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Exploring the feasibility of applying the Land Use Modelling Platform outside the EU

Preliminary estimates of the global demand for urban land

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1. Introduction and scope

This technical note aims to present the progresses done towards the evaluation of the possible application of the Land Use Modelling Platform (LUMP) in a global context or anyhow outside the geographical borders of Europe. The definition and computation of demands for land-uses are the first element to be appraised since these are essential inputs for the modelling platform. The note describes the methodology adopted to compute the demand for urban land (this includes land uses related to residences, leisure facilities and small commercial and industrial activities) in 10 regions worldwide according to a set of different scenarios of demographic expansion.

The Land Use Modelling Platform (LUMP) has been developed by the Institute for Environment and Sustainability (IES) of the Joint Research Centre (JRC) to support the policy design of different services of the European Commission. It aims to provide a comprehensive, consistent and harmonized analysis of the impacts of policies and/or specific proposals in the context of environmental and socio-economic changes in Europe. LUMP is based upon the combination of a spatially explicit land use model and its linkages with other modelling activities in thematic fields such as hydrology, agriculture, economy, forestry, etc.

The Land Use Modelling Platform is currently applied for the 28 Member States of the European Union. The extension of its use beyond the geographical borders of Europe would be beneficial for policies related to international development and cooperation and more generically to evaluate indirect impacts of European policies and programmes.

This short note aims to investigate how global demographic projections can be converted into quantitative drivers for the demand of land for urban areas and how sensitive is such demand to different parameters and assumptions.

2. The Land Use Modelling Platform in brief

The Land Use Modelling Platform has a modular structure and is organized in three main components: 1) the land demand module; 2) the land allocation module; 3) the indicator module. The first module is where demand for different land uses is defined. Different drivers and algorithms are used to compute demands for each land use. A range of maximum and minimum demand for each land use, for each year and for each sub-region of interest, is passed onto the second module, the land allocation module, which is the core of LUMP. This second module is responsible for allocating the yearly projected quantities of land in space (at pixel level). This module is also called EUClueScanner100 (EUCS100) and was developed in collaboration with DG Environment. It is based on the dynamic simulation of competitions between land uses. Its spatial allocation rules stem from a combination of land demand, overall suitability, temporally-dynamic neighbourhood characteristics and scenario/policy-specific decision rules. Finally, the indicator module takes the main output of the land allocation module – a simulated land use map for a given year in the future – and computes various indicators to better interpret the results.

LUMP undergoes a continuous metamorphosis, its development is mainly dependent on the requirements of each project and has already been used to assess land use impacts of key environmental EU policies, such as the sustainable management of coastal zones[1], the greening of the Common Agricultural Policy (CAP)[2], the Blueprint to Safeguard Europe's Waters[3,4] , and other fields related to energy and regional development.

A more technical description of the LUMP, in particular of its land allocation module can be consulted in Lavalle et al. (2011)[5].

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[1] Lavalle C., Rocha Gomes C., Baranzelli C., Batista e Silva F. (2011). Coastal Zones - Policy alternatives impacts on European Coastal Zones 2000-2050. EUR 24792 EN. Luxembourg (Luxembourg): Publications Office of the European Union.

[2] Lavalle C., Baranzelli C., Mubareka S., Rocha Gomes C., Hiederer R., Batista e Silva F., Estreguil C. (2011) Implementation of the CAP Policy Options with the Land Use Modelling Platform - A first indicator-based analysis. EUR 24909 EN. DOI: 10.2788/45131. Luxembourg (Luxembourg): Publications Office of the European Union.

[3] De Roo, A. et. al (2012) A multi-criteria optimisation of scenarios for the protection of water resources in Europe - Support to the EU blueprint to safeguard Europe's waters. EUR 25552 EN. DOI: 10.2788/55540. Luxembourg: Publications Office of the European Union.

[4] Burek P., Mubareka S., Rojas R., de Roo A., Bianchi A., Baranzelli C., Lavalle C., Vandecasteele I., (2012) Evaluation of the effectiveness of natural water retention measures- Support to the EU blueprint to safeguard Europe's waters. EUR 25551 EN. DOI: 10.2788/5528. Luxembourg: Publications Office of the European Union.

[5] Lavalle C., Baranzelli C., Batista e Silva F., Mubareka S., Rocha Gomes C., Koomen E., Hilferink M. (2011). A high resolution land use/cover modelling framework for Europe. ICCSA 2011, Part I, LNCS 6782, pp. 60–75.

The methodology subject of this technical note contributes to the first module (the land demand module) of the Land Use Modelling Platform.

3. Computing global urban land demand 2005-2045

The exercise herein described is based upon the four scenarios of global projections developed in the frame of the FP-7 project VOLANTE[6].

The four scenarios (named the 'marker scenarios') are derived from the IPCC scenarios

A1, B1, A2, B2 (ref. 'Special Report on Emissions Scenarios'[7]) and have been adapted according to the scope and objectives of VOLANTE – and have been renamed respectively V-A1, V-B1, V-A2, V-B2.

The brief narratives for these marker scenarios are defined in VOLANTE as follows[8]:

- V-A1 represents a globalised world with strong economic growth, high growth of food and feed demand, weak regulation on land use change, declining tropical forest areas, a fully liberalized agricultural policy in Europe, and phased-out bioenergy mandates.
- V-A2 represents a fragmented world with modest economic growth, high population growth, high growth of food and feed demand, weak regulation on land use change, declining tropical forest areas, no change in the agricultural policy in Europe, and phased-out bioenergy mandates.
- V-B1 represents a sustainable world with modest economic growth, slow growth of food and feed demand, strong regulation on land use change, protected tropical forest areas, a liberalized agricultural policy in Europe, and modest bioenergy demand.
- V-B2 represents a fragmented world with modest economic growth, modest growth of food and feed demand, some regulation on land use change, some protection of

[6] http://www.volante-project.eu

[7] http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=99

[8] http://www.volante-project.eu/images/stories/DELIVERABLES/VOLANTE_D7.3_Description_of_the_translation_of_sector_specific_land_cover_and_land_management_information.pdf

tropical forest areas, no change in the agricultural policy in Europe, and modest bioenergy demand.

For the purposes of this technical note, only the demographic projections are of concern. Each scenario refers to different prospects of world population growth (being identical for V-A1 and V-B1). These are synthetized in the table below:

***Table 1**: Population projections up to 2040 by marker scenario.*

	V-A1	V-A2	V-B1	V-B2
Population	8.5 billion people in 2040	10.3 billion people in 2040	8.5 billion people in 2040	8.9 billion people in 2040

The demographic projections are provided with a breakdown of 10 macro world regions (AFR = Sub-Saharan Africa, CPA = Centrally Planned Asia including China, EUR = Europe including Turkey, FSU = the Newly Independent States of the Former Soviet Union, LAM = Latin America, MEA = Middle East/North Africa, NAM = North America, PAO = Pacific OECD including Japan, Australia, New Zealand, PAS = Pacific (or Southeast) Asia, SAS = South Asia including India), described in Annex 1.

The urban land corresponds to the artificial surface (measured in squared kilometers) taken by the portion of built-up that comprises residences, leisure facilities and small businesses (e.g. retail, services). The source for urban land use is the MODIS land cover map for 2001.

It is assumed that the future demand for urban land is mainly driven by the size of the total population, trends in household size (which determines the total number of households) and the spatial household density (reflecting the density by which new built-up areas are developed).

The methodology to arrive to urban land demand is based on the following steps:

STEP 1.

The Total number of households *TH* is calculated for each region, according to the following formula:

$$TH_{2001+t,i,S} = \frac{P_{2001+t,i,S}}{\langle H \rangle_{2001+t,i,S}}$$

Where:

$P_{2001+t,i,S} =$ Population for the year 2001+t, for the Region i as assumed in the demographic projection of marker scenario S

$\langle H \rangle_{2001+t,i,S} =$ Average Household size (e.g. average number of household members) for the Region i as assumed in the marker scenario *S.* For the baseline year 2001 this value is the same for all scenarios and is derived from the UN-Statistics

$t = 0,1, \ldots, 44$;   *i = AFR, CPA, etc... ;* $S = V - A1, V - A2, V - B1, V - B2$

STEP 2

The Land Use Intensity (*LUI*) for each region, defined as the ratio between households and urban area, has been estimated for the baseline year 2001:

$$LUI_{2001,i} = \frac{TH_{2001,i}}{U_{2001,i}}$$

Where:

$TH_{2001,i} =$ Total number of households in 2001 for the Region i

$U_{2001,i}$ = Total Urban Area in 2001 for the Region i

i = *AFR, CPA, etc...*

The following datasets have been used for the computation:

- Urban area (artificial surface coverage in Km^2) for each region for year 2001 are derived from the Global MODIS Land Cover Map[9];
- Baseline population statistics are compiled from UN-Statistics, at country level[10] ;

The table below summarizes the computed values for the baseline year 2001:

[9] https://lpdaac.usgs.gov/products/modis_products_table/land_cover/yearly_l3_global_500_m/mcd12q1

[10] http://data.un.org/

***Table 2**: Baseline figures for 2001.*

	Urban area	Average household size	Nr. of households (estimated)	LUI
Region	Km	Persons / household	Million	Households/km2 urban
AFR	30988	4.7	140.5	4534.5
CPA	88770	3.9	351.6	3961.2
EUR	119091	3.0	196.2	1647.7
FSU	60323	2.8	98.6	1635.0
LAM	94565	3.9	135.3	1430.6
MEA	32624	4.0	77.0	2360.4
NAM	129858	2.6	120.4	926.9
PAO	29722	2.7	56.2	1889.2
PAS	29067	4.1	112.5	3870.7
SAS	40858	5.3	263.8	6456.4
Tot Global	**655864**		**1552.1**	

STEP 3.

The last step concerns the actual computation of the required urban area for each region for each marker scenario from year 2001 to year 2045:

$$U_{2001+t,i,S} = \frac{TH_{2001+t,i,S}}{LUI_{2001,i}}$$

The key variable in the described method is the projected average household size $\langle H \rangle_{2001+t,i,S}$ for the future (namely for the period from 2005 until 2045 in this exercise since a 5-years step has been used in the computations).

Three different approaches have been tested to derive the demand for urban land, each one based on hypothetical scenario-specific assumptions on the household size – i.e. the average number of household members.

The three assumptions are as follows:

1) Household size is assumed to be constant in time for all scenarios, equal to the observed value for the baseline year (2001);
2) Household size is assumed to converge world-wide at 2.5 persons/household by 2150 for all scenarios;
3) Household size is assumed to be scenario specific:
    a. converge world-wide at 2.5 persons/household by 2100 for V-A1 and V-B1;
    b. household size is assumed to reduce by 0.01 persons/household/year in all world regions (no convergence) for V-A2;
    c. household size is assumed to reduce by 0.02 persons/household/year in all world regions (no convergence) for V-B2.

These assumptions were drawn upon to test the sensitivity of the method to the variation of the parameter represented by the household since. The first approach can be seen as a 'minimum' urban growth prospect with all the parameters as observed circa 2000. In the other two approaches, the parameters are more dynamic in time.

The subject matter of the exercise being the robustness of the method, the validity of the assumptions chosen (which could be readjusted and retuned) has not been subject of research – nor is it planned to be in the short future.

4. Results

Three different projections have been computed for each marker scenario, each projection corresponding to a different assumption on the trends of the household size (i.e. the average number of household members). Given that population figures for V-A1 and V-B1 are equal, the demand for urban land has therefore been computed for a total of nine diverse combinations. The detailed results of the computation of demand for urban area are presented in Annexes 2, 3 and 4.

The projected global urban area demand (i.e. the sum of the demand for all regions) for the marker scenario V-A1 and V-B1 is presented in **Figure 1**. The overall demand increases substantially for the two converge scenarios, when compared to constant household size. This results is somehow expected and plausible, assuming that the known decreasing trend in average household size will continue in the future, and this parameter slowly converges between world regions.

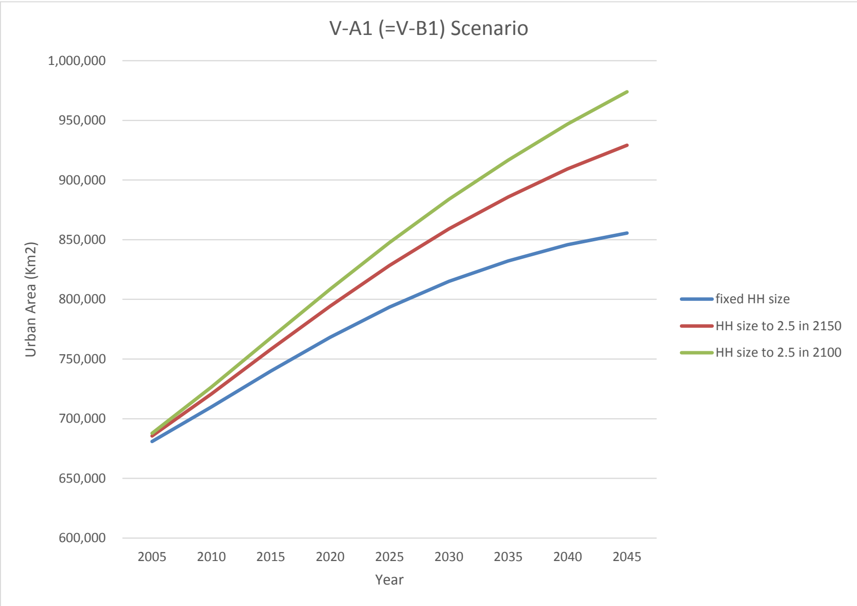

***Figure 1**: Global demand for urban area (artificial surface coverage) for the marker scenario V-A1 and V-B1, for the three assumptions on average household (HH) size.*

The demand for the marker scenario V-A2 (**Figure 2**) presents a similar growing trend, although the differences between the three assumptions are contained in a less pronounced range. Obviously, given the definition of the scenario, the growth in population is reflected in a higher demand for artificial land.

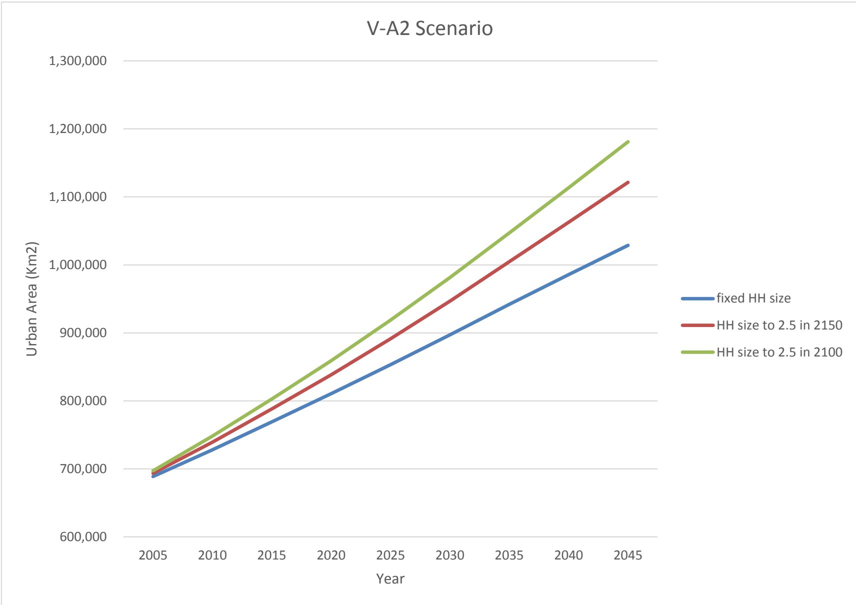

***Figure 2**: Global demand for urban area (artificial surface coverage) for the marker scenario V-A2 for the three assumptions on average household (HH) size.*

Figure 3 presents the global results for the scenario marker V-B2. The demand for artificial areas increases visibly for the third scenario where the number of members per household is gradually reduced by 0.02 per year.

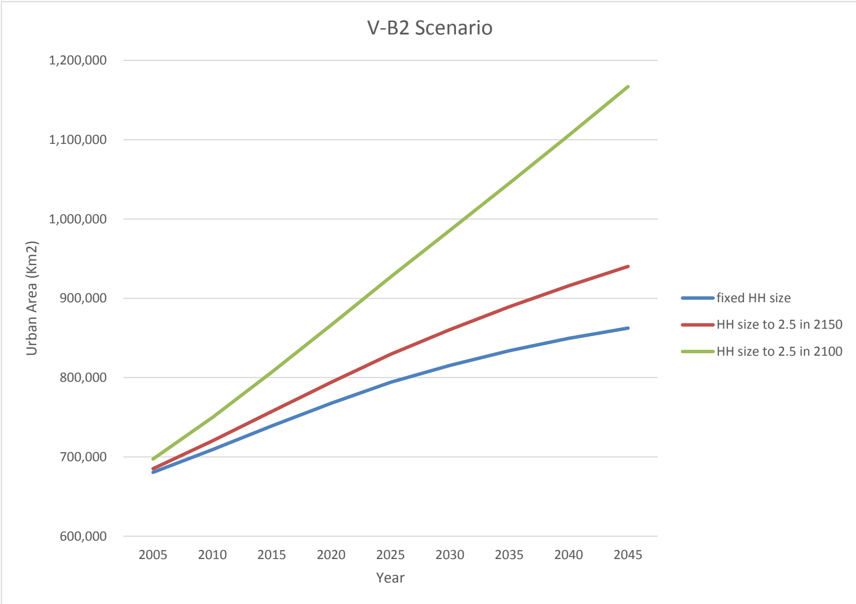

***Figure 3**: Global demand for urban area (artificial surface coverage) for the marker scenario V-B2 for the three assumptions on average household (HH) size.*

The overall growth in demand for urban area for the period 2001-2045 is synthetized in **Table 3**2. It is worth noting that the demands are strongly connected to the assumptions made concerning household size. In particular, the demand for V-A1 (=V-B1) for the third assumption is larger than that for V-B2 for fixed household size, therefore somehow off-setting the main drivers of the storyline for the two marker scenarios, with spatial impacts not directly predictable.

***Table 3**: Overall demand for urban area for the simulation period 2001-2045.*

	Baseline 2001	Fixed Avg Household Size		Converging Avg Household Size by 2150 (at 2.5 people per household)		Avg household size develops according to scenario	
		2045		2045		2045	
	km2	km2	% 2001-2045	km2	% 2001-2045	km2	% 2001-2045
V-A1 V-B1	655864	855556	30.45%	929217	41.68%	973895	48.49%
V-A2	655864	1028706	56.85%	1121499	71.00%	1181113	80.09%
V-B2	655864	862529	31.51%	940296	43.37%	1166983	77.93%

5. Conclusions and way forward

Demographic projections are amongst the most important inputs for any land use model – whatever the scale and the scope of the modelling application may be. Moreover, demographic pressure is associated with built-up pressure. Building, as a major driver of land use change, has important environmental and landscape repercussions that affect mainly local and regional scales. Uncontrolled consumption of land for urbanization processes is, for instance, associated with loss of arable land, and disruption of certain ecosystem services.

The aim of the work herein presented was twofold:

a) test the methodology to derive urban land demand from a set of statistical world projections and parameters;
b) evaluate the sensitivity of the method to the variation of a key parameter such as the household composition.

A total of nine different configurations have been tested and computed, by means of combining different sets of population projections with different assumptions on the evolution of average household sizes. Statistical and geographical information for the baseline year 2001 have been derived from a wide range of sources (i.e. from satellite remote sensing to international statistical repositories), with quite some computing effort for their elaboration and analysis.

The exercise has confirmed that the method provides interesting sets of results that can eventually be used as input for the Land Use Modelling Platform, should the case for an application outside the EU borders rise. Furthermore, the assumptions could be further tuned according to the needs, for example making specific case for each world region.

Also, it has been shown that assumptions based upon the spatial distribution of a statistical variable can sensibly influence the outcome of the storylines behind the original scenarios. This is an aspect to be considered when analysis the impacts of global scenarios at regional or local level.

Further testing exercises to be performed should cover the following aspects:

- inclusion of local characteristics related to the spatial planning practices of each region;
- inclusion of geophysical suitabilities (including those induced by the changing climate);
- consideration of economic variables at different scales.

Since these are already fully embedded in the European configuration of the Land Use Modelling Platform, the application to extra-European regions seems feasible, but would, nonetheless, require relevant investment.

ANNEX 1

World regions

AFR	***CPA***	***EUR***	***FSU***	***LAM***
Sub-Saharan Africa	***Centrally-Planned Asia***	***Europe***	***Former Soviet Union***	***Latin America***
Angola	*Cambodia*	*Albania*	*Azerbaijan, Republic of*	*Argentina*
Benin	*China*	*Austria*	*Belarus*	*Belize*
Botswana	*Laos*	*Belgium-Luxembourg*	*Georgia*	*Bolivia*
Burkina Faso	*Mongolia*	*Bosnia and Herzegovina*	*Kazakhstan*	*Brazil*
Burundi	*Viet Nam*	*Bulgaria*	*Kyrgyzstan*	*Chile*
Cameroon		*Croatia*	*Moldova, Republic of*	*Colombia*
Central African Republic		*Czech Republic*	*Russian Federation*	*Costa Rica*
Chad		*Denmark*	*Tajikistan*	*Cuba*
Congo, Dem Republic of		*Estonia*	*Turkmenistan*	*Dominican Republic*
Congo, Republic of		*Finland*	*Ukraine*	*Ecuador*
Côte d'Ivoire		*France*	*Uzbekistan*	*El Salvador*
Djibouti		*Germany*		*French Guiana*
Equatorial Guinea		*Greece*		*Guatemala*
Eritrea		*Hungary*		*Guyana*
Ethiopia		*Iceland*		*Haiti*
Gabon		*Ireland*		*Honduras*
Ghana		*Italy*		*Mexico*
Guinea		*Latvia*		*Nicaragua*
Guinea-Bissau		*Lithuania*		*Panama*
Kenya		*Macedonia,The Fmr Yug Rp*		*Paraguay*
Lesotho		*Netherlands*		*Peru*
Liberia		*Norway*		*Suriname*
Madagascar		*Poland*		*Uruguay*
Malawi		*Portugal*		*Venezuela*
Mali		*Romania*		
Mauritania		*Slovakia*		
Mozambique		*Slovenia*		
Namibia		*Spain*		
Niger		*Sweden*		
Nigeria		*Switzerland*		
Rwanda		*Turkey*		
Senegal		*United Kingdom*		
Sierra Leone		*Yugoslavia, Fed Rep of*		
Somalia				
South Africa				
Sudan				

Swaziland				
Tanzania, United Rep of				
Togo				
Uganda				
Western Sahara				
Zambia				
Zimbabwe				
MEA	***NAM***	***PAO***	***PAS***	***SAS***
Middle East/North Africa	***North America***	***Pacific OECD***	***Pacific Asia***	***South Asia***
Algeria	*Canada*	*Australia*	*Indonesia*	*Afghanistan*
Egypt	*United States of America*	*Japan*	*Korea, Dem People's Rep*	*Bangladesh*
Iran, Islamic Rep of		*New Zealand*	*Korea, Republic of*	*Bhutan*
Iraq			*Malaysia*	*India*
Israel			*Papua New Guinea*	*Myanmar*
Jordan			*Philippines*	*Nepal*
Kuwait			*Solomon Islands*	*Pakistan*
Libyan Arab Jamahiriya			*Thailand*	*Sri Lanka*
Morocco				
Oman				
Saudi Arabia				
Syrian Arab Republic				
Tunisia				
United Arab Emirates				
Yemen				

ANNEX 2

Results for Scenario V-A1, V-B1

	Urban area km2	Estimated future urban area (km2) *									% growth 2001-
Region	2001	2005	2010	2015	2020	2025	2030	2035	2040	2045	2045
AFR	**30,988**	34,501	39,039	43,701	48,317	52,632	56,366	59,256	62,134	64,812	109%
CPA	**88,770**	90,734	92,869	94,802	96,246	96,938	96,825	96,084	94,665	92,596	4%
EUR	**119,091**	120,505	120,223	121,487	122,592	123,538	124,262	124,727	124,687	124,165	4%
FSU	**60,323**	60,817	61,630	62,421	62,987	63,358	63,653	63,902	63,852	63,481	5%
LAM	**94,565**	99,831	106,253	112,389	118,029	122,977	127,104	130,350	132,903	134,696	42%
MEA	**32,624**	35,990	40,349	44,816	49,256	53,563	57,569	61,048	64,450	67,638	107%
NAM	**129,858**	134,219	139,632	145,258	151,007	156,623	161,910	166,781	171,107	174,888	35%
PAO	**29,722**	30,231	30,693	30,986	31,155	31,266	31,363	31,422	31,330	31,103	5%
PAS	**29,067**	30,517	32,311	34,056	35,674	37,116	38,354	39,379	40,145	40,619	40%
SAS	**40,858**	43,583	46,903	50,079	53,009	55,581	57,706	59,284	60,605	61,558	51%
	655,864	**680,926**	**709,902**	**739,994**	**768,272**	**793,592**	**815,112**	**832,233**	**845,877**	**855,556**	**30%**

	Urban area km2	Estimated future urban area (km2) **									% growth 2001-
Region	2001	2005	2010	2015	2020	2025	2030	2035	2040	2045	2045
AFR	**30,988**	34,943	40,183	45,726	51,407	56,956	62,059	66,397	70,877	75,291	143%
CPA	**88,770**	91,630	94,957	98,161	100,933	102,978	104,211	104,792	104,639	103,754	17%
EUR	**119,091**	121,013	121,371	123,301	125,089	126,735	128,168	129,350	130,016	130,185	9%
FSU	**60,323**	61,009	62,070	63,117	63,944	64,579	65,141	65,661	65,876	65,761	9%
LAM	**94,565**	100,782	108,559	116,229	123,570	130,362	136,443	141,723	146,377	150,305	59%
MEA	**32,624**	36,359	41,292	46,467	51,751	57,037	62,143	66,813	71,529	76,140	133%
NAM	**129,858**	134,381	140,012	145,874	151,878	157,765	163,339	168,510	173,145	177,241	36%
PAO	**29,722**	30,283	30,812	31,173	31,411	31,591	31,757	31,886	31,862	31,701	7%
PAS	**29,067**	30,834	33,077	35,329	37,508	39,560	41,448	43,156	44,624	45,807	58%
SAS	**40,858**	44,215	48,461	52,715	56,868	60,791	64,372	67,477	70,411	73,033	79%
	655,864	**685,449**	**720,795**	**758,091**	**794,359**	**828,353**	**859,083**	**885,764**	**909,357**	**929,217**	**42%**

	Urban area km2	Estimated future urban area (km2) ***									% growth 2001-
Region	2001	2005	2010	2015	2020	2025	2030	2035	2040	2045	2045
AFR	**30,988**	35,170	40,786	46,822	53,122	59,421	65,395	70,700	76,300	81,986	165%
CPA	**88,770**	92,089	96,048	99,949	103,478	106,324	108,387	109,818	110,520	110,477	24%
EUR	**119,091**	121,272	121,960	124,238	126,390	128,413	130,236	131,817	132,885	133,453	12%
FSU	**60,323**	61,107	62,295	63,474	64,439	65,214	65,920	66,587	66,949	66,976	11%
LAM	**94,565**	101,270	109,762	118,270	126,572	134,439	141,702	148,256	154,276	159,648	69%
MEA	**32,624**	36,548	41,786	47,347	53,110	58,968	64,740	70,159	75,731	81,301	149%
NAM	**129,858**	134,464	140,205	146,187	152,322	158,349	164,071	169,397	174,193	178,454	37%
PAO	**29,722**	30,309	30,872	31,268	31,541	31,757	31,960	32,126	32,137	32,011	8%
PAS	**29,067**	30,997	33,478	36,009	38,508	40,920	43,208	45,352	47,289	48,965	68%
SAS	**40,858**	44,541	49,288	54,154	59,038	63,812	68,361	72,540	76,678	80,624	97%
	655,864	**687,766**	**726,479**	**767,720**	**808,520**	**847,618**	**883,980**	**916,751**	**946,956**	**973,895**	**48%**

Notes:

* Household size is assumed to keep constant, as observed circa 2000 (all scenarios)

** Household size is assumed to converge world-wide at 2.5 persons/household by 2150 (all scenarios)

** Household size is assumed to converge world-wide at 2.5 persons/household by 2100 (A1 and B1 specific)

ANNEX 3

Results for Scenario V-A2

Region	Urban area km2 2001	Estimated future urban area (km2) * 2005	2010	2015	2020	2025	2030	2035	2040	2045	% growth 2001-2045
AFR	**30,988**	34,766	39,599	44,629	49,787	54,954	59,930	64,506	69,104	73,533	137%
CPA	**88,770**	92,890	97,840	102,896	107,951	113,215	118,748	124,611	130,078	135,310	52%
EUR	**119,091**	121,231	121,538	123,193	124,610	125,955	127,261	128,430	129,193	129,633	9%
FSU	**60,323**	61,501	63,143	64,732	66,173	67,771	69,780	72,198	74,679	77,216	28%
LAM	**94,565**	101,658	110,649	119,808	129,204	138,986	149,147	159,635	170,073	180,468	91%
MEA	**32,624**	36,391	41,508	47,092	53,126	59,714	66,911	74,673	82,819	91,283	180%
NAM	**129,858**	135,112	141,407	147,847	154,438	161,030	167,493	173,744	179,724	185,707	43%
PAO	**29,722**	30,388	30,963	31,283	31,425	31,522	31,675	31,881	31,984	31,993	8%
PAS	**29,067**	31,078	33,579	36,061	38,513	41,001	43,540	46,123	48,605	50,994	75%
SAS	**40,858**	43,930	47,762	51,573	55,331	59,028	62,653	66,122	69,453	72,567	78%
	655,864	**688,944**	**727,989**	**769,113**	**810,559**	**853,175**	**897,138**	**941,924**	**985,712**	**1,028,706**	**57%**

Region	Urban area km2 2001	Estimated future urban area (km2) ** 2005	2010	2015	2020	2025	2030	2035	2040	2045	% growth 2001-2045
AFR	**30,988**	35,211	40,760	46,697	52,971	59,468	65,982	72,280	78,828	85,422	176%
CPA	**88,770**	93,808	100,040	106,542	113,208	120,269	127,807	135,904	143,783	151,614	71%
EUR	**119,091**	121,743	122,699	125,032	127,149	129,214	131,262	133,190	134,714	135,919	14%
FSU	**60,323**	61,696	63,594	65,454	67,179	69,078	71,412	74,186	77,046	79,990	33%
LAM	**94,565**	102,627	113,050	123,903	135,270	147,332	160,105	173,563	187,315	201,382	113%
MEA	**32,624**	36,764	42,478	48,827	55,817	63,587	72,226	81,725	91,916	102,757	215%
NAM	**129,858**	135,275	141,792	148,474	155,328	162,205	168,972	175,545	181,864	188,206	45%
PAO	**29,722**	30,441	31,083	31,471	31,683	31,850	32,074	32,352	32,528	32,607	10%
PAS	**29,067**	31,401	34,376	37,409	40,493	43,700	47,052	50,546	54,028	57,506	98%
SAS	**40,858**	44,566	49,349	54,287	59,359	64,561	69,891	75,260	80,692	86,096	111%
	655,864	**693,530**	**739,221**	**788,095**	**838,458**	**891,263**	**946,783**	**1,004,550**	**1,062,715**	**1,121,499**	**71%**

Region	Urban area km2 2001	Estimated future urban area (km2) *** 2005	2010	2015	2020	2025	2030	2035	2040	2045	% growth 2001-2045
AFR	**30,988**	35,063	40,367	45,991	51,872	57,892	63,845	69,504	75,315	81,077	162%
CPA	**88,770**	93,845	100,132	106,695	113,432	120,575	128,204	136,406	144,402	152,360	72%
EUR	**119,091**	122,889	125,344	129,299	133,145	137,051	141,062	145,070	148,766	152,230	28%
FSU	**60,323**	62,382	65,215	68,097	70,931	74,045	77,739	82,047	86,602	91,417	52%
LAM	**94,565**	102,724	113,293	124,322	135,900	148,211	161,275	175,071	189,210	203,713	115%
MEA	**32,624**	36,756	42,458	48,791	55,761	63,505	72,113	81,572	91,717	102,502	214%
NAM	**129,858**	137,208	146,442	156,201	166,525	177,284	188,360	199,679	211,187	223,229	72%
PAO	**29,722**	30,851	32,043	33,013	33,832	34,635	35,534	36,532	37,454	38,304	29%
PAS	**29,067**	31,387	34,342	37,351	40,407	43,580	46,894	50,345	53,777	57,201	97%
SAS	**40,858**	44,261	48,581	52,961	57,372	61,804	66,248	70,615	74,922	79,080	94%
	655,864	**697,366**	**748,218**	**802,721**	**859,176**	**918,581**	**981,276**	**1,046,842**	**1,113,353**	**1,181,113**	**80%**

Notes:

* Household size is assumed to keep constant, as observed circa 2000 (all scenarios)

** Household size is assumed to converge world-wide at 2.5 persons/household by 2150 (all scenarios)

** Household size is assumed to reduce by 0.01 persons/household/year in all world regions (no convergence) (A2 specific)

ANNEX 4

Results for scenario V-B2

	Urban area km2	Estimated future urban area (km2) *									% growth 2001-2045
Region	**2001**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	
AFR	**30,988**	34,510	39,272	44,448	49,885	55,376	60,787	65,918	70,512	74,799	141%
CPA	**88,770**	91,592	94,924	98,345	101,495	104,110	105,875	107,044	107,948	108,508	22%
EUR	**119,091**	119,950	118,924	119,334	119,468	119,379	118,730	117,748	116,477	114,972	-3%
FSU	**60,323**	60,488	60,832	61,178	61,236	61,265	61,208	61,059	60,817	60,521	0%
LAM	**94,565**	100,103	106,814	113,283	119,363	125,004	130,488	135,450	139,832	143,621	52%
MEA	**32,624**	35,849	39,924	43,948	47,912	51,689	55,373	58,831	62,011	64,925	99%
NAM	**129,858**	133,736	138,950	144,556	149,955	154,796	157,065	158,694	159,858	160,840	24%
PAO	**29,722**	30,040	30,254	30,262	30,118	29,875	29,446	29,038	28,665	28,285	-5%
PAS	**29,067**	30,601	32,291	33,884	35,362	36,793	38,245	39,507	40,558	41,429	43%
SAS	**40,858**	43,644	46,966	49,967	52,896	55,717	58,303	60,670	62,763	64,629	58%
	655,864	**680,512**	**709,151**	**739,205**	**767,692**	**794,003**	**815,519**	**833,958**	**849,440**	**862,529**	**32%**

	Urban area km2	Estimated future urban area (km2) **									% growth 2001-2045
Region	**2001**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	
AFR	**30,988**	34,953	40,423	46,507	53,075	59,925	66,927	73,861	80,434	86,893	180%
CPA	**88,770**	92,496	97,059	101,829	106,438	110,597	113,952	116,745	119,321	121,583	37%
EUR	**119,091**	120,456	120,059	121,117	121,903	122,468	122,462	122,111	121,455	120,546	1%
FSU	**60,323**	60,679	61,266	61,860	62,166	62,446	62,640	62,739	62,745	62,695	4%
LAM	**94,565**	101,057	109,132	117,154	124,967	132,510	140,075	147,268	154,008	160,264	69%
MEA	**32,624**	36,216	40,857	45,567	50,340	55,041	59,772	64,386	68,823	73,086	124%
NAM	**129,858**	133,898	139,329	145,170	150,820	155,925	158,452	160,339	161,761	163,005	26%
PAO	**29,722**	30,092	30,371	30,444	30,366	30,185	29,816	29,467	29,152	28,829	-3%
PAS	**29,067**	30,919	33,057	35,150	37,180	39,215	41,329	43,295	45,084	46,719	61%
SAS	**40,858**	44,276	48,526	52,596	56,747	60,940	65,038	69,054	72,918	76,677	88%
	655,864	**685,042**	**720,079**	**757,395**	**794,001**	**829,253**	**860,463**	**889,267**	**915,702**	**940,296**	**43%**

	Urban area km2	Estimated future urban area (km2) ***									% growth 2001-2045
Region	**2001**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	
AFR	**30,988**	35,104	40,826	47,245	54,244	61,632	69,285	76,989	84,440	91,901	197%
CPA	**88,770**	93,494	99,479	105,885	112,354	118,587	124,196	129,428	134,662	139,797	57%
EUR	**119,091**	123,277	126,612	131,783	137,036	142,446	147,613	152,801	158,073	163,516	37%
FSU	**60,323**	62,246	64,960	67,889	70,723	73,765	76,968	80,347	83,928	87,798	46%
LAM	**94,565**	102,224	112,044	122,153	132,412	142,777	153,590	164,450	175,289	186,088	97%
MEA	**32,624**	36,577	41,795	47,238	52,914	58,697	64,709	70,808	76,940	83,120	155%
NAM	**129,858**	137,952	149,210	161,871	175,420	189,554	201,771	214,385	227,708	242,292	87%
PAO	**29,722**	30,968	32,441	33,807	35,115	36,422	37,616	38,959	40,493	42,188	42%
PAS	**29,067**	31,217	33,791	36,397	39,019	41,733	44,628	47,467	50,218	52,911	82%
SAS	**40,858**	44,307	48,604	52,730	56,946	61,216	65,402	69,517	73,491	77,372	89%
	655,864	**697,365**	**749,762**	**806,998**	**866,184**	**926,829**	**985,779**	**1,045,151**	**1,105,241**	**1,166,983**	**78%**

Notes:

*	Household size is assumed to keep constant, as observed circa 2000 (all scenarios)
**	Household size is assumed to converge world-wide at 2.5 persons/household by 2150 (all scenarios)
**	Household size is assumed to reduce by 0.02 persons/household/year in all world regions (no convergence) (B2 specific)

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Abstract

This technical note aims to present the progresses done towards the evaluation of the possible application of the Land Use Modelling Platform (LUMP) in a global context or anyhow outside the geographical borders of Europe. The definition and computation of demands for land-uses are the first element to be appraised since these are essential inputs for the modelling platform. The note describes the methodology adopted to compute the demand for urban land (this includes land uses related to residences, leisure facilities and small commercial and industrial activities) in 10 regions worldwide according to a set of different scenarios of demographic expansion.

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