ASSESSMENT OF ENVIRONMENTAL ASPECTS OF THE HYDROLOGICAL CYCLE CASE STUDY HORNÝ ŽITNÝ OSTROV, SLOVAKIA

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Introduction

Water, its use and natural movement over the landscape is an object of intensive interdisciplinary research. This is a result of growing pressure on its use, unfortunately not always in agreement with rational economy. The property of water as a "renewable" resource is often questionable considering its depreciation when used for the technological and water-management purposes.

The ongoing transformation of the economy in Slovakia concerns also water management as a activity that must practically daily balance up the demands of the society with the existing natural resources and natural laws. For such activity it is undoubtedly necessary to know and observe the objective properties of the natural landscape, i.e. the environment, determining the creation of water resources. This knowledge supplemented with the knowledge of human activity realistically and potentially influencing the qualitative and quantitative hydrological regime represents the basis for the rational use of the water stocks of the landscape.

With the aim of rationalizing the functioning of the water-economic activities in the landscape, Hydroecological Plans (HEP) of the river basins, i.e. cartographic and text material facilitating an operative assessment of the effect of human activities on the hydro-ecological properties of a river basin are currently being worked out in Slovakia.

Diagnoses of the hydro-ecological properties of the landscape are based on knowledge of the evolution of the original landscape and its reconstruction as it was before human impact. They concentrated especially upon the links and laws related to the self-regulative mechanism of the hydrological cycle. The process of learning about and knowing the natural landscape tends to identification of the key properties of the hydrological cycle in its spatial conception.

Bemerkung der Herausgeber:
Der Beitrag von M. Lehotský und J. Hanušin befaßt sich mit der Auswertung der Umweltaspekte des hydrologischen Kreislaufes auf dem Beispiel der Region Horný Žitný ostrov (Obere Schütt). Die Autoren stützen sich auf methodologische Ausgangspunkte der integrierten Forschung der Funktionseigenschaften der Landschaft, im gegebenen Raum bewerten sie die ökologischen und anthropologischen Grenzen und schlagen Maßnahmen zum Schutz der Gewässer vor. Das Ergebnis ihrer Arbeit ist ein wertvolles Material für den Vergleich mit dem gegenwärtigen Zustand, der vom bereits mehrjährigen Betrieb des Wasserkraftwerks Gabčikovo beeinflußt ist.

Our approach to hydro-ecological planning is methodologically based in integrated research on the functional properties of the landscape, while water is interpreted as an integrating element of the remaining components of landscape with its specific dynamism and regime variable in time and space. Its skeleton is constituted by assessment of the ecological (sensitivity as an immanent landscape property) and anthropological (rate of intensity of human impact on the hydrological cycle) limits and through their comparison determination of the landscape carrying capacity from the viewpoint of water management.

The methodology presented was tested on a case study of Horný Žitný ostrov (HZO) in the environment of the fluvial plain formed by the river Danube sediments. The study area is located east of Bratislava and delimited by a derivation channel of the Gabcíkovo system of dams in the south and by the Little Danube (Malý Dunaj) river in the north.

1 Assessment of Ecological Limits - Sensitivity of the Area

One of the aims of HEP is assessment of the degree of hydrospheric carrying capacity of the study area. The degree (limit) of the carrying capacity means here the ability of the landscape to absorb human activities without any subsequent irreversible changes in the functioning of the landscape structure. A decisive step to the assessment of the carrying capacity of any landscape type is the determination of landscape sensitivity as its immanent property, determining the type of hydrological cycle. Landscape types delimited on the basis of different sensitivity are then confronted with real anthropogenic (socio-economic) activities (real loading of the landscape), and eventually it is tried to assess the maximum possible limits of loading (potential loading, potentiality). It is not necessary to stress that these activities require an extensive series of precise input data, a task difficult to carry out. The chief instrument then is represented by various qualified estimates, relativized scales, etc.

The region of HZO is a landscape type in which the dominant role is played by water. Its activity conditions the functioning of the whole landscape system, and water is a central part of the HZO landscape. This fact has been fundamental for our methodological procedure, as it is obvious that an eventual disturbance of the qualitative and quantitative hydrologic regime can lead here to the disturbance, even destruction of the entire landscape system. The river Danube with its network of arms is a decisive factor influencing the character of the local landscape. The phenomenon of the Danube controls the hydrologic regime of the area most of all by the percolation of the waters from the main stream and partially from the Little Danube. The system of arms was gradually adjusted to such an extent that today, with small exceptions, we can talk about the system of surface streams as an artificial one, mostly controlled by man. This situation has been enhanced recently by

the construction and opening of the Gabcíkovo System of dams that, although located out of the area of interest, will undoubtedly affect the regime of the ground waters of a part of the area. On the other side, intensive agricultural production utilizing the favourable agro-ecological conditions is directly opposed to ground water protection. This potential, practically jeopardizing the entire hydrosphere (or its most valuable part - ground waters) was the leading idea of the methodology used for the assessment of the area sensitivity. We assume that the more the ground waters is jeopardized, the more sensitive the landscape system of the HZO is.

For the assessment of the sensitivity rate of the area we chose four parameters determining the so-called rate of contact between the ground water and the surface processes (activities). In order of importance they are as follows: morphotype, mean long-term ground water level under the terrain, clay particles contents in the soil, and finally filtration co-efficient. Each parameter was evaluated on a three-degree point scale expressing the rate of contact. An exception is the parameter of filtration co-efficient that was evaluated because of insufficient information on a two-degree scale.

The sum of the points expresses the resulting rate of contact on the basis of the above-mentioned assumption of the relation between the contactness and sensitivity. The areas with very low contactness are considered to be very little sensitive, the areas with low contact little sensitive, etc. We also assume a decrease of carrying capacity with increasing sensitivity, and a simultaneous growth of ecological limits of the areas as related to the hydrosphere.

As the basic division of the area from the point of view of sensitivity, the individual areas are delimited by the boundaries of lower hierarchic level on the basis of the character of sensitivity. We basically distinguished between parameters increasing sensitivity and parameters lowering sensitivity of an area. The parameters increasing area sensitivity include positions on depression morphotypes, shallow ground water level, light soils with potentially efficient infiltration and finally the elevated values of the co-efficient of water saturated layer filtration. Among the parameters lowering area sensitivity we classified a position on aggradation morphotypes, deep ground water level and presence of heavy soils with potentially poor infiltration.

From the point of view of control of anthropogenic activities, areas with high and very high sensitivity are decisive. Areas with high sensitivity occupy prevailingly parts of the fluvial swamp depressions with heavier soils, eventually young aggradation ridges along the Little Danube river. Areas with very high sensitivity can be found on fluvial swamp depressions with ground water level less than 1.5 m u.t. with prevailingly light soils and a higher co-efficient of filtration. The most extensive area of this type is located between the upper part of the Klátovské rameno branch and the Little Danube river.

We simultaneously delimited the boundaries of legislatively protected areas that in their own way also limit socio-economic activities, decrease the loading of the area, or artificially increase its sensitivity.

2 Assessment of Anthropogenic Limits - Loading of the Landscape

Assessment of the anthropogenic limits was methodologically based on determination and spatial representation of anthropogenic activity followed by determination of the degree of environmental load. The first step was determination of the main point, line and area of anthropogenic effects upon hydrological cycle and water economy. We determined 7 groups of activities related to the following activities:

a) agriculture: 1) farms, 2) fertilization, 3) irrigation
b) communal activity: 4) communes with communal liquid wastes,
c) dumping: 5) dumps,
d) discharge of polluted waters, 6) localities of discharge and pollution of surface waters,
e) collection of ground waters: 7) collecting wells

For all groups an ordinal scale, i.e. rate of their effect according to the individual degrees, was determined. The ordinal scale for farms (5 degrees) and communes (4 degrees) was determined according to the number of cattle, pigs and other farm animals, or the number of population and character of sewage on population equivalent. The capacities of cesspools, ensilages and dung-heaps were assessed by a particular point evaluation. Dumps were evaluated according to their depth (we took into consideration only those that are in contact with the ground water level) and the amount of material (4 degrees). Irrigation was classified according to the amount and quality of irrigation water (quantitative differences are relatively small - the average is around $2 l.ha^{-1}.s^{-1}$) and we classified them into 3 qualitative degrees. A similar 3-degree scale was used for the determination of the effects of discharged waters and ground water collections.

The methodology used was cartographically projected on maps with a scale of 1:50,000.

3 Proposal and Character of Measures Improving the Protection of Water in HZO

The proposed measures are based on comparison of the characters of natural landscape (sensitivity) and its loading by anthropogenic activities. Solution of the following problems in the study areas is considered crucial:

- to re-evaluate the conception of large-scale animal production on the whole area from the viewpoint of production of large amounts of manure and its rational use;

- to re-evaluate the strategy of agricultural production in the most loaded area i.e. Gabčíkovo-Sap in the southeastern part of the area (reduction of the fertilization doses and improvement of the irrigation water quality);
- removal of the existing field dung-heaps and prevention of the foundation of new ones;
- a detailed research and subsequent sanation of the farms located within the sensitive landscape types;
- to stress the improvement of irrigation water quality, especially the water of the Little Danube river, eventually use other sources as well (ground water),
- to monitor the present situation of dumps in relation to water sources, to adopt sanation measures if necessary,
- to work out a conception of dump-management with the use of separated collection and omitting the storage of harmful water or unfriendly wastes on the area of HZO,
- to finish the construction of sewage and sewage treatment plants in all communes of the area of interest with preferential construction in sensitive areas,
- to devote attention to the qualitative and quantitative monitoring of ground water in relation to the operation of the Gabcíkovo system of dams and to operative interventions in the event of undesirable changes,
- to devote attention to the flooded gravel pits as potential focuses for ground water pollution,
- gradual solution of the colmatation of the bed of the Little Danube river,
- to revive the system of channels and chosen rests of the river net while preserving the water-economic function.

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