ANNALS OF FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL OF ENGINEERING
Tome X (Year 2012) – FASCICULE 3 (ISSN 1584 – 2673)

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POSSIBLE LANDSCAPE ECOLOGICAL ANALYSES OF THE CORINE DATABASE BASED ON GIS SYSTEMS

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ABSTRACT: *The importance of landscape ecology is continuously growing nowadays, as its results can be used in wide ranges. GIS based applications presented in this study are especially important among the research methods of landscape ecology. In this paper the measurements of landscape metrics – edge density, the change in land cover – based on the CORINE database is presented. These indexes – among others – are suitable to show the effects of agricultural production on landscape variegation. The application of this method makes it possible to understand better the processes going on in the landscape and to prepare a more precise forecast for the next 10-20 years.*
KEYWORDS: *landscape ecology, CORINE database, landscape metrics, GIS, land cover*

INTRODUCTION

Landscape ecology puts forward proposals for landscape planning and landscape management for the proper use of landscape that establishes connection between nature, agriculture, human beings and urban systems (Naveh – Lieberman, 1994). Usually it takes as its starting-point that the landscape pattern and structure influences the ecological processes to a great extent (Turner, 1989).

This assumption played a role already in the first steps of establishing landscape ecology, when Carl Troll, the "founding father" of this discipline took aerial photos in East- Africa in 1939 to examine the spatial spread of plant communities. With this method not only the basic connections of landscape ecology were explored, but the methodological diversity of the examinations was established as well. Among the applied methods the use of aerial photos is of outstanding importance. Next to this method lined up in the last 15-20 years both the possibilities offered by the satellite images and the databases completed by ground references, like the MÉTA database (Magyarország Élőhelyeinek Térképi Adatbázisa; Landscape Ecological Vegetation Database and Map of Hungary) developed by the ÖBKI (Ökológiai és Botanikai Kutatóintézet; the Institute of Ecology and Botany) and the CORINE database used in this study.

The number of the studies on landscape has been increasing not only in Hungary, but in the European Union as well (Kollányi, 2006). The common point in the numerous definitions of the landscape is that it is a well-defined unit of the ground surface, which – based on its physical appearance and structure – can be divided from its neighbouring units (landscapes) (Csorba, 1999). In many cases it is exactly this division that raises many questions and leads to a field of landscape ecology where the methods of GIS and mathematical-statistical analyses gain significant role in the research. Many researchers deal with the problem how to draw borders between geographical landscapes (Csorba, 2008; Lóczy, 2002; Mezősi, 2011). The question of drawing borders, similarly to the calculation of landscape metric indexes, belongs to the quantitative research field of landscape ecology. In calculating landscape metric indexes there is a need for a consistent database set by using unified principles, in which the landscape patches appear as basic units. The CORINE database coordinated by the European Union is like that. As this database is free and available for everyone without restraints, instead of other possible solutions, it was used as the starting point of this study.

The ecological patches are the basic elements of the ecological pattern. These certain landscape patches can be established by designating homogenous units of landscape use – by appointing land cover and land use units in the CORINE program. This database can be downloaded from the webpage of the European Environment Agency both in vector and in raster formats. In this study the vector-format database was used, as the processing and the completion of the relational databases attached to them ensures further possibilities for examination.

The primal aims of this study are to introduce the mapping possibilities of some indices applied in the European Union by using the CORINE database and to introduce the results concerning Hungary.

MATERIAL AND METHOD

The CORINE basically consists of two databases that are focusing on different matters: while one of the databases shows the landscape cover of a certain time, the other records the changes between the times of measurements. The hypothetical measurement periods of the mapping are 1990, 2000 and 2006.

When preparing landscape ecological analyses it is of primary importance to designate properly-sized investigation units. In this case, due to the scale of the CORINE database and the characteristics of its procession (the minimal size of the mapping unit is 25 ha) and due to the results of other examinations, the ideal size of the smallest cells still analysable is 3 x 3 km. At the same time in England, the country that has the strongest tradition in Europe regarding the evaluation of the landscape character, data-collection is carried out in every 5 or 6 years based on a 5 x 5 km grid. After preparing the "trail" map representing the changes of land cover, it was decided that the 5 x 5 km grid would be used in this study as well. The changes of edge density were also projected on this grid.

The edge density index shows the length between the edges of the various land cover patches projected to a reference territory. The more "compact" – homogeneous from the point of view of landscape ecological diversity and stable regarding the landscape use – the territory, the lower the index. Figure 1 shows the changes in the edge density of the landscape patches in Hungary between 2000 and 2006. The figure depicts the changes where decrease was sensed during the examined period, thus where the edge density and related to it the diversity of the various landscape patches was decreasing. This is one of the consequences of the fact that the size of the patches has been growing, which is due to the extension of the land use categories of the same classes.

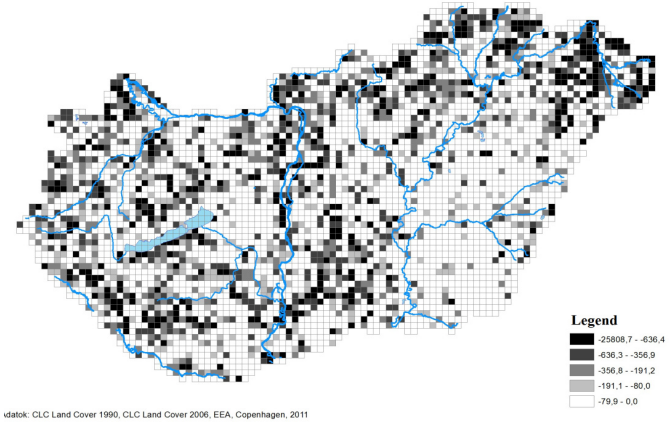

Figure 1: Edge density decrease in Hungary between 2000 and 2006 (m). Source: own calculation based on CORINE data

RESULTS AND DISCUSSION

The negative tendencies concern mainly the Nyírség and the Danube-Tisza Interfluve in the Great Hungarian Plain that are large sand regions. In other words these are the territories that were partly exempted from the effects of the large-scale agricultural production, thus the degradation of landscape was of a smaller extent here than in the other territories of the Great Hungarian Plain. At the background of the present unfavourable process are the changes in land cover that has been going on since 1990.

After the change of regime the crisis of agriculture and the system of compensation had its consequences on land use. The decrease in the livestock brought about the decrease of the pastures that later on made the recovery and the development of the agricultural sector impossible. Besides, due to the fact that the wood of the forest plantations grew up, the transitional woodland-scrub territories also declined. If the data of Table 1 are examined, it becomes visible that the category of the broad-leaved forests has significantly risen, primarily due to the transformation of the transitional woodland-scrub territories.

From 1998, during the preparation phase for the EU accession – and from 2004, already as the member of the EU – new assistance resources opened up for agriculture and later on their number also grew. This process brought about changes in land use, the quantifiable results of which are presented in Table 2.

Table 1: Change in the CORINE-categories between 1990 and 2000 (ha)

		Categories in 1990						
		Non-irrigated arable land	Pastures	Broad-leaved forests	Transitional woodland scrub	Sum total 2000	Sum total 1990	Difference
Categories in 2000	Non-irrigated arable land		11938.1	20.9		13319.9	9246.8	4073.1
	Pastures	3000.1				3461.9	13260.9	-9798.9
	Broad-leaved forests	1691.7			19573.9	21517.4	6533.5	14983.8
	Transitional woodland-scrub	2842.0	621.9	6495.8		10678.0	20088.1	-9410.1
	The change in categories all together	9246.8	13260.9	6533.5	20088.1	48977.1		

Source: own calculation based on CORINE data

The data in the table show that while the territory of the pastures has decreased significantly, the territory of the fruit tree plantations and the broad-leaved forests have considerably enlarged, which is partly due to the financial assistance of forestry (National Forest Program) and partly to the subventions for reconstructing plantations and for planting launched in 1998 (until 2004 this was

guaranteed still by the Ministry of Agriculture). Both measures concerned significantly the environmentally sensitive territories of the Nyírség and the Danube-Tisza Interfluve. The yield of the intensive cultures grown here, that depends highly on the weather conditions, fundamentally influences the achievements of the farming activity. The profitability of farming is also determined by the small-sized-land structure and by the difficulties of selling the products, so the farmers on these territories try to seize all the opportunities for their assistance (the stabilisation of their incomes). Thus the support policies of agriculture and the related fields are able to induce a very significant change in land use in a rather short period of time (in approximately 2-3 years), which finally turns the development of landscape into the direction of homogenisation.

Table 2: Change in the CORINE-categories between 2000 and 2006 (ha)

		Categories in 2000							
		Non-irrigated arable land	Fruit trees and berry plantations	Pasture	Broad-leaved forests	Transitional woodland-scrub	Sum total 2006	Sum total 2000	Difference
Categories in 2006	Non-irrigated arable land		1084.3	3654.5			4972.0	24997.8	-20025.8
	Fruit trees and berry plantations	9662.5					9885.6	1538.7	8346.8
	Pasture	1999.3					2282.0	6056.7	-3774.7
	Broad-leaved forests	3106.7				12995.7	16299.7	9083.0	7216.7
	Transitional woodland-scrub	9426.9		1838.1	9044.1		22347.6	13155.6	9192.0
	The change in categories all together	24997.8	1538.7	6056.7	9083.0	13155.6	55786.9		

Source: own calculation based on CORINE data

It is also important to highlight that forestation does not result in a growing of landscape ecology diversity. In contrast with the nearly natural forests that appear as heterogeneous landscape ecological patches, the planted forests increase the homogeneity. It has to be mentioned that that the majority of the planted trees are not native species but poplar trees, acacia, the European Black Pine trees, the spread of which species turns the landscape into the direction of uniformisation.

The change in the edge density index reveals that there is a strong relationship between landscape diversity and land cover (change). The data presenting the changes of the land cover is summarised in Table 3. Based on this table it can be stated that these transformations do not affect a great territory, as it comprises only 7-8 % of Hungary. At the same time Figure 2 shows that the change of landscape is highly concentrated in space, and primarily concerns the Danube-Tisza Interfluve, the Nyírség and in a smaller extent the landscapes of the North Hungarian Mountains and the Transdanubian Mountains.

These processes have the slightest effect on the territory of the Plain where industrial agriculture is pursued – like the Nagykunság and the territory between the rivers Körös and Maros. Despite the process of compensation, a dualistic lad system evolved on the great part of these territories, where the newly formed economic companies and agricultural cooperatives use the vast majority of the lands in the large-scale land system, similar to the previous period.

Table 3: Land cover change in Hungary between 1990 and 2006

Classes	Difference 1990-2000 (ha)	Difference 2000-2006 (ha)	Change (ha)
Artificial surfaces	3644.7	15160.89	**18805.59**
Agricultural areas	-45784.76	-61732.1	**-107516.86**
Forests and semi-natural areas	33851.63	43605.03	**77456.66**
Wetlands	410.92	-32.19	378.73
Water bodies	7877.51	2998.31	10875.82
All together	**434336.83**	**272768.75**	**707105.58**

Source: own calculation based on CORINE data

The change was more significant at territories with weaker production potentials, the majority of which was mainly cultivated in labour unions. This is due to the fact that there is a so called "continuity" with the pre-1945 peasant life that could be characterised by mosaic-like land use – like the scattered farms in Hungary. According to the studies focusing on the agriculture of the scattered farms of the Homokhátság area, the dualistic land structure is also typical of this territory, but the average land size of the joint ventures is much smaller than the Hungarian average (Farkas – Gaborjákné, 2006).

Besides the mosaic-like landscape use, there is one more thing to be highlighted in connection with the area of Homokhátság. The grape, as the basic plant of the "sand culture", that had a significant role in stopping the sand movements, has nearly "disappeared" from the landscape. In numbers, this means that according to data of the Hungarian Statistical Office the size of the grape plantations has been reduced by 15 700 ha between 1990 and 2008. This is due to the fact that the financial aids of the

CAP highly influence the profitability of certain agricultural activities and consequently the land use as well. Therefore the agricultural policy of the European Union plays a significant role in the development of the rural landscapes. Instead of enhancing the production this policy highlights the ideas of agricultural landscape ecology and sustainability nowadays, which is directing the local societies towards the establishment of a so called "post-productivist rural landscape" (Marsden, 1998).

CONCLUSIONS AND FURTHER POSSIBLE UTILIZATION

Based on this study it can be concluded that by analysing the CORINE database with the help of GIS systems both research studies and maps for presenting landscape ecological diversity and landscape stability can be prepared (Feranec et. al., 2005). This is important as the spatial and temporal comparison of these indices may become easier and more wide-spread this way (Kollányi, 2006).

Due to the more simple application it is easier to understand the processes going on presently in the landscape and their probable results appearing 10-20 years later can also be forecasted in a more precise way. All this becomes possible in an era when the preservation of landscape diversity became an outstanding aim owing to suburbanization and urban sprawl. In fulfilling this aim the maps on landscape diversity and landscape stability may become fundamental aids for landscape planners and spatial planners in evolving the suitable practice of landscape ecology in Hungary.

The particular result of this study is that it proved that the changes in land cover and land use are rather concentrated in space in Hungary, mainly concerning the Nyírség and the Danube-Tisza Interfluve. In the background of this process are the economic-social factors of the period following the change of regime, out of which the most important are the structural characteristics of the agricultural production and the preferences of the agricultural financial support. The change of land use in these environmentally sensitive territories is associated with the decrease of landscape diversity, which is unambiguously the first sign of homogenisation.

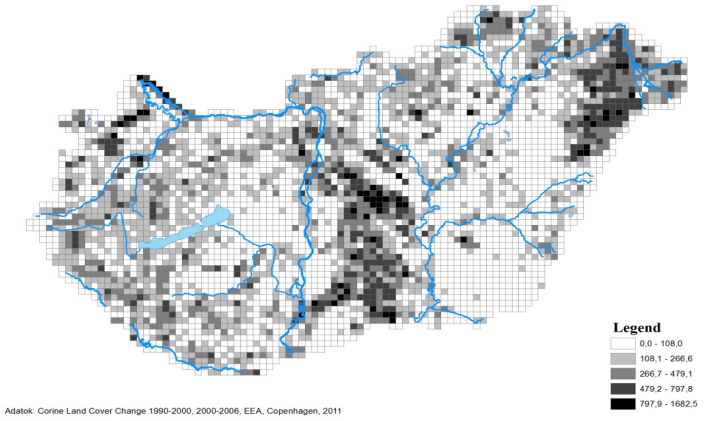

Figure 2: Land cover change in Hungary between 1990 and 2006. Source: own calculation based on CORINE data

In our opinion this method may become a basis for a set of new, applied research studies in the following topics: designating new nature reserves, appointing agricultural landscapes of high natural values, specifying the target areas for the financial support in agricultural-landscape economy and monitoring the agricultural processes modifying the landscape. Moreover, by breaking away from society and agriculture, important research direction may become the analyses of the relationship between landscape fragmentation and the quality of habitats and its effect on biological diversity as well (Egbert et. al., 2002).

ACKNOWNLEDGEMENT

The project TÁMOP-4.2.1/B-09/1/KONV-2010-0005, called „Establishment of Center of Excellence of University of Szeged" is cofinanced by the European Union and the European Regional Development Fund.
The intermediary body of the TÁMOP project is the Support Management Directorate of the Ministry of Education and Culture (1055 Budapest, Bihari János u.5.).

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