PLUREL

Land Use Relationships
In Rural-Urban regions

Module 2

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Land use projections based on Moland output

Part C: Summary of effects of policy and summary of effects by the rural/periurban/urban subregions in Leipzig, Haaglanden, Montpellier and Koper

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SIXTH FRAMEWORK PROGRAMME

Contents

Abstract

The cellular-automata model Moland was applied to four case studies throughout Europe: Leipzig (DE), Koper (SI), South Holland (NL) and Montpellier (FRA) at variable spatial and thematic resolutions. The scenario description, the land use classes and the time frame were developed in collaboration with local stakeholders within the context of the project PLUREL, and therefore differ from one another. Qualitative scenario descriptions were laid out and translated into appropriate terms for the land use modelling exercise.

Firstly, this note presents the aggregated results for the land use simulations performed for the four PLUREL case studies, following the sub-regional subdivision defined in the RUR terminology: urban, peri-urban and rural areas. For each case study a brief description of the policy scenarios and of the achieved simulations is given.

Then, a more detailed analysis is performed for the scenario B1 which, although with many local variations, is common to all case studies. MOLAND simulated results are herein compared with a common European-wide simulation for the same baseline scenario.

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/European
DPSIR framework: Driver, Pressure, State, Impact, Response	Driver/Pressure/State/Impact/Response
Land use issues covered: Housing, Traffic, Agriculture, Natural area, Water, Tourism/recreation	Housing, Traffic, Agriculture, Natural area, Water, Tourism/recreation
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	None
Knowledge type: Narrative storylines; Response functions; GIS-based maps; Tables or charts; Handbooks	Tables and charts

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

1. Introduction

The main aim of this note is to compare the outcomes of the four PLUREL test cases duly taking into account the dissimilarities amongst the cases and keeping present that it is not logically (nor technically) correct to directly compare the case studies to one another because of differences in legend, scale and input parameters between the test cases.

Moland was specifically developed for urban and regional simulation, with the aim of representing spatial dynamics. Each cell in the input/output maps corresponds to a different land use, and the change of the status of each cell depends on a set of parameters such as the inherent suitability for each land use, zoning restrictions, and accessibility of transport network, but also on the composition of the neighbourhood. To achieve this goal, the model incorporates several transition rules which establish the attraction or repulsion between different land uses. The manipulation of input parameters and transition rules allows the definition of 'ad-hoc' scenarios of future land use developments.

Scenario development is a well known tool for the assessment of land use changes in a large number of studies. **Scenarios are not predictions**; they are an approach to help manage decisions based on interpretation of qualitative descriptions of alternative futures translated into quantitative scenarios. We can learn from the past by tracing analogies between historical and current situations. Different future possibilities can be illustrated and compared by using our imagination, intuition and creativity to question what could we do if the assumptions occur (Petrov, 2009).

At first, this note presents the statistics for the land use simulations for the four PLUREL Case Studies as performed the urban growth model MOLAND. Statistics are aggregated according to the sub-regions (urban, peri-urban, rural) subdivision defined in PLUREL. Then, a more detailed analysis is performed for the scenario B1 (common – although with many differences – to all case studies), comparing the MOLAND simulations with the land use projections provided by the European Land Use Model EUClueScanner.

2. The four PLUREL Case Studies

Within the context of the project PLUREL, the model Moland was applied to four case studies throughout Europe: Leipzig (DE), Koper (SI), South Holland (NL) and Montpellier (FRA) at 50 or 100m resolutions. The scenario description, the land use classes and the time frame were developed in collaboration with local stakeholders, and significantly differ from one another. Qualitative scenario descriptions were laid out and translated into appropriate terms for the land use modelling exercise.

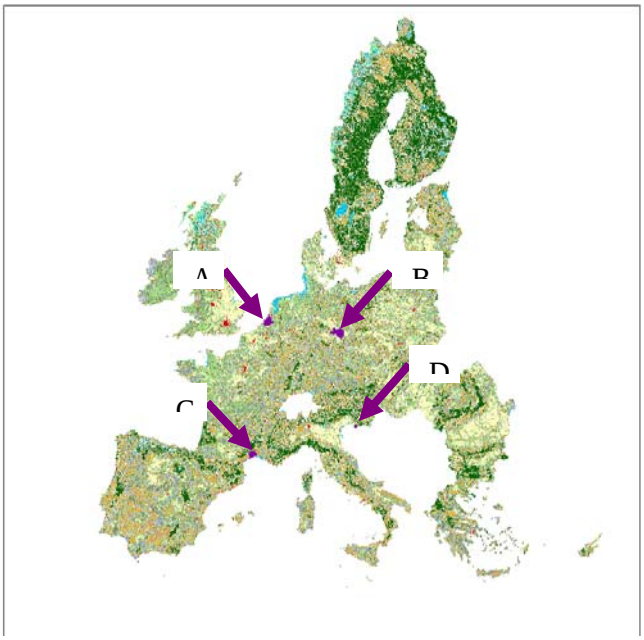

Figure 1. The test case areas for the PLUREL project

A. South Holland (NL)
B. Leipzig and Halle (DE)
C. Montpellier (FR)
D. Koper (SI)

In the PLUREL framework, global IPCC/SRES scenarios have been downscaled and refined with the involvement of stakeholders for the select study areas.

For **Leipzig**, simulation of land use evolution (2000-2025), considered different scenarios developed by local stakeholders - “Business-as-usual”, “Hyper-Tech”, “Peak Oil” and “Fragmentation”.

Leipzig — Halle
Location: C. Germany
Economic profile: services
Scenarios run: BAU, A1, A2, B1, B2
Input LC map: Corine Land Cover 2000
Forecast: to 2025
Uniqueness: Agent-based modeling on Moland results
Scenario description:
BAU:increase in construction, industrial sites and discontinuous urban fabric (DUF) in S. Halle and S. Leipzig at expense of open and shrub lands
A1: Growth of industrial and construction sites, mainly due to the decline of arable land. Expansion of DUF shows a more polycentric pattern in S. Leipzig at expense of forest and agricultural land
A2: Expansion of continuous urban fabric (CUF), mainly in peri-urban areas, at the expense of pasture and shrub. Growth of industry and commercial areas is more common in rural areas
B1: densification of dense urban fabric (CUF); new clusters of DUF emerge close to or connected to industrial sites, mainly in peri-urban and rural areas
B2: modest growth in urban fabric; 40% increase in industry and commerce at expense of pasture, mixed agricultural and shrubs

Three scenarios were run for the **Koper** municipality from 2007 to 2025: Business as usual, Hyper-tech (A1) and Peak oil (B1). The parameters for the scenarios were set in collaboration with local stakeholders which specifically requested to have the results for each scenario broken down to community level. Statistics per soil type classification were also requested and extracted in order to facilitate analysis of impacts of each scenario on quality soil.

Koper
Location: W. Slovenia
Economic profile: tourism, services
Scenarios run: BAU, A1, B1
Input LC map: Municipal maps, 2007
Forecast: to 2025

Uniqueness: Implementation of soil quality mapping for the B1 scenario; extrapolation of land use data on best soils

Scenarios description:

BAU:abandonment of agriculture and residential areas in hinterland, expansion of port and roadside expansion of built-up in peri-urban zones

A1: increase of tourist attractions and infrastructure; and commerce, residential and services at expense of permanent crop and pasture land. Competition for best soils results in loss of best soils to built-up

B1: growth in agricultural sector and subsequent valorization of hinterland with new residences and services appearing in those areas (taking pressure off the coastline). Best soils are used for agriculture

Three scenarios were run for the **Haaglanden** (South-Holland province (Netherlands)) from 2004 to 2040: 'Business as usual', 'Peak oil' (B1) and 'Fragmentation' (B2). The parameters for the scenarios were set in collaboration with local stakeholders at several meetings spanning 2008-2010. Three of four strategies defined by the stakeholders were also run on top of these scenarios. Strategy 1 refers to 80% of new construction happening in already existing urban areas and is run by allowing construction of new residences inside of the already existing urban fabric. Strategy 2 is the "Discourse development" whereby making green space important is emphasized. This strategy is not included in the scenarios. The third strategy refers to green and blue services. This strategy is run using arbitrarily chosen parcels of a given percentage (stipulated by Alterra). The fourth and final strategy, referring to the Agrarian banking system, is also run using arbitrarily selected parcels as part of the incentives. The number of parcels used in this scenario was dependant upon the number stipulated by Alterra.

Location: Haaglanden

Economic profile: horticulture, services

Scenarios run: Business as usual, B1, B2 + 3 strategies for each baseline scenario

Input LC map: Alterra, 2004

Forecast: to 2040

Uniqueness: Application of planning strategies to each scenario (Urban compactness, Green and Blue Services, Agrarian land banking)
Scenario description:
BAU: Limited extension of urbanization and limited loss of arable and pasture land. Residential development at cost of greenhouses. Rotterdam port is transferred from the city center to the sea; the eastern part of the port is replaced by housing and work places.
B1: Less urbanization than for BAU. Growth of greenhouses (used as alternative energy sources); Rotterdam port is transferred from the city center to the sea. Some of the vacated port land is transformed into residential.
B2: 50% of greenhouses and much of Rotterdam port are vacated. The only thriving area is near Delft because of the R&D sector

Four scenarios were run for **Montpellier** from 2000 to 2025: 'Business as usual', 'Peak oil' (B1) and two variants of the 'HyperTech' (A1). The main characteristics of the simulations were the role of the zoning plans: rather restrictive in the first variant of HyperTech (HT1), more permissive only outside the metropolitan agglomeration in the second variant (HT2), and almost fully relaxed for the other two scenarios, despite of different socio-economic drivers.

Montpellier
Location: S. France
Economic profile: tourism, services
Scenarios run: BAU, A1, B1
Input LC map: Corine Land Cover 2000
Forecast: to 2025
Uniqueness: Study of the implementation of the detailed ScOT regional planning tool
Scenario description:
BAU:abandonment of existing planning tool leads to uncontrolled urban sprawl, predominantly replacing pasture
A1:Key planning instrument in place; higher demographic and economic growth than for BAU.
B1:Economic and social decline leads to few improvements to infrastructure and very few changes in land use because of lack of demand for land

3. Aggregated results

Aggregated land-use simulation results according to the RUR classification are presented in the following table for all scenarios for each case study.

The following tables resume the statistics for the four case studies.

Table 1: Leipzig: the simulation of land use evolution (2000-2025), considered different scenarios developed by local stakeholders - "Business-as-usual", "Hyper-Tech", "Peak Oil" and "Fragmentation".

% change from 2000 to 2025 per scenario					
		BAU	*HT*	*PO*	*FR*
% change in built-up	*Urban*	3.27	1.93	1.84	1.44
	Peri-urban	23.85	34.05	18.81	13.49
	Rural	29.09	47.7	29.23	14.72
% change in farmland	*Urban*	-31.04	-16.9	-11.95	-13.5
	Peri-urban	-2.33	-3.09	-1.26	-1.1
	Rural	-1.01	-0.95	-0.34	-0.38
% change in natural	*Urban*	-29.05	-17.11	-16.32	-12.84
	Peri-urban	-3.4	-4.85	-2.68	-1.92
	Rural	-2.06	-3.37	-2.07	-1.04

Leipzig: The BAU scenario produces the highest impacts in the RUR-Urban area for what concern increase of built up areas and decrease in farmland and natural areas. The HT scenario results in the highest increase of urbanisation in both the peri-urban and rural areas. Farmlands are decreasing in the urban area, especially for the BAU scenario – with an analogous trend for natural areas. Farm/valuable land changes are more intense in Hyper-tech scenario and not so significant in Fragmentation scenario. On the opposite side, new urban land emerges mainly on Hyper-tech scenario, and Fragmentation register the smallest increase.

These results must be analyzed considering the "shock" storylines and overall trends introduced in each scenario. If in Hyper-tech scenario, there is a "passive management leading to peri-urbanization and metropolization of rural area", in Fragmentation scenario the emphasis is in the "high environmental protection: green ring map".

Table 2: Koper: Three scenarios were run for the Koper municipality from 2007 to 2025: Business as usual, Hyper-tech (A1) and Peak oil (B1).

		% change from 2007 to 2025 per scenario		
		BAU	*HT*	*PO*
% change in built-up	*Urban*	7.83	12.4	10.77
	Peri-urban	26.3	33.43	12.71
	Rural	-21.6	-15	24.36
% change in farmland	*Urban*	17.78	-11.11	22.22
	Peri-urban	4.26	3.17	5.17
	Rural	2.51	2.48	2.61
% change in natural	*Urban*	-38.46	-55.56	-11.11
	Peri-urban	5.43	5.54	4.48
	Rural	5.24	5.53	5.25

Koper: The peri-urban area is the most impacted by all three scenarios in terms of increased urbanisation. Changes in extent of farmlands is rather limited, but in the urban area. It is worth noting the increase of farmland as result of policies for BAU and PO and a net decrease in the HT scenario. Natural areas are particularly 'suffering' in the BAU and HT scenario.

Table 3: Haaglanden - Three scenarios were run for the South-Holland province (Netherlands) from 2004 to 2040: 'Business as usual', 'Peak oil' (B1) and 'Fragmentation' (B2).

		% change from 2004 to 2040 per scenario		
		BAU	*PO*	*FR*
% change in built-up	*Urban*	0.10	0.10	-1.24
	Peri-urban	-0.06	4.17	-6.62
	Rural	3.82	5.82	6.41
% change in farmland	*Urban*	-5.17	-10.69	34.00
	Peri-urban	-0.22	-1.27	2.36
	Rural	-0.55	-0.99	-1.09
% change in natural	*Urban*	0.00	0.00	0.00
	Peri-urban	0.00	0.00	0.00
	Rural	-0.75	-0.75	-0.75

Haaglanden: The relative land use/cover changes over the all zones are limited to less than 1%, apart for the loss in farmland in the urban area for all scenarios. The Fragmentation scenario produces increased urbanization only in the rural area.

Table 4: Four scenarios were run for Montpellier from 2000 to 2025: 'Business as usual', 'Peak oil' (B1) and two variants (HT1 and HT2) of the 'HyperTech' (A1).

% change from 2000 20 2025 per scenario					
		BAU	HT1	HT2	PO
% change in built up	Urban	-0.2	-0.1	-0.1	-0.1
	Peri-urban	70	65.3	64.2	37.5
	Rural	39.8	55.1	56.8	24.3
% change in farmland	Urban	0	0	0	0
	Peri-urban	-12	-11	-10.9	-6.5
	Rural	-2.8	-3.8	-4	-1.6
% change in natural	Urban	0	0	0	0
	Peri-urban	-4.6	-12.1	-7.3	-2.1
	Rural	-0.8	-1.1	-1.1	-0.5

Montpellier: The business as usual scenario assumes the abandonment of planning and zoning tools to allow market-driven developments. Sparse residential developments are the main spatial characteristics of this scenario.

The long-march HyperTech is the most realistic scenario for what concerns the application of planning and zoning policies. The resulting projected land use developments present compact urban and industrial patterns for the more controlled alternative (HT1) and a sparser – although still aggregated around existing blocks – for the HT2 alternative. The peak oil scenario represents a negative economic and demographic situation. The resulting developments are limited, as expected. As final remarks, it is confirmed the decisive role of zoning maps in the modelling exercise as key drivers for spatial development. Despite the mismatch between the detailed maps - produced in the frame of the SCoT planning tool - and the coarse Corine Land cover/use does not allow precise thematic correspondence of the most important land use/cover classes (e.g. housing density classes), the simulation has allowed to distinguish main trends towards compactness or sprawl.

4. Interpretations of the B1 Scenario

Table 5 summarises the interpretations of the B1 scenario for each of the test cases. It is difficult to find a common thread in all test cases. Most emphasise environmental protectionism and urban compactness, there is also however a movement to valorise the agricultural sector, and this comes at the expense of farmland.

Table 5 : The different B1 scenario interpretations for the four Moland test cases in PLUREL

	Leipzig-Halle	Montpellier Agg	Haaglanden	Koper
General description	On the existing brown fields and empty redeveloped houses, new residential development inside of the city leading to. Existing old buildings are preserved or demolished leading to perforation. Services close to industry.	Finite urban world with the disappearance of oil. A law now prohibits any new urban development without integrated solution of collective transports.	Emphasis is placed on social issues and environmental sustainability	Society whose priorities are in services and informatics rather than industry and production. Emphasis is placed on social issues and environmental sustainability
Population	Increase of population due to in-migration of the young.	Halt to population growth (0.1%)	The population is described as reaching a peak growth and the decline after 2020 Some housing appears in hinterland but growth is limited due to strong incentives to maintain “natural” areas such as agricultural areas, pasture and bulbs	Peak growth and the decline after 2020 overall increase of 12% from 2000-2025

Economy	GDP is increasing. The industrial activity is reinforced. New investment in manufacturing, tourism and services. More employment in science.	Logistics hubs of the L*anguedocian corridor* close one after the other. Only new technologies make the most of this delicate situation. Alternative energies are developing (solar cells, wind mills).	The services-based areas of The Hague and Delft prosper while Rotterdam is on the decline due to a slightly shrinking port, which in turn is due to the rising costs in petroleum and its derivatives; The greenhouse industry suffers from increasing transportation costs, but does not collapse entirely	Economic incentives to agriculture sector; growth of this sector in hinterland
Infrastructure	Low transport investment due to high fuel costs and environmental concerns. There are encouraged the fast railways to Munich, Berlin and Erfurt (ICE)) and airport development.	Public transports are at the heart of this scenario; housing redistribution within sprawled urban areas stabilizes along transport infrastructure and near services. Urbanisation refocuses in a sense of strong polarization on Regional Express Train (TER) and tramway. Public transport is strengthened but not enlarged: the peri-urban is neglected. Regional train network is maintained for the benefit of central cities.	Port activity remains somewhat steady, as for the BAU scenario, there is a shift towards the water from the city center of Rotterdam, thus leaving land available for other uses.	Densification within the areas of the port but port does not spread Encouragement of housing in hinterland, relieve pressure on coastline Rail: branching rail of hinterland to Koper; Koper to Izola
Environment	Moderate environmental intervention. High energy prices affect transport costs limiting commuting distances.	There is a boom in family food gardens, and for the movement “back to the land”. The concept of agripark is developed.	Emphasis is placed on environmental sustainability; new building is limited in hinterland	Conservation of quality soils; Respect soil fertility classification and Natura 2000 as zoned for no building; Eco-tourism emphasizes attractiveness of natural areas and inland areas

In order to compare the land use changes between the different scenario configurations and the baseline pan-European configuration, an approach detailed in Pontius et al (2004) is used. This method is adopted because it corrects for the persistence of land use classes, an annoying factor which is cause for bias and misleading results in the calibration process and comparative studies. In this method, the results are corrected for amount of change and persistent land use is not taken into consideration in the final statistics.

First, matrices for the percent changes in terms of net gains were produced for each of the test cases for the B1 scenario and for the European baseline B1 scenario, performed by the EUClueScanner model. Within these matrices, the values for the actual percent of the landscape, the expected percent of landscape if the change was random and the actual percent minus the expected percent are calculated. Finally, the difference between the expected change for the random model and the actual percent is divided by the expected change if the model were random. The exercise is repeated for the percent change in terms of net losses and the two main matrices, net gains and net losses, are summarised in a third matrix. Finally, the three resulting matrices are therefore re-scaled in order to make the test cases comparable to the pan-European baseline.

In order to make the case studies comparable and for the cross-tabulation matrix to be comparable in terms of total change in land use categories using net change and land use exchange; as well as net gains and losses in land use change, a few alterations were made to the original data:

1) The legends were all concentrated to four classes
    a. built-up
    b. natural
    c. farmland
    d. other
2) The output from the year 2025 was taken for all PLUREL scenarios
3) The PLUREL test case results for the simulated end year 2025 were compared with the European baseline simulation.

Three tables are shown for each of the test cases. In the first two tables, the percent gains and the percent losses, the values in bold refer to the percentage of

the total landscape; the values in italics refer to the percent of the landscape expected in a random model; the values in red are the differences between the number in bold and the number in italics and the values in blue is the number in red divided by the number in italics. It is this number in blue which indicates a systematic process relative to the size of the category and it is therefore this number which is most telling if one were looking for systematic changes in the landscape. It is also this number which is used in the EU-wide study to establish which land use transformations are most systematic (i.e. statistically robust).

4.1. Koper

For the Koper test case, the B1 scenario is characterised by incentives for agricultural exploitation and strong zoning impediments result in a revival in the municipality's hinterland, even to the remotest rural areas. A growth in housing and services in these areas are the result of incentives to grow permanent crops. The peak B1 also results in an exploitation of best soils for agriculture, whereas moderate soils are reserved for housing. Tables 6 and 7 show the percent in gains and losses of the land classes. Table 8 shows the summary of these results.

Table 6 : Percent land changes in terms of gains

	built-up	natural	farmed	other
built-up	**1.50**	**0.49**	**0.69**	**0.24**
		1.52	*0.35*	*0.08*
		-1.03	0.34	0.16
		-0.68	0.96	1.86
natural	**2.80**	**53.11**	**7.57**	**1.21**
	4.86		7.83	1.88
	-2.05		-0.26	-0.67
	-0.42		-0.03	-0.36
farmed	**3.97**	**17.72**	**8.62**	**1.44**
	2.38	*16.47*		*0.92*
	1.59	1.24		0.51
	0.67	0.08		0.56
other	**0.52**	**0.12**	**0.00**	**0.01**
	0.05	0.18	0.08	
	0.47	-0.05	-0.08	
	9.56	-0.31	-1.00	
sum T1	**8.78**	**71.44**	**16.88**	**2.91**

Table 7: Percent land changes in terms of losses

	built-up	natural	farmed	other
built-up	**1.50**	**0.49**	**0.69**	**0.24**

		1.11	*0.26*	*0.05*
		-0.63	0.43	0.20
		-0.56	1.62	4.36
natural	**2.80**	**53.11**	**7.57**	**1.21**
	3.56		*2.35*	*0.40*
	-0.76		5.22	0.81
	-0.21		2.22	1.99
farmed	**3.97**	**17.72**	**8.62**	**1.44**
	7.11	*19.87*		*0.81*
	-3.14	-2.15		0.63
	-0.44	-0.11		0.78
other	**0.52**	**0.12**	**0.00**	**0.01**
	0.06	*0.47*	*0.11*	
	0.46	-0.35	-0.11	
	7.95	-0.74	-1.00	
sum T1	**8.78**	**71.44**	**16.88**	**2.91**

Table 8: Change in terms of percent landscape

	gain	loss	total change	SWAP	abs value 'net change'
built-up	7.29	1.42	8.71	2.85	5.86
natural	18.33	11.58	29.91	23.17	6.74
farmed	8.26	23.12	31.38	16.52	14.86
other	2.89	0.64	3.53	1.28	2.25
total	36.77	36.77	73.53	43.81	29.72

4.2. Haaglanden

Because of its configuration, the Haaglanden scenario sees the B1 scenario as negatively influencing the industry and commerce sectors but not the services sector upon which it is so heavily dependant. In this scenario, the only sector actually experiencing growth in terms of infrastructure is in the research and development sector in Delft, whereas the Rotterdam port and The Hague are stable. For this test case the main concern was with the conservation of pasture and arable land with the implementation of policy alternatives, called "Strategies". Three strategies are tested on top of the B1 baseline scenario, testing the efficiency of each for the goal of conservation in mind.

Tables 9 and 10 show the percent in gains and losses of the land classes and Table 11 shows the summary of these results.

Table 9 Percent land changes in terms of gains

	built-up	natural	farmed	other

built-up	**16.13**	**3.12**	**6.74**	**3.41**
		5.45	*6.03*	*1.68*
		-2.33	0.71	1.72
		-0.43	0.12	1.03
natural	**0.50**	**2.32**	**1.24**	**0.33**
	0.37		*0.90*	*0.25*
	0.12		0.34	0.08
	0.34		0.38	0.31
farmed	**4.41**	**3.47**	**42.52**	**1.15**
	4.38	*9.55*		*2.95*
	0.03	-6.08		-1.80
	0.01	-0.64		-0.61
other	**1.09**	**11.12**	**1.95**	**0.50**
	1.25	*5.36*	*3.01*	
	-0.15	5.76	-1.06	
	-0.12	1.07	-0.35	
sum T1	**22.13**	**20.03**	**52.45**	**5.39**

Table 10 Percent land changes in terms of losses

	built-up	natural	farmed	other
built-up	**16.13**	**3.12**	**6.74**	**3.41**
		3.41	*8.94*	*0.92*
		-0.29	-2.20	2.49
		-0.09	-0.25	2.71
natural	**0.50**	**2.32**	**1.24**	**0.33**
	0.57		*2.28*	*0.23*
	-0.08		-1.04	0.10
	-0.13		-0.46	0.41
farmed	**4.41**	**3.47**	**42.52**	**1.15**
	2.50	*3.80*		*1.02*
	1.91	-0.33		0.12
	0.77	-0.09		0.12
other	**1.09**	**11.12**	**1.95**	**0.50**
	3.31	*3.00*	*7.85*	
	-2.22	8.12	-5.90	
	-0.67	2.71	-0.75	
sum T1	**22.13**	**20.03**	**52.45**	**5.39**

Table 11 Change in terms of percent landscape

	gain	loss	total change	SWAP	abs value 'net change'
built-up	6.00	13.27	19.27	11.99	7.28
natural	17.71	2.07	19.78	4.14	15.64
farmed	9.94	9.02	18.96	18.04	0.92
other	4.88	14.16	19.05	9.77	9.28
total	38.53	38.53	77.05	43.94	33.12

4.3. Leipzig-Halle

The Leipzig test case for the B1 scenario is characterised by an increase in population and a reshuffling of the economic sectors. The prohibitive costs associated with commuting leads to a densification of the already existing urban areas and vicinity of new urban areas to existing urban areas.

Tables 12 and 13 show the percent in gains and losses of the land classes and Table 14 shows the summary of these results.

Table 12 Percent land changes in terms of gains

	built-up	natural	farmed	other
built-up	**8.53**	**0.41**	**4.26**	**2.84**
		0.73	*4.26*	*0.58*
		-0.32	0.00	2.26
		-0.43	0.00	3.89
natural	**1.09**	**6.30**	**2.92**	**0.24**
	0.68		*2.80*	*0.38*
	0.41		0.12	-0.14
	0.60		0.04	-0.37
farmed	**4.07**	**2.41**	**64.41**	**0.46**
	4.60	*3.25*		*2.58*
	-0.53	-0.84		-2.12
	-0.12	-0.26		-0.82
other	**0.26**	**1.25**	**0.43**	**0.12**
	0.13	*0.29*	*0.55*	
	0.13	0.96	-0.12	
	0.96	3.26	-0.22	
sum T1	**13.95**	**10.37**	**72.01**	**3.66**

Table 13 Percent land changes in terms of losses

	built-up	natural	farmed	other
built-up	**8.53**	**0.41**	**4.26**	**2.84**
		0.91	*6.29*	*0.32*
		-0.49	-2.03	2.52
		-0.54	-0.32	7.88
natural	**1.09**	**6.30**	**2.92**	**0.24**
	0.66		*10.92*	*0.56*
	0.43		-8.00	-0.32
	0.64		-0.73	-0.57
farmed	**4.07**	**2.41**	**64.41**	**0.46**
	1.08	*2.57*		*0.91*

	2.99	-0.16		-0.45
	2.77	-0.06		-0.49
other	**0.26**	**1.25**	**0.43**	**0.12**
	0.28	*0.21*	*1.45*	
	-0.02	1.04	-1.02	
	-0.07	4.99	-0.70	
sum T1	**13.95**	**10.37**	**72.01**	**3.66**

Table 14 Change in terms of percent landscape

	gain	loss	total change	SWAP	abs value 'net change'
built-up	5.42	7.52	12.93	10.83	2.10
natural	4.08	4.25	8.32	8.15	0.17
farmed	7.61	6.94	14.55	13.89	0.66
other	3.54	1.94	5.48	3.88	1.60
total	20.64	20.64	41.29	36.75	4.54

4.4. Montpellier

The B1 scenario for the Montpellier test case is described as being a scenario with very conservative new developments due to rising oil prices, of which the services sector (port) is heavily dependant. As in the Koper test case, the inhabitants are somewhat encouraged to return to the hinterland to cultivate crops. For the Montpellier test case, there is a densification of the actual urban core, whereby discontinuous urban fabric is converted to continuous urban fabric.

Tables 15 and 16 show the percent in gains and losses of the land classes and Table 17 shows the summary of these results.

Table 15 Percent land changes in terms of gains

	built-up	natural	farmed	other
built-up	**6.71**	**1.46**	**3.53**	**0.43**
		2.98	*1.99*	*0.12*
		-1.52	1.53	0.31
		-0.51	0.77	2.72
natural	**0.65**	**36.88**	**6.41**	**0.19**
	1.55		*7.26*	*0.42*
	-0.90		-0.85	-0.23
	-0.58		-0.12	-0.55
farmed	**2.05**	**3.93**	**27.82**	**0.24**
	1.20	*8.36*		*0.32*
	0.85	-4.43		-0.08
	0.71	-0.53		-0.26
other	**0.39**	**8.34**	**0.91**	**0.07**

	0.34	*2.02*	*1.60*	
	0.05	6.32	-0.69	
	0.13	3.13	-0.43	
sum T1	**9.80**	**50.60**	**38.68**	**0.93**

Table 16 Percent land changes in terms of losses

	built-up	natural	farmed	other
built-up	**6.71**	**1.46**	**3.53**	**0.43**
		3.04	*2.32*	*0.06*
		-1.58	1.21	0.37
		-0.52	0.52	6.72
natural	**0.65**	**36.88**	**6.41**	**0.19**
	1.44		*4.58*	*0.11*
	-0.79		1.84	0.08
	-0.55		0.40	0.72
farmed	**2.05**	**3.93**	**27.82**	**0.24**
	1.23	*5.13*		*0.09*
	0.82	-1.20		0.15
	0.66	-0.23		1.56
other	**0.39**	**8.34**	**0.91**	**0.07**
	0.95	*4.92*	*3.76*	
	-0.57	3.42	-2.85	
	-0.59	0.69	-0.76	
sum T1	**9.80**	**50.60**	**38.68**	**0.93**

Table 17 Change in terms of percent landscape

	gain	loss	total change	SWAP	abs value 'net change'
built-up	3.09	5.41	8.51	6.18	2.32
natural	13.72	7.26	20.98	14.51	6.47
farmed	10.85	6.22	17.07	12.44	4.63
other	0.86	9.64	10.49	1.71	8.78
total	28.52	28.52	57.05	34.85	22.20

The following tables (Tables 17-20) show the numeric comparison between the pan-European B1 baseline scenario i ("EU" header) and the test case areas ("LOCAL" header).

Tables 17-20. The data related to the gains, losses, total changes, swapping between land uses and net change in land use class categories for both the pan-European baseline model and the case studies.

EU

Koper

	gain	loss	total change	SWAP	abs value 'net change'
built-up	0.94	0.00	0.94	0.00	0.94
natural	0.00	3.14	3.14	0.00	3.14
farmed	3.14	0.94	4.09	1.89	2.20
other	0.00	0.00	0.00	0.00	0.00

LOCAL

	gain	loss	total change	SWAP	abs value 'net change'
built-up	5.89	1.02	6.91	2.04	4.87
natural	20.91	8.23	29.14	16.45	12.69
farmed	5.57	25.72	31.29	11.14	20.15
other	2.64	0.05	2.70	0.10	2.59

S Holland

EU

	gain	loss	total change	SWAP	abs value 'net change'
built-up	6.47	0.00	6.47	0.00	6.47
natural	0.99	2.96	3.95	1.98	1.98
farmed	0.00	7.12	7.12	0.00	7.12
other	2.62	0.00	2.62	0.00	2.62

LOCAL

	gain	loss	total change	SWAP	abs value 'net change'
built-up	6.57	3.72	10.29	7.44	2.85
natural	4.44	1.94	6.38	3.88	2.50
farmed	2.10	8.50	10.60	4.19	6.41
other	3.61	2.56	6.16	5.11	1.05

Leipzig

EU

	gain	loss	total change	SWAP	abs value 'net change'
built-up	0.05	0.00	0.05	0.00	0.05
natural	0.49	0.86	1.34	0.97	0.37
farmed	0.00	0.53	0.53	0.00	0.53
other	0.86	0.00	0.86	0.00	0.86

LOCAL

	gain	loss	total change	SWAP	abs value 'net change'
built-up	2.14	0.03	2.18	0.06	2.11
natural	0.00	1.03	1.03	0.00	1.03
farmed	0.03	1.12	1.15	0.06	1.08
other	0.00	0.00	0.00	0.00	0.00

Montpellier

EU

	gain	loss	total change	SWAP	abs value 'net change'
built-up	0.40	0.00	0.40	0.00	0.40
natural	0.30	1.05	1.35	0.60	0.75
farmed	0.00	0.70	0.70	0.00	0.70
other	1.05	0.00	1.05	0.00	1.05

LOCAL

	gain	loss	total change	SWAP	abs value 'net change'
built-up	0.32	0.01	0.33	0.02	0.31
natural	0.18	0.10	0.28	0.20	0.08
farmed	0.10	0.49	0.59	0.20	0.39
other	0.03	0.03	0.06	0.06	0.00

Figure 1 shows the differences in the results for the test case areas for the pan-European model. The figure demonstrates the differences in results for the test cases from the same model with a homogeneous configuration. The Haaglanden region experiences, according to this model output, a strong growth in built-up and farmed areas whereas Koper shows a strong growth in natural areas. Development in Montpellier and Leipzig is more restricted, with moderate growth in the 'other' land use categories.

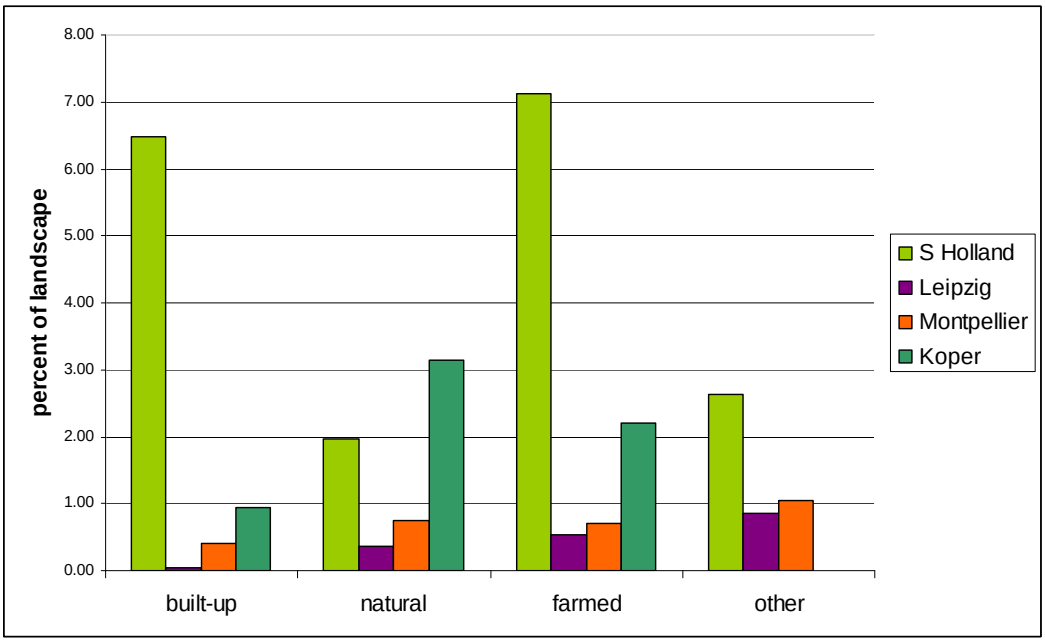

Figure 1 The percent net changes in landscape per land use category as resulting from the pan-European land use model with homogeneous configuration

4.5. Discussion of B1 simulations

The case study areas were first examined for systematic changes from the base year to 2025. By “systematic” we intend the definition as outlined in Pontius Jr *et. al.* (2004) whereby the true changes in the landscape are compared to the plausible changes in a random model and a conclusion is then drawn according to the total size of the land use class. We therefore formulate the outcomes in terms of: “If there is a demand for land use 'A' , what will it be most likely to replace?” or “If demand for land use 'A' is shrinking, what will it be most likely replaced by?” This information is extracted from the data in blue within the contingency tables from the base year to the final year of the simulation. We discuss these results in the following case-study-specific sub-sections below.

Koper

According to the results for the Koper test case, the main trends are a consistent transformation from ‘other’ to built-up and a loss of natural land to farmland. This case study was indeed configured to encourage a revival of the municipality’s hinterland, with local incentives for agricultural products and it is in fact the increase in farmed land which is the most dominant in this test case. In the European baseline, general trends remain the same however this particular case study is penalised because of its small size. Thus the larger areas of the study site, the farmland and the natural areas, are given more emphasis than the marginal built-up areas. Most small settlements in the hinterland are swallowed up in the aggregation process. When compared to the results for the pan-European model, very different trends emerge. In the pan-European configuration, farmland areas are systematically taken over by built-up areas. This implies an opposite effect in the hinterland: its abandonment.

Haaglanden

In Haaglanden , the main trends are less evident. The strongest trend is a loss of ‘other’ land to natural land and from the loss of built-up ‘other’ due to vacated built-up areas, namely the port. The evidence for these trends is rather weak with a value of less than 3% for both conversion types (normalised for percent occupation in the landscape; i.e. the “blue values” in the matrices). This case study is more robust at European scale than is the Koper test case, namely because it is a bit bigger and also more urban. Built-up areas therefore tend to survive the aggregation procedure. Natural areas are slightly exaggerated if anything. When comparing the systematic changes from one class to another, the

evident trend in the European baseline is from natural land to 'other' land classes. This is not the case in the local study because of the strong zoning maps imposed in the local model run.

Leipzig-Halle

Fairly strong persistent conversions are shown in this test case. When 'other' gains, it replaces built-up and when farmland loses, it is replaced by built-up. A If anything, the farmed land is under-represented in the low resolution version of the Moland output. Very different systematic changes are seen between the pan-European output and the locally configured output. In the pan-European version of the B1 scenario, the main conversion occurs between 'other' and the natural classes. Thus when 'other' gains, it replaces natural land. Furthermore, when farmed land loses, it is replaced by natural land and never by built-up or 'other' land.

Montpellier

The most prominent systematic changes in Montpellier according to the local Moland study are the conversions from other to built-up; and from natural to 'other. Also, when 'other' loses, it is twice as likely to be replaced by farmland as by built-up land. The aggregation has an effect on the Montpellier test case, mainly for the built-up region and the natural areas. These tend to be exaggerated in the aggregation process because of their significant and un-fragmented presence in the land use map. For the pan-European study in Montpellier, the main persistent trends are in the conversion from 'other' to natural land and from farmed land to built-up land – there again not in line with the localised study results.

5. Conclusions

The application of the MOLAND model to four regions in Europe had a two-fold result:

- from one side it has demonstrated the flexibility of the modelling tool, as being able to translate local policies (in some cases these were stakeholders' wishes or visions) in concrete land use projections
- from the other side it has proven the difficulties of generalising processes and procedures such as land planning, which are – by nature – very local and geographically specific.

The application of the RUR sub-regional scheme is not always reflecting the actual characterisation of the area under study – this is partially due to the difference system of territorial government of each site – but also on the necessary generalisation of the definition of each RUR sub-region.

Zoning restrictions and planning regulations are – as largely expected – the most influential in the definition of future land use/cover patterns. The impact of infrastructure is also a key element for the dynamics. The model – because of its own configuration - does not capture social effects but reflects rather well economic drivers.

In conclusion – although it is not possible to make sensible comparisons amongst the case studies –it is certainly possible to adapt the interpretation of scenarios and storylines with local wishes and common visions. The new challenge in the research for land use/cover continental simulations is indeed in finding the right matching between wide European drivers and local ambitions.

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