

ARTIFICIAL SURFACES IN EUROPE: MAP OF CHANGES IN 1990-2006

FERANEC J.(1), SOUKUP T.(2)

(1) Institute of Geography SAS, BRATISLAVA, SLOVAKIA ; (2) GISAT s.r.o., PRAGUE, CZECH REPUBLIC

BACKGROUND AND OBJECTIVES

Among the most dynamic landscape transformations under the impact of human activities is the one in favour of artificial surfaces. Scalenghe and Marsan (2009) report that the sealed soil covers around 9% of Europe's area. Hasse (2009) brings a similar proof reporting that during 1992-2002 around 2,080,000 acres (3.95 acre /min. or 1.6 ha/min.) were built-up in the USA. Kampouraki et al. (2006) offer the basic methods for identification and measuring of areas by sealed by impermeable materials (concrete, asphalt, etc.). An important information source for the assessment of the changed artificial surfaces, especially their spatial distribution and intensity, are the aerial and satellite images, or the derived data (e.g. CORINE land cover – CLC). The aim of the paper is to demonstrate the methodology and map presentation of changes that affected artificial surfaces in Europe in last decades (1990-2006) through CLC data.

APPROACH AND METHODS

All data concerning spatial distribution and areas of CLC1990, CLC2000 and CLC2006 classes and their changes are available at <http://terrestrial.eionet.eu.int>. Those of identified land cover changes that were associated with the process of urbanization (changes of agricultural areas, forest and semi-natural areas into artificial areas) and are referred to as land cover flow urbanisation (LCFU) were selected.

Individual changed areas of artificial surfaces are mostly too small (e.g. the smallest identified change area in the frame of CLC mapping is 5 ha) to be presented on a map either on the national or European levels. Practical solution how to “visualise” such small areas of change is the presentation of their intensity through a regular grid pattern. Pursuing the study Feranec J. et al. (2010), the 3×3 km grid has been used as a compromise between the actual spatial distribution of changes concerning processes of urbanisation, intensification of agriculture, extensification of agriculture, afforestation, deforestation, construction of water bodies and their presentation on the European level at an accessible scale. The mean LCFU value presented in the map was calculated by summing up all areas within the 3×3 km squares that are characterised by this specific LCF divided by the number of 3×3 km squares where such changes took places. The obtained value of LCFU change in the square was compared with the mean change value of the particular LCFU and it was assigned the tone of light red colour if the percentage of the changed part was smaller than the mean change value or the dark red tone if the percentage of the changed part was greater than the mean change value.

RESULTS

980,620 ha of landscape (mean yearly 98,062 ha) in 1990-2000 and 686,397 ha (mean yearly 114,400 ha) in 2000-2006 changed in favour of artificial surfaces (urbanisation) in Europe. These changes are more clearly demonstrated by the share of mean annual LCFU in total LCFs, which enlarged from 1.11% (in period 1990-2000) to 1.74% (in period 2000-2006) (see Tab. 1). Spatial distribution of these changes is demonstrated on the poster map Spatial distribution of urbanisation in European countries 1990-2006. It is evident that areas of artificial surfaces in eastern part of Ireland, western part of the Netherlands, southern part of France, along the River Po in northern Italy, in central and eastern Spain, western Albania or northern parts of Hungary, etc. (Feranec et al. in press) were the ones that most increased.

	1990-2000			2000-2006		
	Total area (ha)	Mean early increase in the period (ha)	Mean yearly LCFU of total LCF area (%)	Total area (ha)	Mean yearly increase in the period (ha)	Mean yearly LCFU of total LCF area (%)
LCFU	980,620	98,062	1.11	686,397	114,400	1.74
Total LCF area	8,850,550			6,572,187		
Total countries area	369,012,006*			542,417,086**		

*29 countries; **37 countries – new countries have joined the CLC programme, so the total area mapped in 2000-2006 period was considerably enlarged.

Table 1 Changes of artificial surfaces (LCFU) in Europe 1990-2006

The fragment of the quoted map demonstrates that the corresponding squares of the 3×3 km grid also contain other types of changes (LCFs). However, those were not taken into account in the LCFU rate assessment by the means of applied methodology.

CONCLUSION

The results confirmed expansion of built-up areas in Europe in the period of 1990-2006. These enlarging areas through their patterns represent the sprawl of artificial surfaces.

Map presentation of changed artificial surfaces, their spatial distribution and their intensity may be valuable for identification and assessment of causes of landscape changes not only from the research but also the applied points of view. Apart from enriching thematic cartography it has certainly proved to be useful in environmental planning.

REFERENCES

- Feranec, J., Jaffrain, G., Soukup, T., Hazeu, G. (2010): Determining changes and flows in European landscapes 1990-2000 using CLC data. *Applied Geography*, 30, 19-35.
- Feranec, J., Soukup, T., Hazeu, G., Jaffrain, G. (in press): Land cover and its changes in Europe 1990-2006. In Chandra, G., ed. *Remote sensing of land use and land cover: principles and applications*.
- Hasse, J. (2007): Using remote sensing and GIS integration to identify spatial characteristics of sprawl at the building-unit level. In Mesev, V., ed. *Integration of GIS and remote sensing*. Chichester (Wiley), pp. 117-147.
- Kampouraki, M., Wood, A. G., Brewer, T. (2006): The application of remote sensing to identify and measure sealed areas in urban environments. In Lang, S., Blaschke, Th., Schöpfler, E., eds., 1st International Conference on Object-based Image Analysis (OBIA 2006). <http://www.isprs.org/proceedings/XXXVI4-C42papers.htm>
- Scalenghe, R., Marsan, A. F. (2009): The anthropogenic sealing of soil in urban areas. *Landscape and Urban Planning*, 90, 1-10.