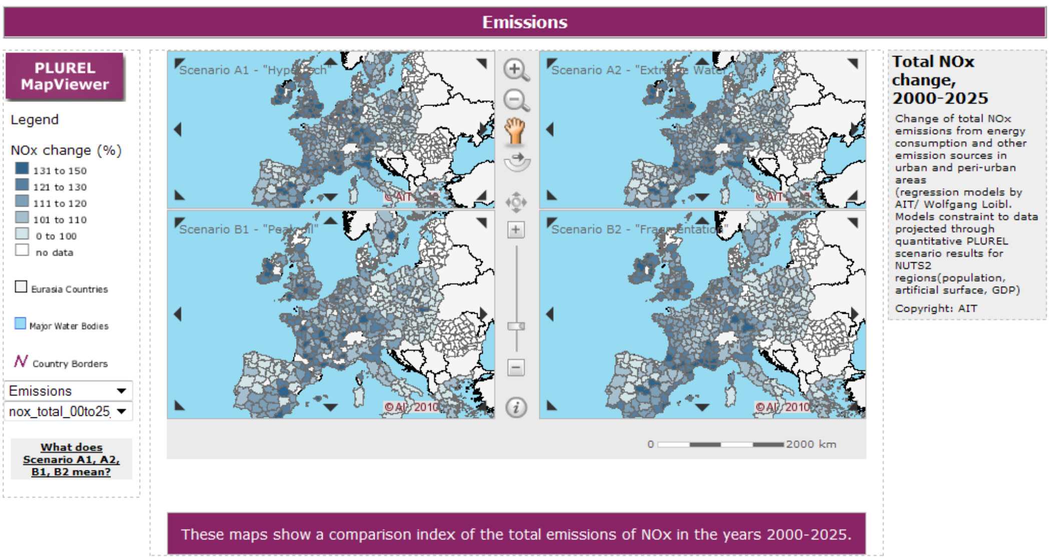


Fig. 11: MapViewer interface

The Viewer offers a set of functionalities:

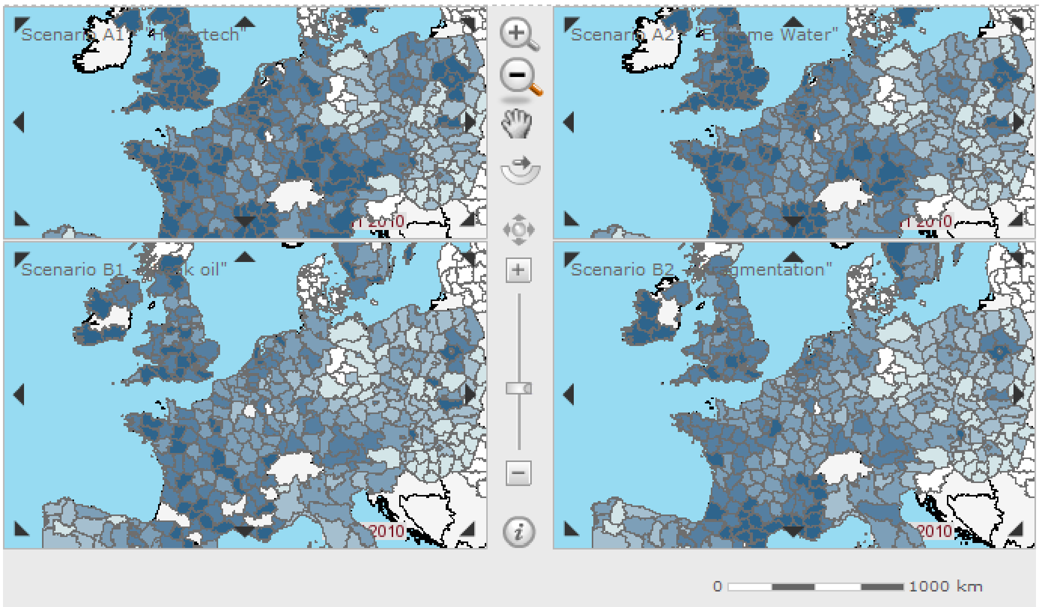
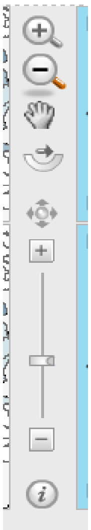


Fig. 12: MapViewer Map window



Zoom in
Zoom out

Pan
Measure

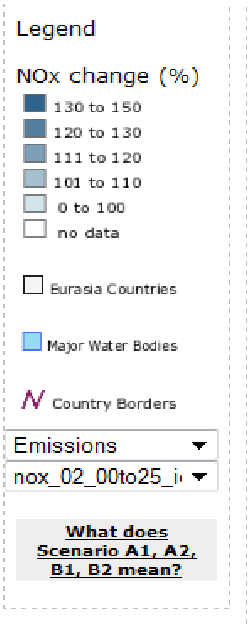
Full Extent

Zoom via slider

Map Query

Fig. 13: Tool bar fot the available functionalities.

Legend



Theme drop-down

Sub-category drop down

Scenario explanation

Fig. 14: MapViewer Legend and category dropdowns

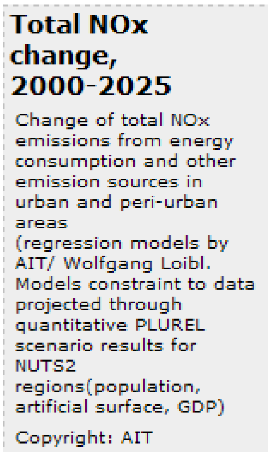


Fig. 15: Map explanation

2.4 Provision of acess capabilities from other PLUREL products

The MapViewer has been designed to be “link-able”, i.e. it is possible to access a desired content via URL parameters like:

http://plurel.ait.ac.at/plurel/mapviewer32/css_test.html?theme=emissions &sub=co_02_00to25_idx

In this way it is possible tohave direct access to maps from e.g. the PLUREL Xplorer or the PLUREL iIAT.

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