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APPLYING GEOGRAPHICAL INFORMATION SYSTEMS IN WETLAND MANAGEMENT IN THE BALATON-HIGHLANDS NATIONAL PARK

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The Pécsely-basin is situated in the Balaton-Highlands National Park, which was founded in 1997. The basin is rich in wetlands increasing landscape diversity and the aesthetic value of this area. This paper gives a review on how different information sources, especially remote sensing can be used for inventorying wetlands. By using GIS, our basic intention was to establish a digitised inventory and database, which can serve in the future as a basis of any nature conservation work. In addition, we have investigated what information different layers might provide in wetland management and how it can be interpreted.

Keywords: wetland inventory; wetland management; Geographical Information Systems

Introduction

Wetlands have been considered as wastelands or even nuisance. Only recently did we discover their values. Wetlands are amongst the most productive environments in the world, and due to the specific components (such as soil, water, plant and animal species) they are capable of performing certain functions, therefore playing an essential role for the health, welfare and safety of people living nearby.

As wetlands are non-renewable natural resources, first of all it is essential to be aware what we have and to make an inventory of existing wetlands. Such an inventory can basically answer such simple questions as "for the selected region, how many and what types of wetlands are there?" (Naturally, for answering the second part of the question, the inventory must have some previously defined classification as its basis but wetland classification in general and existing wetland types in Hungary are out of scope of this paper. For wetland classification see COWARDIN et al. [1] and DAVIS [2])

An inventory can be made for a geographical or for an administrative region: for a watershed, for a county, for a province or for an entire country. Whatever the selected area size is, the nature of the inventory means that on the selected area all wetlands have to be included and surveyed. The use of remote sensing platforms has proved to be an effective way of gathering data for wetland surveys. However, the choice of which platform to use depends on the resolution required, the area to be covered and the costs implied [3]. The available data sources can be:

- remote sensing platforms
- topographic maps
- land use maps
- field survey.

The first aim of our study was to review how these data sources can be applied for a selected area of the Balaton-Highlands National Park (Hungary), in order to make a comparison amongst them considering information provided.

Nevertheless, the scope of such wetland inventory can be expanded and other, useful information on the wetland can be included, considering their status and the degree of degradation. Functional loss of wetlands can be caused basically by two factors: **loss of area** (in other words, the wetland or part of it is transformed into a different land cover or land use not capable of performing the same functions) or **degradation**, which is the loss of function resulting from a **stressor** [4]. These stressors can be natural, but many of them are of anthropogenic origin. Five important categories of stressors can be distinguished: (1) hydrologic modification, (2) physical alteration, (3) sedimentation, (4) nutrient loading and (5) toxic contaminants [5].

The degree of functional loss is sometimes very difficult to determine. First of all, how to find out what

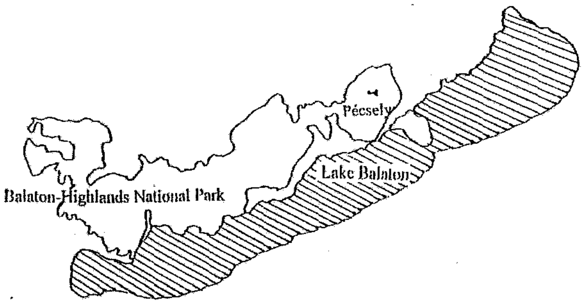

Fig.1 Situation of the Pécsely-basin

area changes a wetland might have undergone in the past? Secondly, how to identify potential or actual stressors? Therefore the second aim of the study was to investigate to what extent different existing data sources can be used to answer these questions before a time- and money-consuming field monitoring should start.

Geographical Information Systems have become widely used in wetland management [6,7]. There comes the third aim of our study: to create a database of these wetlands in a digitised form which can serve as the basis for any future wetland conservation or restoration work.

Material and Methods

Study Area

For study area, we choose a small basin within the National Park, called Pécsely-basin (*Fig.1*). Although the area of the basin is relatively small, the vegetation is very heterogeneous. Typical natural associations are xerotherm oak forests and steppe vegetation. Main wetlands of the basin are shown in *Fig.2*.

Due to their small extension, these wetlands might not have important hydrological or water purification functions. However, they support such wetland-dependent species which are unique in this relatively dry region and among which rare and protected species are found (*Epipactis palustris*, *Dactylorrhiza incarnata*, *Orchis laxiflora*, etc.).

Moreover, these wetlands contribute to the diversity of the whole landscape. According to historical data [8], the basin has been populated for thousand years; today, though several villages are situated here with more or less stable population, the region is mostly favoured for recreation. The question of conserving landscape diversity has become topical since August 9, 1997 when the Pécsely-basin was declared as landscape reserve, and especially since 15th September the same year, when the Balaton-Highlands National Park was established.

Methods

Two remote sensing platforms, namely a LANDSAT-5 imagery and 1700-m altitude aircraft photos were used.

Of topographic maps available, the 1:10000 scale maps proved to be the most useful for creating a digitised database and for field surveys. However, not only recent topographic maps were used but older ones as well. The Archives of Veszprém County is in the possession of very accurate cadastrial maps from the period of the Austrian-Hungarian Empire, from 1857. These maps delineate wetlands, showing their past extension and surrounding land-use as well. These maps could be transformed into digitised form as well.

Processing of maps can be considered as a secondary data source. Using geographical Information Systems (ARCINFO and ARCVIEW), such digitised database was established which contains the following layers:

- road map
- wetlands and water courses
- topography
- land use
- and past extension of wetland (from the 19th century) (*Fig.2*).

Results and Discussion

Wetlands of the basin can be classified as marshes, sedge marshes and seasonally flooded meadows. It turned out that such types of wetlands cannot be detected in satellite imagery. On the one hand, these wetlands are rather small, on the other hand, their vegetation coverage is rather high, and therefore they cannot be distinguished from their environment. This coincides with what American scientists working on the National Wetlands Inventory reported [9]. They found that several small wetlands, namely prairie potholes were not identified by LANDSAT.

On the contrary, colour aircraft photos can be very well used as a data source. Although colour-infrared photography might provide the best data source for delineation of wetlands [10-12], such infrared photos were not available for our study area. As our main goal was to investigate the applicability of existing data sources, these 1700-m altitude aircraft photos provided the best fit for our purposes. The scale, as well as the colours, which reflect different land cover types, can provide a good basis for distinguishing the diverse elements of the landscape, including wetlands. Practically all wetland types can be detected. However, their identification can be accomplished only combining aircraft photos with field surveys. These photos can be well used for identifying small (app. 1 ha) wetlands.

Although the 1:10000 scale topographic maps proved to be the most useful of maps available for delineating wetlands, their accuracy is far from being perfect. One wetland type, seasonally flooded meadows normally cannot be distinguished on these maps. For determining the extension of a given wetland and for wetland classification, excessive field survey had to be conducted. It also means that topographic maps cannot be transferred into digitised form without additional field surveys when making a wetland inventory.

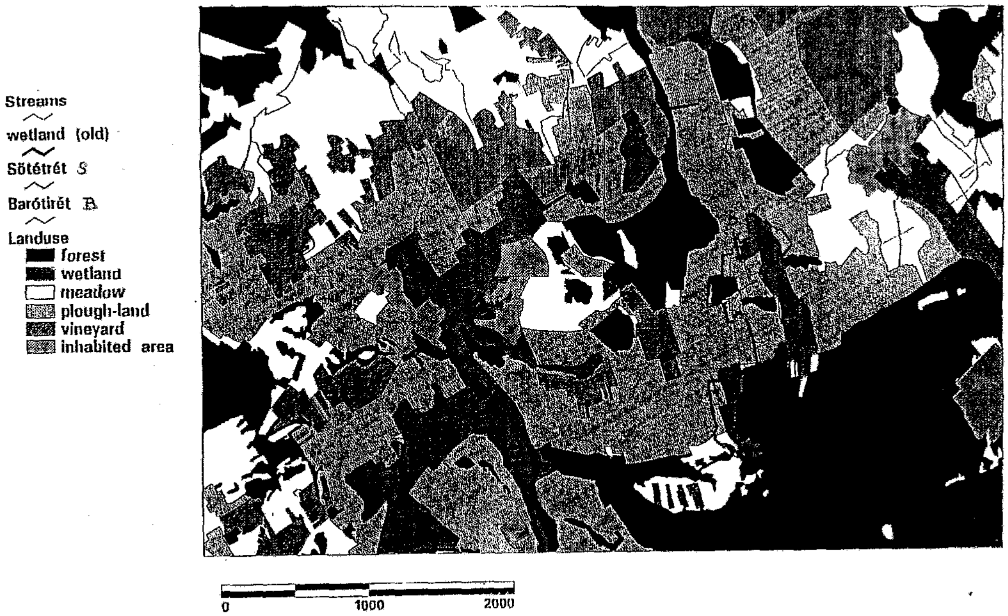

Fig.2 Land-use map of the basin. It is a combination of two layers, namely land-use and past extension of wetlands. In this way area loss can be determined

Of different layers of the digitised map, 19th century extension of the wetlands can give useful information, especially in comparison with recent wetland areas (*Fig.2*). Such comparison was made for three wetlands: Bozóti-rét, Nagytói-rét, Sötét-rét. It can be seen that the area of these wetlands has changed to different extent. A severe area loss has happened in the case of the Bozóti-rét, but the Nagytói-rét has not undergone almost any area loss. Although no general trend can be drawn concerning area loss of wetlands in the Pécsely-basin, some wetlands have been greatly influenced by this stressor.

Analysing the water current layer, it can be seen that most of these wetlands are without inlet and outlet. Their only water source is the rainfall, the quantity of which has shown great variation in the past few years. Data available cannot make it possible to draw long-term trends but in principle, lack of rainfall in successive years might also pose a big risk to the proper functioning of these wetlands.

From the land-use map it becomes obvious that agricultural land which surrounds most of the wetlands can provide excessive nutrient input for them. Also, from these lands toxic pollutants such as pesticides might be transferred to the wetland. However, we have to emphasise that these are potential stressors. Field surveys are needed in order to determine what actual risk these stressors might pose.

Conclusions

The very first step of wetland conservation is inventorying them. Our basic aim was to review how already existing information sources can be used for this purpose before an expensive and lengthy field survey would start. For our model area, the Pécsely Basin, of the investigated data sources (satellite imagery, aircraft photos, and topographic maps), LANDSAT imageries proved to be completely useless for detecting wetlands.

For detection, identification and inventory of such wetlands, 1700-m altitude aircraft photos and 1: 10000 scale topographic maps proved to be the most useful. Topographic maps provide the best basis for making a digitised inventory, but they might be not as accurate as they should be. Some wetland types (sedge marshes, seasonally flooded meadows) might not appear on these maps or their size might not be delineated properly.

On the contrary, diverse patches of the environment, including different wetlands are distinguished on the investigated aircraft photos but exact identification of these patches, especially of non-woody vegetation can be made only in the field.

We have come to the conclusion that however tempting remote sensing platforms might seem, neither of these information sources might be used alone. Even for answering such simple question as how big a wetland is, both aircraft photos and topographic maps have to be supplemented with field surveys. Relying upon only existing data sources might imply that serious errors would be made and important information would be lost.

However, these information sources might be used to some extent in identification of potential stressors posing risk to a given wetland. Such stressors might come from agricultural land use (such as toxic contaminants or excessive nutrient input) or from hydrological characteristics of the catchment area. Having this preliminary information, our field survey can be much more targeted: it has to be checked whether these potential stressors pose actual risk (risk qualification) and if so, to what extent (risk quantification).

We have to emphasise that such digitised inventory might be very helpful in any further conservation or restoration work. Perhaps the biggest benefit that it can be easily stored, modified and amplified. Wetlands are very vulnerable systems, and once such a database is established, even short-term changes might be followed and documented.

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