

**ANALYSIS OF LAND USE DEVELOPMENT
IN RELATIONSHIP TO NATURAL CONDITIONS
(CASE STUDY OF BRATISLAVA)**

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Introduction

Knowing the natural landscape as a basic prerequisite for the land-use and social promotion, means knowing the key properties or mechanisms of landscape functioning, as it was before mans' interference. It is a reconstruction of the landscape not only in the sense of knowing the essence of the landscape, but also that of the preventive and therapeutical solutions used in landscape planning and management. Consequently, knowledge of the natural landscape types are the preliminaries to the analysis of the natural potential as an offer on one side, and the limits of land use in synergic, choric, as well as dynamic aspects on the other (see Oťahel', J., Poláčik, Š. 1987, Seger, M. 1988, Richling, A. 1990, Drdoš, J. 1991, Jordan, P. 1991, Lehotský, M. 1991, Drgoňa, V., Oťahel', J., Ira, V. 1992).

For the analysis of the overall development of land-use pattern, and the development of the relation between the natural landscape types and land-use forms on a selected section in part of Bratislava, we use the military topographical maps of the years 1782-1783 and 1839, 1873 on the scale 1:28 880 (Military Archive in Vienna), and the maps and remote sensing data of 1954 and 1991 on the scale 1:25 000, as well as a map of natural landscape types on the scale 1:25 000. Methodologically we depart from the works of F. Žigrai, 1973a, 1973b.

Direct comparison of natural landscape types and land-use in the concept of one map of landscape use, represents one of the direct measurements of the relation society/landscape or one of the possible methods of spatial environmental impact assessment. It directly points to the possibilities of exploiting the potential, or assessing the reserves, and also the limits, environmental conflicts and risks. Identification of the landscape/ecological phenomena in the context of differentiated degrees of nature protection or limits of mainly spatial development (soil value, phenomena of fauna and flora, biocentres and biocorridors, water resources and

Bemerkung der Herausgeber:

F. Žigrai und J. Oťahel' analysieren anhand der alten topographischen Karten die mehr als zweihundertjährige Flächennutzungsentwicklung im Bezug auf die naturräumlichen Verhältnisse am Beispiel des östlichen Teiles der Stadt Bratislava. Die Ergebnisse der Grundlagenforschung mit noch immer gültigem Trend der Flächennutzungsentwicklung finden außer anderem auch eine wirkungsvolle Anwendung in der Landschafts- und Umweltplanung.

their buffer zones, etc.) serve as a source for the solution of alternatives and estimation of risks in the decision-making process. They are used as one of the fundamental sources for environmental planning.

Natural Landscape

The Danubian Lowland SE of Bratislava, is filled by a massive alluvial cone of the Danube with a set of strata of heavily watered gravels over 100 m thick. The region is one of the richest reserves of ground water in Central Europe. The Danube together with tectonic movement was one of the principal morphological factors in this part of the lowland, and via accumulation of prevailing carbonate gravels to clays, it differentiated the natural landscape. Young aggradation plains are typical for the alternation of the typical Calcaric Fluvisols to Fluvi-eutric Gleysols, mostly covered by willow-poplar, or oak-elm-ash floodplain forests. Old aggradation cores are also characterized by the chernozems and xero-thermophilous oak groves. To more elevated terraces and alluvial cones with Cambisols originally oak-hornbeam forests were linked. Undulating plain is completed by foothill swampy depressions with organic sediments and peat bog forests and peat bogs. Another modelling and landscape-forming agent, that manifested itself markedly especially in the northern part, were the climatic variations and the related eolitic processes. The Neogene blocks in the hilly part were covered by loesses with oak-hornbeam forests. Ground water reserves are substantially lower in the hillyland than in the region of gravel fluvial plain. The Danubian Lowland has a warm to moderately warm and dry climate with slight temperature inversion, frequent occurrence of sultry atmosphere with mean July temperatures 18.5 - 20.5 °C. Moderate winter with mean January temperatures of -1 to -4°C.

Development of land use

On individual topographical maps representing the simplified maps of land-use of the area extension of 41,7 km with its main land-use forms that were put on a uniform scale 1:25 000, we have first of all planimetrically measured their spatial values and these were chronologically arranged. The most important development trends of land-use pattern are the following:

- Considerable shrinkage of the originally most extended grassland and pasture areas (66,2% of total area of analyzed territory), that were especially in the years 1782-1873 changed to arable land and in the period 1873-1991 all these areas were built up. Grassland and pasture have practically disappeared.
- Arable land doubled its area from 24% to 49,6% of the total area of the study territory in the interval 1783-1873. In the period 1873-1954 the development of arable land stabilized in the courses of further urbanization and

expansion of the city of Bratislava to the NE and E, the area of arable land diminished to the present state representing 20,4% of the area of the study territory.

- The highest gain of the area within the land-use pattern has been registered by the built-up area, which in the years 1782 and 1873 occupied only the negligible 2,6% out of the total area of the studied territory. The crucial period in the spatial development of the built-up areas was the one of 1873-1954, but specifically the interval of 1954-1991 in the process of revolutionary urbanization and industrialization of Slovakia, connected with the growth of the built up area of Bratislava which at the present moment occupies 72,2% out of the total area of the studied territory.
- Variations can be seen over the observed period of two hundred years, in other land-use forms, such as vineyards, orchards, forests and water areas, which were less important from the point of view of area.

Development of the land-use pattern within the framework of the natural landscape types

The above-mentioned data on the overall land-use pattern relate to the part of the study area while not taking into consideration its inner physical geographical construction. Types of natural landscape with different physical (geographical traits are characterized by certain forms of land-use and simultaneously affect the sort and intensity of the changes. This subtler special differentiation makes possible an understanding of the development of the relationship between the natural endowments of the landscape, and its use in certain periods and in individual parts of the studied territory.

The numerical data obtained by planimetry of the spatial portion of the individual land-use forms - in our case arable land within the corresponding natural landscape-types, particularly fluvial plains (floodplains) (Type 2), old aggradation plain (Type 3), fluvio-eolian terraces and proluvial cones (fluvial terraces) (Type 4), swampy depressions (backswamps) (Type 7) and upland of the Little Carpathians (Type 15) are chronologically ordered in tables. These tables can be analyzed in two ways. On the horizontal level we assess the development of the changes of spatial proportion of the individual forms of land-use in the framework of the corresponding natural landscape types. On the vertical level we analyze the development of the spatial changes of the landscape types within the framework of the individual land-use.

On the basis of the land-use maps 1782, 1873 and 1991, as well as the above-mentioned tables we composed the graphs that represent the development of the spatial land-use pattern in the framework of the individual landscape types for four time horizons. These tables, graphs and maps suggest the following principal de-

velopment trends of the spatial pattern of land-use in the individual landscape-types of the studied territory:

- Land-use forms (i.e. their number) for the observed more than two hundred years' period in spite of its large inner mutual interchange as far as size is concerned, have not substantially changed. Out of the original 6 land-use forms, i.e. arable land, grassland and pastures, vineyards and orchards, forests, built-up areas and water areas, the last remnants of the grasslands and pastures were built up before 1991.
- The most intensive changes in the land-use pattern can be observed in the built-up areas, arable land, as well as grasslands and pastures, fluvial plains, old aggradation plains and fluvial terraces and proluvial cones (natural landscapes types No 2, 3, 4). The greatest mutual spatial changes occurred between the grassland and pastures on one hand and the built-up areas on the other on the Danubian fluvial plains, where its spatial ration of 116:1 in 1782 gradually changed to 24:1 in 1873 and 1:1,8 in 1954 to the favour of the built-up areas. At the present only negligible remnants of the former grasslands and pastures remain in the landscape types. Similar trend can also be observed in the old aggradation plains (natural landscape type No 3) and to a considerable extent on the fluvial terraces and proluvial cones (natural landscapes types No 3 and 4). Development and the spatial ratio between land and built-up areas shows a similar trend.
- The greatest changes in spatial ratio between the grasslands and pastures on one side and arable land on the other from 4:1 in 1782 to 1:4 in 1954 occurred in old aggradation plains (natural landscape type No 3).

Development of spatial changes of the natural landscape types within the framework of land-use forms

The development of spatial changes of natural landscape types in the framework of land-use forms from 1782 to 1991 can also be graphically represented by diagrams. These graphs were composed by the evaluation of the particular tables on the vertical level. The individual natural landscape types are arranged in the corresponding diagrams according to their size, in columns and aligned to the corresponding land-use forms. The aim of this analysis is to find out to what extent the landscape-ecological patterns, and the composition of the individual land-use forms changed in the observed time interval. The above-mentioned graphs and the corresponding maps suggest the following principal trends:

- a relatively stable situation in the development of the changes of natural landscape types from 1782 to 1991 in arable land, represented mainly by the fluvial plains and aggradation plains,

- a similar trend was also shown by the spectra of the natural landscape types within grassland and pastures, though limited to the period of 1782 to 1954,
- expansion of the changes of natural landscape types in old aggradation plains (natural landscape type No 3) in vineyards and orchards in the period between 1954 and 1993. This expansion of vineyards over the atypical ecological stands was caused by the higher economic profit obtainable from vineyards than from arable land.

Diagnosis for environmental planning in part of Bratislava

Besides its purely academic interest on the level of landscape-ecological and geographical basic research, the result of analysis of land-use development in relation to the natural conditions of the studied territory, has practical significance on the level of applied research. In our case, it is suitable for the needs of landscape and environmental planning. The analyzed topographical maps of 1782 and 1873 contain besides other, landscape-ecological information like for instance, land-use i.e. the spatial distribution and arrangement of the individual forms of land-use in a period when man did not possess technical means required to change substantially the natural landscape types and to adapt them to his needs. Instead man was more or less obliged to adapt himself to the natural conditions. This means that he managed landscape in a differentiated way, basically according to the landscape-ecological principles. He either avoided the extreme positions with extreme ecological properties or he entirely adapted the form and way of their use. The spatial distribution of the individual land-use forms at that time, was therefore in a harmony with the landscape-ecological positions. We have, then, a very valuable testimony which might serve as one of the various interpretative and decision-making criteria for the compilation of the landscape and environmental plans.

Conclusion

The result of analysis of land-use development in relation to the natural conditions of the studied territory can be used mainly in the constitution of the coefficient of the link between the natural landscape types and land-use forms, as well as in the establishment of the degree of synanthropization, or the originality of the landscape (hemerobia). These criteria are important for the assessment and establishment of the landscape potential, necessary for the compilation of the landscape plan with the proposal for ecologically optimal land-use. Moreover they represent the individual forms of land-use with their time/spatial changes of the carriers of the potential threat to the environmental quality. Considering the above-mentioned reflections it is possible to use and interpret the result of the analysis for the needs of the landscape and environmental planning:

- a marked change of the grassland and pasture into arable land and built-up areas on the natural landscape type,
- fluvial plain of the Danube, originally grassland and pasture eco-systems gradually changed in arable land, eventually they were later built up by the expanding city of Bratislava. This process meant not only a considerable unification of the use of landscape and natural conditions in general, but also a heavy environmental intervention into the water and ground water quality. Arable land and built-up areas represented by the industrial and settlement buildings belong to an anthropogenic ecosystem, maintenance of which requires a considerable material and power input, like for instance: fertilizers, pesticides, coal, oil, etc. but also an output in the form of urban and economical wastes. It is therefore necessary to avoid further coverage of this landscape type,
- further territorial development of Bratislava will have to be controlled and oriented to unbuilt-up areas on the natural landscape types No 3 and 4 (old aggradation plains), or fluvial terraces and proluvial cones.

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