APPLYING VEGETATION MAPS IN THE CALCULATION OF PLANT COMMUNITIES AREA IN KIS-BALATON

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Abstract

Vegetation maps of Kis-Balaton were made since 1980 knowing the changes of the marsh vegetation. For the changes of the environmental factors for the stresses the plants reacts, they often react as indicators, so we can make conclusions for the ecological condition, for the environmental stresses, and for the biodiversity of the biotopes. In this paper the results of the vegetation mapping made for the Lake Fenéki in the time-series are shown, in connection with area calculation. Despite of the big heterogeneity characteristic for our sampling area using the times-series aerial photographs the dynamic of the changes can be easy describe, and calculate. Considering spatial spreading the main plant communities, and using the crop coefficient the evaluation of the regional evaporation can be estimated more exactly.

Key-words: Kis-Balaton, aerial photography, vegetation maps, plant communities, macrovegetation changes

Összefoglalás

A Kis-Balaton területére vonatkozóan már az 1980-as évek óta készítenek vegetációtérképeket a magasabb rendű növényzet változásának megismerése céljából. A környezeti feltételekben bekövetkezett változásokra, stresszhatásokra a növények válaszreakciót adnak, gyakran indikátorként viselkednek, így segítségükkel következtetni tudunk az egyes élőhelyek ökológiai állapotára, biodiverzitására, környezeti terheltségére. Jelen publikációban a Kis-Balaton Fenéki-tó területére elkészített idősoros vegetációtérképek területszámítást érintő eredményeit mutatjuk be. A mintaterületünkre nagyfokú heterogenitás jellemző, ennek ellenére a vegetációban bekövetkezett változások idősoros felvételek alkalmazásával kitűnően leírható és számszerűsíthető azok dinamikája. A főbb növénytársulások területi elterjedésének figyelembevételével valamint a növénykonstansok felhasználásával a későbbiekben pontosabban becsülhetővé válik majd a területi párolgás.

Kulcsszavak: Kis-Balaton, légifelvételek, vegetációtérképezés, növénytársulások

Introduction

Data supplied by remote sensing and Geographic Information System (GIS) have of the utmost importance for getting information about our environment. The plant research methods based on remote sensing, supplemented with surface data collecting techniques, significantly support the exact and reliable data collection in the course of defining land cover categories. They can be used in situations, in case of protected, or hardly accessible territories, or if the land cover is rather heterogenic (Goetz et al., 2007). For these reasons in many researches in the course of investigation of vegetation pattern the use of remote sensing data happens (Dronova et al., 2012, Berke, 2010, Klenoid et al., 2005). If the aim of the research is to detect changes in the plant communities, vegetation maps based on aerial -, or satellite images give essential information (Kelly, 2011, Zlinszky 2012). The key objective of the vegetation mapping is to follow the changes in the structure of the vegetation caused by changes of environmental factors and by identifying the principles the possible impacts of further changes can be forecasted. Analysing time-scale structure of vegetation maps hydrobiological, ecological, botanical changes can be detected. space structure can be detected. With the help of this information the ecological state, biodiversity, and the environmental load can be concluded.

Connecting diverse data sets in GIS database all information regarding the vegetation changes can be handled together (Dömötörfy, 2003). Time-series monitoring of GIS databases can provide useful information for identifying and understanding problems of other phenomenonspecialites, e.g. climate change.

From 2012 at the University of Pannonia Georgikon Faculty Department of Meteorology and Water Management evaporation researches have been carried out that aim is to estimate the evaporation of Kis-Balaton area considering crop coefficients (Anda et al., 2014), and their spatial spreading. The basic pillar of these researches are spatial data sets based on the vegetation maps, that insure a comparison base for further evaluation of the results of aerial- and spatial measurements.

Materials and Methods

Research area

The Kis-Balaton together with the Lake Balaton composes a special ecological system and designated for the ”List of Wetlands of International Importance” in 1979 and 1989, respectively (Website of the Ramsar Convention on Wetlands) The need of building the Kis-Balaton Water Protection System (KBWPS) raised in 1970s, when the water quality of the Lake Balaton deteriorated. The main goal of constructing KBWPS was to moderate nutrient pollution of the Lake Balaton (mainly diffuse contamination) originated from the water reservoir of the River Zala. The KBWPS was built in two stages and consist of two lakes: KBWPS Stage I. - Lake Hidvégi and KBWPS Stage II. - Lake Fenéki (Figure 1.). In order to mitigate water quality of the Lake Balaton construction works began in 1984 with the building dams around Lake Fenéki. In 1992 the 16 km^2 area of Grove Ingói was temporarily flooded. Since that time beside the water protection goals the protecting of natural and ecological values came to the view, and this resulted the beginning of the investment of the biological monitoring of the 75 km^2 area KBWPS II. Stage in 2012 (homepage of the West-Transdanubian Water Directorate).

We choose as sampling area for our investigations the Lake Fenéki in KBWPS II. , extending 54 km^2 between Balatonhídvég and the firth of the river Zala. There are 15 water bodies distinguished in the area of Lake Fenéki. The borders of the water bodies are mainly line shape establishments from 1992 like dams, dykes, channels, and ways, paths, because it was assumed, that they can be identified in the future, too. After 2007 an extra water body (nr. 16) was connected to the system, the Zalavár inland water bay.

Figure 1. Map of the Kis-Balaton Water Protection System (Pomogyi, 1996)

Taking into account the heterogeneous plant stands and the main plant communities the following categories were identified: reed stands, other herbaceous marsh plants, trees, terrestrial grass, terrestrial forest, open water, seaweed.

Vegetation mapping

Survey of the vegetation and its classification was made with the traditional method of digital vegetation mapping. The applied method is suitable for making well detailed and precise vegetation maps of the Kis-Balaton that meets our expectation and aims. The process of vegetation mapping basically consists of tree subfields: othophotos, field measurements, and data processing based on the given information. Aerial photography and vegetation mapping were managed until 2006 in the frame of the investment program with the organisation and contribution of West-transdanubian Water

Directorate , in 2007-2008 in the frame of the preparing program finishing the KBWPS II., with the organisation of the Aquaprofit Ltd.

Orthophotos

The vegetation mapping of the Kis-Balaton begun in the early stage of the building works in 1982 before flooding the KBWPS I. Stage (Lake Hidvégi) (at that time with field methods) (Pomogyi, 1985). With these research works the regularly hydro biological-, ecological investigation of Kis-Balaton has began and since than monitoring extended to the territory of the Lake Fenéki (KBWPS II. Stage), too (Szeglet et al., 1998). Since 1985 the vegetation maps are made on the basis of colour infrared (CIR) aerial images with surface interpretation. From the year of 2000 quality change happened, the vegetation maps were made on the basis of digital orthophotos with high resolution. In 1999-2000, due to the developed technical methods, it became feasible to convert the original CIR negatives of Lake Fenéki 1988 aerial images into substantially better quality images, so called "quasi-digital orthophoto (Pomogyi és Dömötörfy, 2002). The elaboration of the aerial images changed radically in course of time, the image processing was initially in an analogue way, and from 1999 making othophotos became general.

Field measurements

The basic aim of the field interpretation is identification of the vegetation units, and other mapping units, the identification in the othophoto visually recognisable spots, the survey, and documentation of the sampling areas. The terrain photo documentation measured with GPS, and fitted in HD72 Oblique Conformal Cylindric proves the vegetation characteristic of the given time and place. This documentation method has been applied since 2003 in Kis-Balaton. Because the vegetation mapping can only be made in the vegetation period, when the plants can be recognised and identified in all developed living conditions. The field measurements and the observation of vegetation from boat began at the beginning of springtime. In territories covered by marsh plants – reed, bulrush, sedges – being under water, where boating is impossible, the field measurements could be made using SEIGA reed harvesting machines. This should be carried out in late autumn, at the end of the vegetation season, when the wheels of the machine does not cause damage in the emerging shoot, and the tread damage could be minimised.

Data processing

For data processing, vegetation map preparations and territorial data visualization ArcInfo/ArcView GIS system was used. Applying digital orthophoto CIR the spots of the plant were marked on the screen, they were measured earlier by GPS. On the territory of KBWRS II. Stage the applied digital othophotos having 0,5x0,5 m high resolution give opportunity to mark spots in 100-200 m^2 with acceptable accuracy, if there is need because of a plant stand with particular interest. In the course of data elaboration we solved the coupling between the data collected on the surface (field notes, photos, etc.) and the maps. After with the help of aerial images, field notes and photos the plant spots were identified, and was given a cönotaxonomical code. To the main taxonomical groups colour code was given, the groups in lower rank were signed by graphical signs used in maps. All this gave the signal code. After the controlling process had finished the editing of the database, making the selection, the layouts, the vegetation maps for demand, editing the printing forms, and the evaluations were prepared.

Results

In the course of our research the changes in the spatial expansion of plant communities and in the tendencies were calculated for the whole region of the Lake Fenéki, and for its two parts: the Grove Ingói, and the water reservoir Zalavár. Based on the results we stated, that before flooding the Grove Ingói (1988 and 1992), and its first stage the cover of reed stands, and herbaceous marsh plants were mostly the same. it can be seen from the data in Figure 1. the cover of the reed stands (reed and bulrush) did not changed: with minimum variation coefficient: CV= 3%. The linear trend line is slightly rising. In a similar way, the tendency of terrestrial forest (because of plantation), and open water/water weed (because of the flooding of Grove Ingói) also slightly increased. The territory of herbaceous marsh plants decreased after 1995, althoug in the last years it was a moderate declining tendency. The territorial changes of the terrestrial grasses, and other herbaceous plants is also slightly decreasing (Figure 2.).

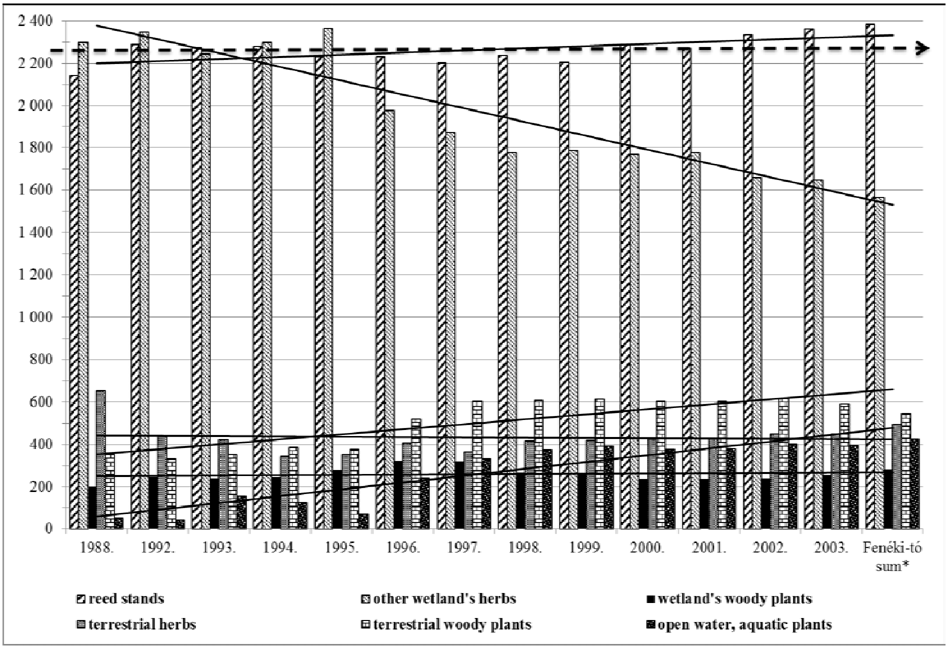

Figure 2. Changes of different plant-groups areas at the KBWPS's Lake Fenéki (ha), between 1988 and 2008, with the lines of trends

This tendency can be concluded to the forestation of the edge territories. Comparing with the main tendency of the changes of Outer-part (Figure 3.), it can be stated that the result is very similar except the open water, and water weed surfaces.

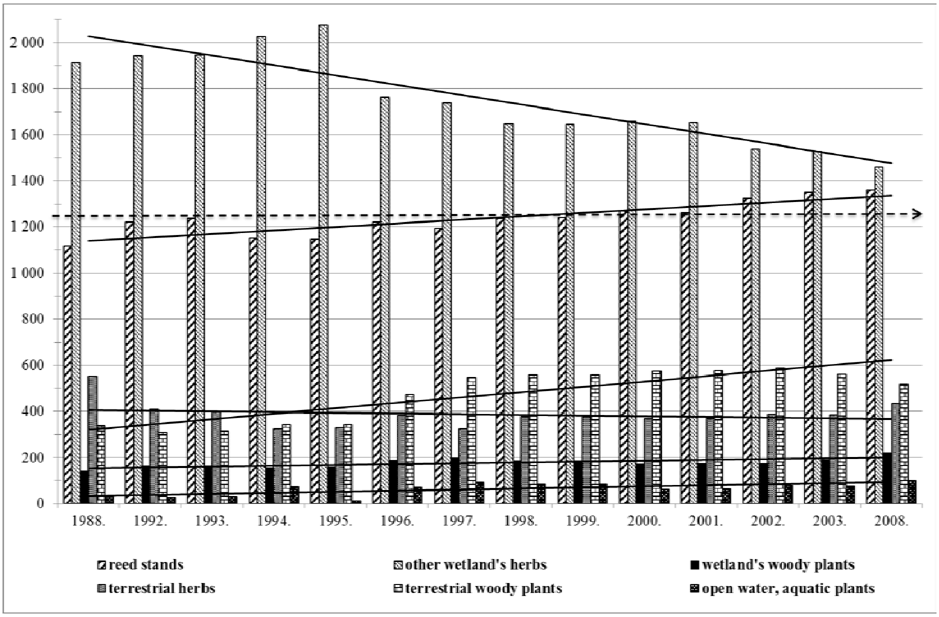

Figure 3. Changes of different plant-groups areas at the Outer-part of the KBWPS's Lake Fenéki (ha), between 1988 and 2008, with the lines of trends

Compared with the Grove Ingói (Figure 4.), it can be seen, that the territory of reed has a slightly declining tendency (average: 1027 ± 4%), but between 1988 (1025 ha), and 2008 (1019 ha) the territorial difference is not significant. After 7-8 years of installation there was a minor fluctuation in the territory of reed, but after 2000 it seems to be stabilizing in about 1000 ha. The proportion of the other herbaceous plant is reducing in the territory of Grove Ingói, the open water, and water weed surfaces are growing at the same time. The other mapping groups are less changeable.

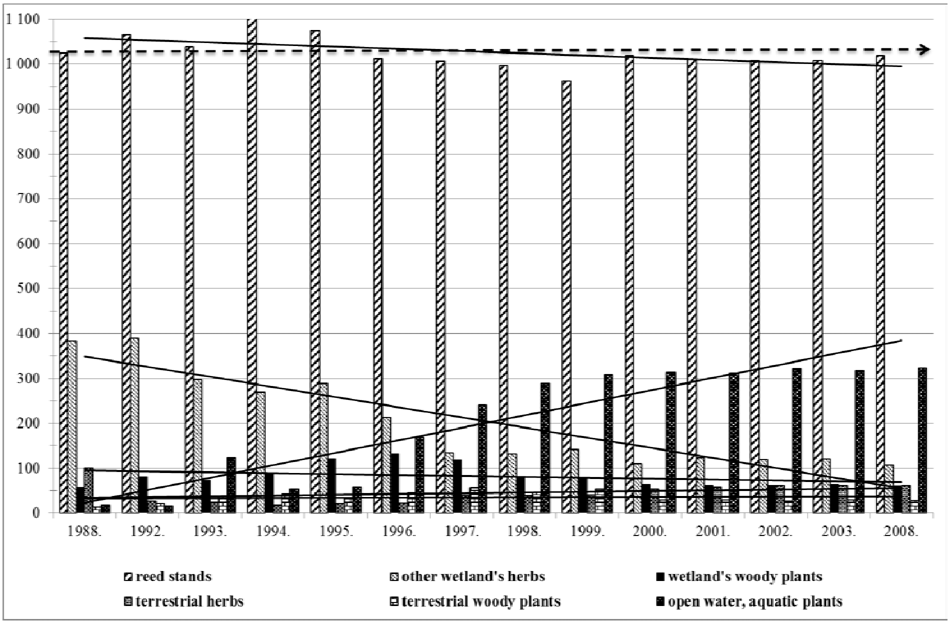

Figure 4. Changes of different plant-groups areas at the Grove Ingói of the KBWPS's Lake Fenéki (ha), between 1988 and 2008, with the lines of trends

The main cause of the changes is, that the Grove Ingói is a 16 km^2 subfield surrounded by dams, where there is no natural area for forest plantation and for natural shrub vegetation, except for the lover part of the dams, and the connecting highlands (e.g. Island Diás).

The water- and/or marsh vegetation can only occupy the habitat at the expense of each other. This happened after a short period of installation of Kis-Balaton Water Protection System. The changes and its trends differ significantly from each other in the four water bodies of the Grove Ingói:

I. On the water body 1 the territory of marsh herbs from 200 ha dropped down fast, with nearly one order of magnitude to the 1/10, in parallel the surface of open water, and water weed grew rapidly. This surface was periodically covered by water and now with 70-100 cm streaming, or standing water, where the place of high sedge vegetation occupied the water weeds alternately with open water. This water body is the upper part of Lake Fenéki, which gets the water from KBWPS I. Stage (Lake Hidvégi)determining the water quality, too. The stress reaction of the vegetation in the first period is clearly seen. The territorial changes of other plants took place in the first 5-6 years with high extremities, but after 1998 remain unchanged. The tendencies can be characterised by polinoms.

II. On the next water body 2 in the flow direction the tendencies of changes are similar to the water body 1 so far, that the reed territories were slightly diminished, but the standard deviation of the 20 years average was only 4% (345 ha ± 4%), and can be described with 2nd grade polinom.

On this water body as well, the place of other marsh herbaceous plants were occupied by the open water/water weeds in 100%. The participation of other groups can be neglected.

III. The water body 3 can be found East to the deflector dam. The water arriving to this water body comes from Lake Hidvégi and had already gone through the reed and bog of water body 2, with a different water quality from the upper part. In this territory are characteristic bog, and the ecological circumstances determined by reed vegetation staying in water since more hundred years. In the mean time Gyöngyös-Páhok channel was lead to the water body, which water reservoir is about 225 km^2, but its effect on the macrovegetation cannot be detected according to the reults of the vegetation mapping. On the about 560 ha territory the plant groups beside the reed does not reach 50 ha. To illustrate the territorial distribution the best way was to use logarithmic scale. The whole territorial change of reed within 20 years showed 2 ha CV% (average 522 ha ± 2%), in such a way there is no importance to put trend on this water body.

IV. The trend of the plant territorial change on the water body 4 differ from the other ones mentioned above. Beside the territory of the marsh herbaceous plants, apart from reed after 2000 became about 15-20% less, then before the installation (1988, 1992), and the trend can be characterised with a linear diminishing curve (R2=0,5), the change seems to be more complicated. A 2nd grade polinom can be better fitted (R2=0,7), and shows more accurately the concrete changes, too. The territorial changes of reed is nonlinear, the growing and decreasing segments clearly differentiate. The long-term average of changes varies between wider extremes (141 ha ± 13%). In the first period after installation the territory of both plant groups showed growing tendency, while the territorial participation of the terrestrial herbaceous plant and trees growing in marsh diminished. After 2000 the territory of reed was growing, the territory of other marsh herbaceous plants was diminishing, while the territory of terrestrial herbaceous plants, and trees was slightly growing, and the surface of open water/water weed was detected.

Conclusion

On the changes of space-time structure of the macrovegetation of Lake Fenéki beyond the natural, or almost natural so called “classical” ecological circumstances the direct human impact - carrying out the investment program - act drastically. For these impacts the living organism, the vegetation gave a fast answer, which we can consider as a stress reaction. During our research work the analysis of the macrovegetation changes were achieved. According to the results of our investigation we decided to take vegetation maps of 1992 as basis. The main reason for our decision was that the earlier survey in 1988 was less detailed, the mapping methods were not so developed. The state in 1988 posteriorly elaborated digitally and can be used to supplemental analysis, in doubtful cases for corrections, or to state assessment of technical impacts. We propose the consideration as background documentation, too. Using the area calculation data based on the time-series vegetation maps of

Lake Fenéki, and the crop coefficient measured in situ the evaporation can be calculated. In future investigation we plan to calculate the changes of the climate with weather generator to which the dynamic of vegetation change will be adjusted. At the end of our investigation a prognosis will be given from the evaporation of Lake Fenéki.

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