Complex Eco-environmental Study on Urban Area

Judit Mizsei-Nyiri[1], Peter Udvardy[2], Margit Horosz-Gulyas[3], Katalin Katona-Gombas[4], Janos Katona[5],
[1-5]*University of West Hungary, Hungary*

Abstract. **One of the main goals of the TÁMOP project called "Complex eco-environmental study of the cities in the Western Transdanubian region" was the study of the interaction between urban and natural areas. The major task was to reveal the conflicts and their location in the urban areas and use these data in the decision making process concerning the land use in the cities. The protection of the urban green areas and the prevention of the built structures had a top priority in this research considering the increase of the urban environmental life quality and the development of the environmental protection infrastructure. Therefore it was necessary to study and evaluate the so-called urban ecological parameters. The next step was the creation of an environmental cadastre and the elaboration of an eco friendly urban development plan proposal. The results of these complex studies should be part of the urban development processes in the future.**

Keywords: **urban ecology, ecological parameters, land use.**

I. Introduction

Landscape ecology which includes urban ecology is a multidisciplinary subject since it exploits several results of social and natural sciences. The location of urban areas was basically influenced by environmental components. The relationship is mutual because not only the environment defines the urban areas' location but the urban areas have an effect on the environment. There is a permanent flow of material, energy and information between the cities and the environment. Although the two components had been examined separately several times there is only a little knowledge about their impact on each other especially the ecological aspect. The aim of our study is a better understanding of these relationships.

During our work the connection between the urban and periurban areas and their mutual effects on each other were studied in three cities in Hungary (Sopron, Szombathely, Székesfehérvár). An important part of our work was the examination and evaluation of the so called urban ecological parameters (climate, water balance, vegetation, noise, air pollution, etc.); creation of an environmental cadastre and working out of ecological based suggestions for urban management and city development. These ecological city development suggestions become an organic part of urban development and urban management programmes.

The examination of the urban environmental conflicts and their location aroused as a major task of the project or rather the decisions connected to the urban land use. The spatial elements concerned may consist natural systems such as agricultural and natural ecosystems, land coverage elements, ecological networks, green areas. The maintenance of the green areas and the avoidance of damages caused by erosion and drying in built environment is an important issue which can be achieved by the improvement of environmental quality, environmental protection infrastructure, and protection of built and cultural heritages (Pődör – Nyiri 2011).

II. Materials and Methods

A. Study site

During the last decades the University of West Hungary Faculty of Forestry and Faculty of Geoinformatics had many research programs on natural and human environmental issues,
mainly on forests (Albert-Jancsó 2012). These studies highlighted the details of the natural (geographic, soil, air, water, plants, aminals, etc.) and artificial (built areas, infrasructural networks, etc.) environment. The two Faculties have a long and successful experience in this study area and were participants of different national and international projects (i.e. INCO, EU Marie Curie, etc).

The TÁMOP 4.2.1.B-09/1/KONV-2010-0006 is an EU project aiming at "The improvement of the quality of higher education through the development of research-development-innovation-education…" At the same time this is also a "Research University Proposal" (Neményi 2012).

The main goal of the project is to analyze the interaction between the urban areas and their surroundings (Katona-Gombás – Horosz-Gulyás 2010), to create the integrated monitoring system of the urban environmental quality concerning the urban development issues. There is a continuous material-, energy- and information exchange between the city and the surrounding territories. Although the two big systems were deeply examined separately, the integrated monitoring was not well studied. As the urban areas are different from each other thus the interactions between these areas will be different, too.

As a result the subsystems of the urban environment and their interactions are examined better. The collection of data and their evaluation with remote sensing and GIS methods give a good opportunity for showing the connection and coherence of spatial and thematic data in larger areas.

Due to the up-to-date complex research approach new eco-environmental models can be created which will be unique even at international level. New information will be available for the urban-natural border areas which were changing very rapidly in the past few decades. The newly created and easily usable databases will support the decision making process in

these regions. The results will help to maintain the successful sustainable city conception.

Our aim was to analyse the interaction between cities (Sopron, Székesfehérvár, and Szombathely) and their close environment formed in different natural conditions in the Western and Middle Transdanubian region. We are creating an integrated monitoring system of the urban environmental quality concerning the urban development issues with a system oriented scientific description of urban ecological systems.

We are concentrating on a complex study report containing the following main topics:

- Székesfehérvár: analysis of the settlement patterns and distribution of vegetation. Delineating zones by functionality. Land cover maps and conclusions derived from them.
- Szombathely: effect of the topography and the vegetation on the settlement structure.

As a result we can perform an image analysis and classifications (thematic maps) using a geographic information system architecture.

Fig. 1. Location of Székesfehérvár on Google Map.

B. Data

The main objective during the land ecology examination data collection procedure was the complexity of data sources which assure the high level data procession. During our work satellite images, topographic maps, meteorological datasets, green areas maps, etc. were collected and used. Some of the data were available in raster format but most of them were used and examined in vector format such as point located spatial data (Mizseiné – Pődör 2011).

The long term statistical datasets which were collected by the Hungarian Statistical Office (KSH) (i.e. population, precipitation, temperature, wind, etc.) were also used for timeline analyses. A detailed study was made in Székesfehérvár, but only major urban ecological data were examined in Szombathely.

C. Methodology

Different amount of samples were collected according to the environmental elements and affecting factors in the examined cities. At the end of the project the following matrix is used to define the given status of the environment (Table I) (Csóbor 2004).

TABLE I
IMPACT MATRIX

Pollution source	Concerned environmental elements, and effect factors					
	Air	**Water**	**Soil**	**Green surface**	**Waste**	**Noise**
Traffic	X	X	X	X	X	X
Industry, trade	X	X	X	X	X	X
Health					X	
Wastewater management	X	X	X		X	
Agriculture	X		X	X	X	
Cities and built up environment	X	X	X	X	X	X

The study of changes in demographical data of a city considering the urban environmental examinations is very important since the population carrying capacity of a settlement can be seen. Demographical trends correlates strictly with the intensiveness of environmental usage and environmental impact (Konkolyné 2003).

The population of Székesfehérvár decreased permanently in the past decades, the number of inhabitants is around 100.000 persons. This number correlates with the general trends in Hungary, some of the inhabitants move to the periurban areas. The population density is around 600 persons per square kilometre which is not too high compared to the western European countries. The advantages (i.e. green areas) and disadvantages (less developed areas) of the city must be revealed by the city's decision makers in order to make the city more comfortable. The creation of spatial usage map and spatial structure map is a good tool in decision making process.

During our examination the advantages of GIS software were utilised. The IDRISI Taiga software showed the directions of the urban areas' increase. The ArcGIS 9.3. software was used to visualise the spatial structures of the urban areas. The two software above complete each other during the data processing procedure and can handle both type of data models (raster and vector data). The modelling of the urban areas' increase was done by visual interpretation, the spatial structure analyses was made by the help of GIS software.

III. RESULTS AND DISCUSSION

The spatial structural examinations were conducted considering several aspects. One of these aspects was the demarcation of the green areas which was a great job since there are big green areas in Székesfehérvár. The green areas which are intended to increase the ecological capability of a city must be integrated to the whole city's spatial structure (Konkolyné 2003). The large part of the urban dendroflore (trees) is not native at that area. The number and species of the urban trees are various considering the different cities and a large number of different tree species can be found in the cities (Nagy 2008).

TABLE II
SZÉKESFEHÉRVÁR – SPATIAL STRUCTURE AND LAND USE CATEGORIES

Code	Land structure category	Land use category	Land use code
1.	City centre	Mixed city centre	A.2.1.
2.	Block of flats area	Metropolitan residential area	A.1.1.
3.	House area	Small-town residential area	A.1.2.
		Suburban residential area	A.1.3.
		Village residential area	A.1.4.
4.	Industrial area	Economical area	A.3.
		Special area	A.4.
		Mixed central area	A.2.2.
		Traffic-, public facility- telecommunication area	B.1.
5.	Landscaped area	Green area	B.2.
		Forest	B.3.
		Agricultural area: plantation	B.4.2.3.
6.	Natural grassland area	Agricultural area: pasture	B.4.2.2.
7.	Bare surface area	Agricultural area: arable land	B.4.2.1.
8.	Water surface area	Water management area	B.5.

In this study the protected trees of the different cities were localised during the examination process of the green areas. As it is written in the literature it can be said that significant number of trees can be found in alleys and city parks. Protected areas and parks were localised in a different category.

Land usage index is a complex indicator which characterise the urban structure. Thus land use types were created which were characterised in details by further indicators which consider their ecological contents. With the help of the analyses of the existing databases available at the local municipalities the land use types can be interpreted easily thus the studying of the urban ecological structure also can be made. On the basis of the existing database a new urban area use database can be created which considers the ecological aspects and helps to make a complex comparative study with other cities (Nagy 2008).

A. Spatial structure

The spatial structure and land use analyses were conducted with the help of the actual urban planning and urban development issues. The category structure of the two maps can be easily compared by the table under (Table II) (Mizseiné – Horoszné 2012).

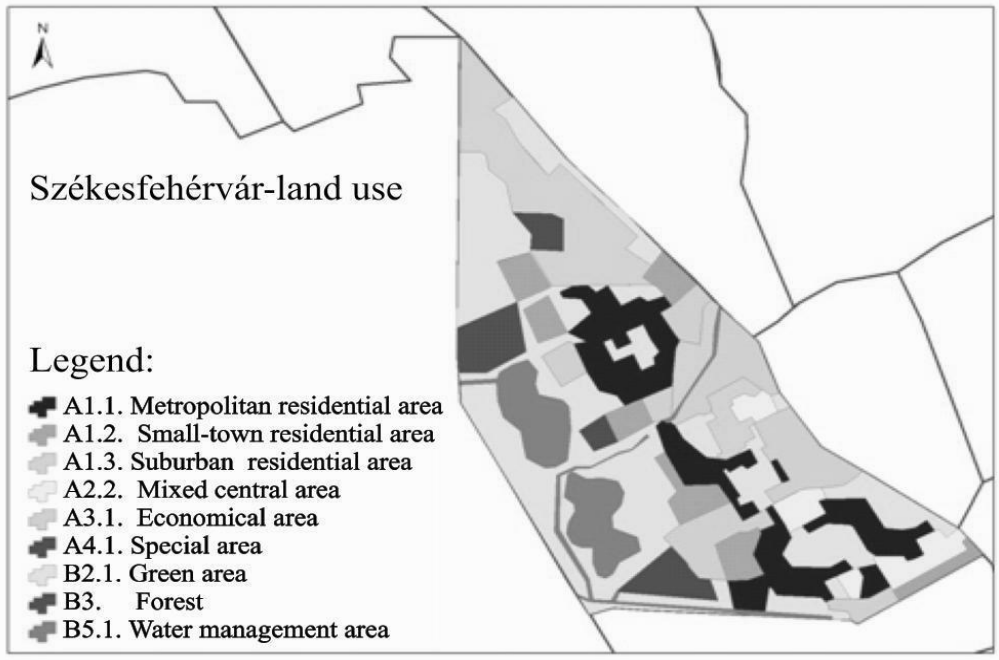

Fig. 2. Székesfehérvár – land use.

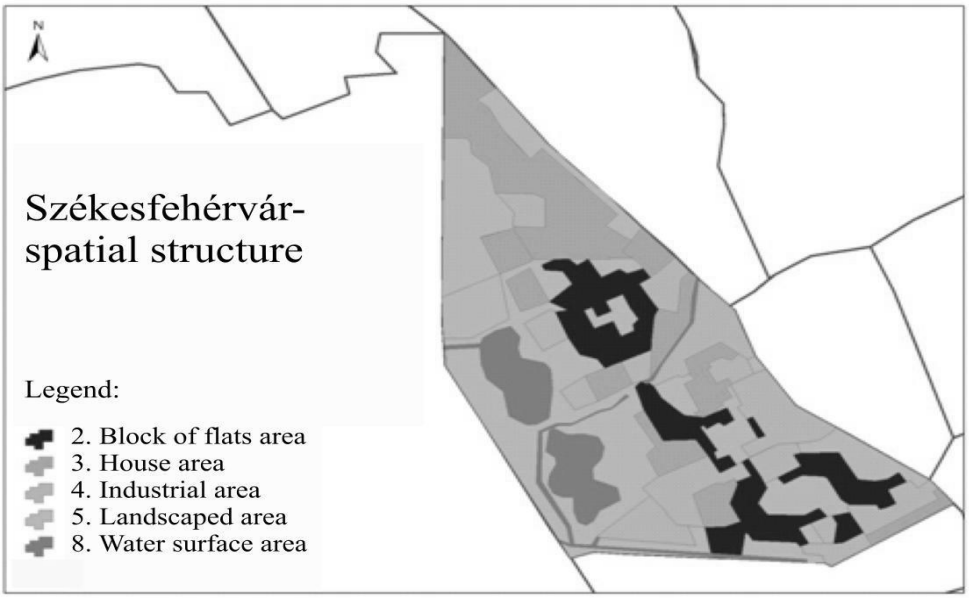

Fig. 3. Székesfehérvár – spatial structure.

B. Land use changes

Land use changes and urban area increaset were examined in Szombathely and statistical analyses were done. It can be seen that the city area doubled in the last 200 years which was caused by its favourable location, geographical conditions and special natural-economic potential (Katona 2007).

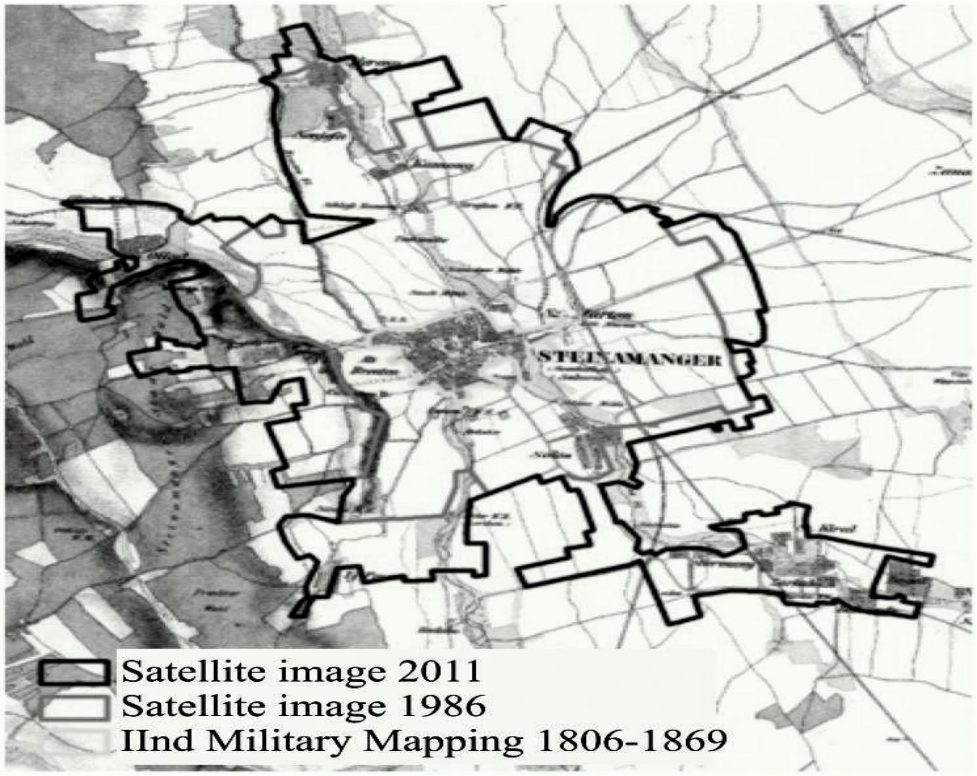

Fig. 4. Szombathely – land area changes in the last 200 years.

Fig. 5. Szombathely – land area changes in the last 200 years in WorldView image.

The increase of the urban area in Szombathely is not parallel to the changes of the population but because of the increase of the industrial areas and the need for residential areas. The size of the residential areas get bigger in the past decades as it happened in west Europe.

One of the main objectives during the study was to determine the urban ecological footprint. The measurement method for the environmental impact was developed by Wackernagel and Rees called 'ecological footprint' evaluation method. This value is determined in hectares and contains the input and output energy and materials used by the certain group of people.

After finishing the calculation the result reveals the quantity of land and water surface that is necessary to sustain the system. The impact of any regional economy or enterprises or sport event or a single human being can be specified with this method (Szigeti – Borzán 2010).

IV. CONCLUSIONS

The results of studying the human-environmental interaction in urban areas help the determination of real and specific environmental problems and the specification of the environmental sensitivity of the groups. In former researches on individual and its surrounding environment scientists mainly focused on social environment instead of natural and material environment. These factors have been only studied recently.

The urban ecology science reveals the connection and cause and effect interaction between the urban inhabitants and the biosphere, the environmental harms and conflicts and highlights the regularities of social mechanism and social and psychical reaction (Nagy 2008).

The aim and objectives of the research study is in harmony with the cities development projects. Thus the results can be used in decision making processes. The implemented project proposals can be specified upon the results of the health check and the professional and NGO's' requirements. This study gives a scientific support and adequate information for decision makers on these specific fields:

- Urban environmental hygiene;
- Precipitation sludge management;
- Sewage sludge management and purification;
- Communal waste management;
- Local public transportation management;
- Air pollution management;
- Drinking water supply;
- Energy management;
- Green area management;
- Wreck control;
- Natural and built heritage protection;
- Urban environment protection;
- Landscape protection;
- Biosphere and natural conservation.

The current and future urban development and urban land management plans and the need for areas for enterprise development are directly or indirectly affect the existing protected or worthy protected natural and environmental values. That is why these values must be considered during the planning process of the future development. The main objectives are the protection of the biosphere and biotopes and the subservience of these areas in the non-protected zones.

Our study helps to fulfil these above mentioned aims by providing data and suggestions.

Acknowledgements: We wish to thank TÁMOP-4.2.1/B-09/1/KONV-2010-0006 project.

REFERENCES

[1] Albert, L., Jancsó, T. Complex study of urban eco-environment in the Western Transdanubian Region. In: Proceedings of *the International Scientific Conference on Sustainable Development & Ecological Footprint* - Sopron, Hungary, March 26-27, 2012.

[2] Csóbor, J. *Székesfehérvár védett fái.* Szakdolgozat, UNIGIS Továbbképzés, NymE Geoinformatikai Kar, Székesfehérvár. 2004.

[3] Katona-Gombas, K., Horosz-Gulyás, M. Microregions agricultural aptitude test methodology. In: *Geographica Technica* Nr. I/2010, p. 11-16.

[4] Katona, J. *Természetvédelmi Információs Térkép publikálása az Interneten.* Szakdolgozat, NYME-GEO. 2007.

[5] Konkolyné, É. Gy. *Környezettervezés*. Mezőgazda Kiadó, Budapest, 2003., 398 p.

[6] Mizseiné, Ny J., Horoszné, M.G. Zöldfelületek hatása a szociológiai faktorra. In: GISopen konferencia *Nyugat-magyarországi Egyetem Geoinformatikai Kar* - Székesfehérvár. 33 dia. 2012.

[7] Mizseiné, Ny J., Pődör, A. Városökológiai kutatások Székesfehérváron. In: Térinformatikai Konferencia *„Az elmélet és a gyakorlat találkozása*", 2011. május 19-20. Debrecen, 2011., p. 71-77. ISBN 978-963-318-116-4.

[8] Nagy, I. *Városökológia*. Dialóg Campus Kiadó, Budapest-Pécs, 2008., 335 p.

[9] Neményi, M. Introduction to the Project – The Impact of Urbanization, Industrial and Agricultural Technologies on the Natural Environment. In: Proceedings of *the International Scientific Conference on Sustainable Development & Ecological Footprint* - Sopron, Hungary, March 26-27, 2012.

[10] Pődör, A., Nyiri, J. Urban ecological monitoring in Székesfehérvár European Academy of land Use and Development. In: EALD nemzetközi konferencia "*Focus on Urban and Peri-Urban Development*" - Liverpool, September 2-3, 2011. 26 p.

[11] Szigeti, C., Borzán, A. *Ökológiai lábnyom mutató számítása*. Gazdasági élet és társadalom. 2010, p.8.

Judit Mizsei-Nyiri is Head of Department and Associate Professor at the Department of Land management at University of West Hungary. She has a Doctoral Degree and is qualified land surveyor engineer. Her research topics include land management, real estate valuation, land qualification and valuation. E-mail: nyiri@geo.info.hu

Peter Udvardy is an Associate Professor at University of West Hungary, Department of Land management. He is qualified agricultural engineer. His research field is land tenure and rural development and EU land policy. E-mail: up@geo.info.hu

Margit Horosz-Gulyas is doctoral student at University of West Hungary, Department of Land management. She has received Master degree in engineering, she is also qualified geographer. Her research interests focus on water management, land use and environmental protection, GIS. E-mail: hm@geo.info.hu

Katalin Gombas is a lecturer at University of West Hungary, Department of Land management. She is qualified Forestry engineer and environmental engineer. Her research fields include environmental sciences, land use and nature protection. E-mail: gombas@geo.info.hu

Janos Katona is PhD candidate at University of West Hungary, Department of Land management and qualified land management engineer. E-mail: kj@geo.info.hu