VEGETATION FORMATIONS MAP COMPILED BY APPLICATION OF THE COLOUR INFRARED AERIAL PHOTOGRAPHS AND GIS "SPANS" AS A TOOL FOR FLOOD PLAIN VEGETATION ANALYSIS

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RESUMÉ

Cette communication illustre une compilation des cartes des formations végétales faite à l'aide de photographies aériennes infra-rouge couleur et du SIG «SPANS». Le cas illustré est celui du cours inférieur de la rivière Morava (qui forme la frontière entre la Slovaquie et l'Autriche). Il examine également une utilisation conjointe des cartes étudiées et du SIG «SPANS» à une analyse des relations entre végétation et terrain sur la zone considérée.

INTRODUCTION

Using remote sensing data occupies an important place in present cartography. Photographs and images have become an important source of information for the creation of different kinds of thematic maps including maps of real vegetation. The conventional map creation is based on field mapping which consists especially of the vegetation formations boundaries marked in the topographical map at a competent scale. This approach requires a considerable amount of time and field work especially in rather inaccessible, intensively flooded areas. Yet it is characterised by inaccuracies in the process of drawing the vegetation formations into the topographical map.

This contribution is linked to the results published by Otahel and Feranec (1993) and Feranec et al. (1993). The aim of the work is to document the compilation of the vegetation formations map by colour infrared aerial photographs and the GIS SPANS, as well as to document the application of this map and the GIS SPANS in the analysis of the relations between vegetation and terrain of the studied territory.

STUDY AREA

The study area is to the SE from Vysoká pri Morave (river kilometres 12 to 15). Its size is about 2.4 sq. km. In earlier times the area was covered mostly by the elm flood plain woods (Ulmion), to a lesser extent by willow - poplar flood plain woods and calcareous fens. Today there prevail various formations of wetland vegetation together with formations of tall reeds and small reed which dominate in the depressions. The area has been evaluated in 1993 as an internationally important wetland according to the Ramsar Convention.
DATA AND METHODS

Aerial photographs - interpretation

The photographs were taken from a helicopter (June 12, 1991) on Kodak 24-43 Ektachrome Infrared film in a 1:200,000 scale and set into a mosaic (scale 1:100,000) corresponding with the topographic map at the same scale. Identification of the habitat type patterns was carried out by analogue interpretation based on the analysis of texture and colour of objects, manifested in the photographs. The map of land cover - habitat types at the scale 1:100 000 was compiled by analogue interpretation (Olah and Ferenczi 1993).

The delimitation of land cover - habitat types was based on works by Baker et al. (1979), Iles (1978), Murdoch and Turčová (1980), Sagar (1985) and the CORINE (Coordination of Information on the Environment of the Commission of the European Communities), above all the methodology of the BIOTOPES and Land Cover Projects [3, 4].

Application of geographical information system SPANS

For data integration, geodetic, analysis, and thematic map creation we have used the geographical information system SPANS, version 5.2 running under OS/2 operating system on PC 486. SPANS GIS is based on the quincunx data model and it is oriented mostly to spatial analyses and modelling. Advantages of this data model are economic data storage, effective spatial orientation and searching, the possibility of change between hierarchical levels and suitability for several types of analytical operations. According to our experience the most helpful program modules are those for spatial analyses and modelling.

Map creation

Before vegetation map compilation, the land cover (habitat types) interpretation scheme was created (fig. 2). This scheme is a result of basic operations (Ferenczi 1984, Ferenczi and Othriel 1988, Othriel and Ferenczi 1992):
- delimitation and classification of the land cover - habitat types,
- their delimitation in the colour infrared aerial photographs as a result of interpretation and the comparison with the results of field botanical investigations,
- transformation of the habitat types into the topographical map (digitizing and cartographic processing).

Digitizing the habitat types was done using the autonomous program module TYDIG. Digitized data were imported to GIS SPANS. Similarly, the terrain (elevation) data were digitized from a topographic scale 1:100 000 (fig. 1). Polygons delineated by elevation contours were labeled with attributes characterizing interval values of elevation. Using ground control points both data files were geometrically transformed to Gauss-Krüger map projection and integrated within the SPANS GIS environment (fig. 1 et fig. 2).

The two information layers (habitat types and elevation) were used as a base for the vegetation formations map (fig. 3). Spatial knowledge was derived from detailed field research of terrain, soils and vegetation. Mapping units were created according to their floristic content and structure of vegetation. Plant names are used according to Novák and Křupka, Kolář et al. (1992), phytosociological terms according to Lunický and Máglová (1985). The biotope classification followed the methodological approach of CORINE Biotopes. Visualized data sets were complemented with cartographic attributes (legend, scale, title, etc.), and saved as a digital thematic maps. Cartographic outputs (hardcopies) were created on a laser printer HP LaserJet II P (fig. 3).

RESULTS

The characteristics of the mapping units:

Open waters (open-wat)

This unit is created by existing side arms and the old meanders. The relatively big meander in the southern part of the study area is connected to the main river during periods of high discharge only. When the aerial photographs were taken, the surface of the open water was free from any plant growth. Although a number of macrophyte species was present (Potamogeton nodosus, P. pectinatus, Sparganium erectum, Rorippa ficulnea, Ceratophyllum demersum), the stands had little cover by the time of the year and cannot be distinguished in this scale of the map.

Aquatic vegetation (aq-veget)

This unit covers the surface of still water. The sites are characterized by water depth ranging between 60 to 100 cm. Nuphar lutea dominates the floating-leaved vegetation. Potamogeton nodosus and Hydrocharis morsus-ranae create small covers only. Lemna minor creates a scattered pattern.

Tall reeds (t-reeds)

Rapid and formations of tall helophytes, which are often dominated by a single species create the mapping unit. They usually occupy large, homogeneous areas of Phragmites australis. Urtica dioica occurs quite regularly. Scattered islands of Schoenoplectus lacustris, which are less abundant, overgrow the bottoms of former channels and surface depressions topped with fine sediments. These sites are typically characterized by stagnant water of fluctuating depth, with higher levels in springtime, eventually also during floods in summer.

Medium-tall waterside communities (wat-comm)

The mapping unit includes a wider scale of plant communities than the previous ones. Almost monospecific stands of following dominants are frequently formed: Glyceria maxima, Carex riparia, C. gracile, C. capitata, Phalaris arundinacea. However, these stands can not be differentiated well at the given
scale. Despite the heterogeneous floristic composition, the unit is ecologically very well defined and its occurrence is relatively stable. Important abiotic factors are the water regime, especially the duration of the inundation periods.

**Eutrophic humid grasslands (eu-grass)**

This unit consists of alluvial meadows, which are flooded in springtime, and get mown twice a year. Dominant species are the grasses Alopecurus pratensis, Poa pratensis, subsp. angustifolia, Elytrigia repens. Other abundant species are Cnidium dubium, Clematis integrifolia, Galium pyrenaicum. On water sites communities with a higher proportion of Agrostis stolonifera, Ranunculus repens, Phalaris arundinacea and Rumex crispus are detected.

**Oligotrophic humid grasslands (ol-grass)**

Compact clumps of Festuca nigrescens dominate these meadows, but Poa angustifolia, Serratula tinctoria and Chondrillio arvensis are abundant also. This unit is developed on gravel terraces, which are rarely flooded.

**Abandoned fields (ab-fields)**

This unit consists of communities located on the low terrace at an elevation higher than 140 m above sea level. Elytrigia repens dominates and therophytic species Arabidopsis thaliana and Hispalis arvensis show high cover.

**Willow shrubs (w-shrubs)**

The shrub grows in small groups as solitaries. It is composed of Salix triandra, S. cinerea, and scarcely S. purpurea and S. viminalis. It is formed in surface depressions and on oxbow shores, which are flooded regularly and are influenced by sufficiently high levels of ground water.

**Solitary trees (sol-tree)**

Solitaries, as remains of the original alluvial forests, are frequent in the study area. Extraordinary large individuals of Salix fragilis grow at elevations lower than 140 m a.s.l. and Quercus robur and Ulmus laevis grow at relatively higher spots.

**Tree and shrub lines (ts-lines)**

This mapping unit includes narrow strips of a mixed composition of trees (Salix fragilis, S. x rubens, S. alba, Populus nigra, P. tremula) and shrubs (Salix purpurea, S. triandra, S. cinerea), which are the remains of original wetland forests.

**Salix woods (s-woods)**

This unit represents wetland forests with reduced species numbers. It can be classified as a Salici-Populetum association. Salix x rubens and S. fragilis are most abundant trees, and Populus nigra shows low coverage. They are either closely located to the main river or in surface depressions with strong influence of floods and high levels of ground water.

**DISCUSSION**

Apart from the map of vegetation units and the 3D view of the land cover - habitat types, a spatial analysis of the mapping units of vegetation and of terrain in the sense of elevation was done within SPANS. The dependancy of the aquatic vegetation, the tall reeds and the medium-height woodland communities on terrain depressions is very high. The relative representation of these units in the lowest elevation class is shown in Tab. 1 and Figs. 4 and 5 (Tableau 1, figure 4 et figure 5).

The vegetation unit of medium and medium-high terraces communities is precisely specified by its dependance on the sloping terrain forms and, at the same time, on the high ground water level. Because the terrain data and their altitudes above sea-level were determined from older topographic maps (1969), data obtained from aerial photographs are positionally more correct and contain more details in the sense of the vegetation recognition in terrain microdepressions. The most widespread unit by area is the Eutrophic-humid grasslands vegetation. Although it is also the most widespread in elevation above 138.5 m, which cover almost 50% of the area, it is a typical secondary community of fluvial plains. Therefore it can be found in all elevation classes of our study area at least in minimum amounts. For the compilation of vegetation map the terrain elevation map was a useful tool also especially for identification of relatively dryer oligotrophic humid grasslands, that are connected with the remains of WTmil ice age terraces in elevation above 140 m. Another indicator of the relation between vegetation and terrain is the unit of abandoned fields communities of which are covered on the remains of the low terrace (prevalently in elevation above 140 m) in the oxbow of the Morava. It is characterised by sporadic and short-time inundation.

Other vegetation units like the forests are considered at present as the remains of the original alluvial woods (willow-poplar and elm flood plain woods). Their dependance on special terrain features is rather low.

**CONCLUSION**

The investigation on vegetation formations of the Morava river floodplain confirmed that infrared colour aerial photographs and GIS SPANS are convenient tools for mapping and vegetation analysis of the areas with difficult access and high demand on spatial orientation. The GIS SPANS was valuable especially in the context of operative processing, for creation of graphic outputs and for spatial analyses that increase the applicability of the obtained results.

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References


## Spatial Distribution of Vegetation Formations Within Elevation

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<th>Elevation Class</th>
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<th>Sg-veg</th>
<th>T-woods</th>
<th>Wat-comm</th>
<th>Eu-grass</th>
<th>Ol-grass</th>
<th>Ab-field</th>
<th>W-shrubs</th>
<th>Sol-tnags</th>
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| Area (%)          | 100            | 100      | 100    | 100     | 100      | 100      | 100      | 100      | 100      | 100       | 100       | 100      | 100                   |
| Area (sq. km)     | 0.076          | 0.074    | 0.085  | 0.481   | 1.490    | 0.002    | 0.052    | 0.031    | 0.005    | 0.006     | 0.011     | 2.365    |                      |

| Average Elevation | 137.30         | 137.76   | 138.15 | 138.57  | 138.76   | 140.61   | 140.18   | 138.36   | 138.48   | 138.54    | 138.20    | 138.54   | 138.20               |
| Standard Deviation| 0.25           | 0.08     | 0.39   | 0.67    | 0.39     | 0.37     | 0.17     | 0.67     | 0.66     | 0.53      | 0.80      | 0.60     |                      |
| Average - 1 std. dev. | 137.52         | 137.68   | 137.76 | 137.90  | 138.37   | 140.24   | 140.01   | 137.69   | 137.79   | 138.02    | 138.39    | 138.02   | 138.39              |
| Average + 1 std. dev. | 138.08         | 137.94   | 138.53 | 139.24  | 138.14   | 140.99   | 142.35   | 139.03   | 139.16   | 139.07    | 140.00    | 139.07   | 140.00             |
VEGETATION FORMATIONS
(spatial distribution within elevation)

Figure 4
AREA COVERED BY VEGETATION FORMATIONS