THE RECONSTRUCTION OF VEGETATION CHANGE IN THE LAST 55 YEARS ON A MIRE OF BEREG PLAIN (HUNGARY)

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The study area is the peaty bed of Navad-patak mire situated in the North-Eastern Alföld, on the Bereg plain, which is slightly investigated area. The purpose of our research was to reconstruct the recent vegetation dynamic processes of the mire from 1950 till 2005. Beside the aerial photos we used the ERDAS Imagination remote sensing program, and made digital photo interpretation. We divided the vegetation history into three parts. In the first period, the nutrient load of the mire was increased, peat decaying and foresting processes started, the open peat-moss dominated associations (Eriophoro vaginati-Sphagnetum, Carici lasiocarpace-Sphagnetum) were disappeared. In the second period the expansion of the forest vegetation continued, the species composition transformed, and the characteristic species of the mentioned associations (Eriophorum vaginatum, E. angustifolium, Carex lasiocarpa, Drosera rotundifolia, Sphagnum magellanicum) were all disappeared. The third period starts with the artificial flooding in 1994. In the beginning the peat-mosses were all extinct, floating mires appeared immediately and their quick succession started and still runs. The fourth period would be start with the appearance of peat-mosses.

Key words: aerial photo, carr, ERDAS, image interpretation, Navad-patak, Sphagnum

INTRODUCTION

The study area is the peaty bed of Navad-patak mire situated in the North-Eastern Alföld, on the Bereg plain, which is slightly investigated area. The site was previously known for its Oxycocco-Sphagnetea associations. The presence of these associations on the Bereg plain is the southernmost occurrences of these associations on the plains of Europe (Simon 1992). Navad-patak was

As the coenological data was slightly deficient, aerial photos were used to help in the reconstruction of the changes. There are several examples for the application of aerial photos (Jakucs 1966, Kadmon and Harari-Kremer 1999, Kleinod et al. 2005, Langake et al. 2007, Lőrinci et al. 2001, Pellerin and Lavoie 2003, Vona et al. 2006), but most of the Hungarian researches based on only visual photo interpretation. Panchromatic photos have rather low information content, and only subjective data can gained from them, the digital interpretation can help to get extra information, which can enable an objective approach. The purpose of our research was to reconstruct the vegetation dynamic processes of the Navad-patak mire in the last fifty-five years, mainly with panchromatic aerial photos, literary and meteorological data.

**MATERIAL AND METHODS**

The study area (48° 10’ 32” N, 22° 30’ 45” E) is about 500 metres long and on average 80 metres wide (Szurdoki and Nagy 2002) peaty bed of Navad-patak. It belongs to the Samicum plant-geographical region on the North Eastern part of Pannonicum that lies on the South Eastern part of the Holarcticum (Soó 1964) (Fig. 1).

In the Köppen (1923) system the climate of the Bereg plain is: Cbfx (between the moderate warm and the moderate cool). The mean annual number of hours of sunshine is ca 1950, annual mean temperature is 9.4–9.5 °C. Yearly precipitation is 630–660 mm, of which 370–380 falls during the vegetation period (Marosi and Somogyi 1990). The distribution and amount of precipitation and the ground water level can vary greatly in successive years (Fig. 2).

The mire belongs to the administration territory of the Hortobágy National Park. It gets artificial water supply from 1994. Until 2001 it was surrounded by arable fields, now it is belted with a young *Quercus robur* plantation.

Aerial photos taken from the study area were bought from the Ministry of Defense Mapping Company. The black and white photos were taken in different periods of the day, and with different weather conditions, which can cause problems during the digital interpretation. The differences between the qualities of each photo can also effects difficulties. The first photo was taken in 1952, the others with a ten-year periodicity until 2002.
At first, we made georectification with the ERDAS Imagination remote sensing program, and used contrast adjustment with the photos. With the "model maker" function we created multitemporal colour composites. Every pixel of the original photo has a luminous intensity value, which is equal to the digital photos’s DN-value (digital number value). If we combine two different photo’s DN-values in a model (stack layer function), the program creates a false-colour photo. Those patches where was not any detectable change between the two phase were coloured with grey, which means, that they had the same DN-value. Patches, where the program can detect increasing DN-values
are coloured with red, and where the values decreasing are coloured with blue (ERDAS Inc. 1999). In the analysis of the vegetation changes it means, if a patch was red, than it was brighter in the second phase, so there had been biomass decreasing, whereas blue patches mean increasing biomass.

The coenological records were made by the method of Braun-Blanquet (1964) in permanent and temporary sampling plots. In the sample plots cover was estimated species by species on a percentage scale in the case of higher plants in all of the associations.

The size of the minimal area of each association were estimated by eye, if it seemed to be differs from the Central European conventional sizes (Kovács 1962).

RESULTS

In the fifties, there still were Oxycocco-Sphagnetea associations in the Navad-patak whereof Simon (1960) published coenological records. At that time the peat-moss dominated spot could not be larger than a few hundred square meters, and it could presumably be at the place of the present-day alder carr. A pig farm was held on the north side of the bed. The documentation of the establishment was lost in the course of years. It had less than hundred pigs (Zengő 2003, ex verb.). By reason of the pig farm and the arables, the mire was

Fig. 2. Data of precipitation (mm) and ground-water level (m) between January, 1993 and August, 2001 in Csaroda
exposed to permanent loading and eutrophication. On the one hand, it means permanent trampling, digging and wallowing, on the other hand, continuous manure loading. It caused not merely eutrophication, mechanical damages and dragging in the seeds of weeds, but the spreading of nitro frequent species and the decreasing of oligotrophic species.

After many arid years and increasing nutrient load, the raised bog associations were presumably forced back, and forest associations came to the front. The willow carr expanded, and nitrofrequent species \(\text{Bidens cernua, Bidens tripartita, Polygonum lapathifolium, Epilobium tetragonum, Epilobium hirsutum, Cicuta virosa}\) overran the open peat-moss surfaces, just like in the Nyíres-tó mire after two drying years, and heavy wild-treading in 1996 (Nagy et al. 2007). It seems, the foresting processes not just caused by the weather conditions, but the effect of the pig farm.

In the second part of the sixties the pig farm was closed, and the anthropogenic effects decreased. The weather turned to more arid so the weeding and foresting processes continued. The mire was greatly burned down in 1967 (Fintha 1994, ex verb.) and the Oxyccocco-Sphagnetea associations and their oligotrophic species disappeared. The coverage of the contiguous Sphagnum-carpet decreased, and on the edges it fragmented into minor patches. Till the seventies the mire was almost covered with willow and alder carr. Probably many \text{Betula pubescens} existed in the central area, former covered with \text{Eriophoro vaginati-Sphagnetum}.

Fig. 3. The vegetation map of the Navad-patak mire
Till the eighties, the weather conditions and the precipitation supply were fair enough, the former changes get into stagnate period, and probably the dominance of the peat-mosses increased. However, the gravitating water from the surrounding arable fields was involved continuous nutrient load. The peat-moss dominated patch could not be larger than 20 square metres (Szurdoki and Nagy 2002). *Salici cinereae-Sphagnetum recurvi sphagnetosum squarrosi* and *Glycerietum maximae* were dominated in the middle of the bed, the vegetation was drying in the littoral zone, and the natural plants mixed with weeds (Tóth 1997). Presumably only the shade tolerant *Sphagnum squarrosum*, *Sphagnum fimbriatum* subsp. *fimbriatum* or *Sphagnum palustre* and some *Sphagnum angustifolium* could be in place as these species present on the nearby Zsid-tő mire.

The artificial flooding of the mire started in 1994 for helping the propagation of *Sphagnum* species. The carriage of the water replenishment was wrong, as the *Sphagnum* species all disappeared because their growth could not follow the fast elevation rate of the water level (Nagy 1999). Shortly afterwards different floating mire originating processes started, skirt mires covered the *Salix cinerea* dominated bed, which was previously described by Nagy in 1996 (Nagy and Tuba 2003). Forested and scrubby areas were unclosed caused by the flooding. During the low water level and the almost dried state of the mire *Glycerietum maximae* covered the middle of the bed. Above 50 cm water level *Stratiotetum aloidis* and *Lemno-Spirodellietum* were the dominant associations. The peat of floating mires thickened, the dominant associations have been the *Cicuto-Caricetum pseudocyperi* on the dense floating carpet of *Stratiotetum aloidis*, *Thelypteridi-Typhetum latifoliae* on the edges of skirt mires forming on half-submerged *Salix cinerea* and floating mats of *Glycerietum maximae* (Fig. 3). There have not been peat-moss on the floating-mire surfaces yet, but its reappearance can be expect in a few decades due to the close-by propagulum resources (1.5 km), and the mildly acidic (pH: 5.91–6.22) mire surface.

**DISCUSSION**

After the analysis of the coenological records, aerial photos and colour composites, the last fifty-five years of the vegetation history of the Navadpatak was divided into three periods.

In the first period it appears as a *Sphagnum*-dominated mire. This state keeps till the middle of the sixties, when the Oxycocco-Sphagnetea associations disappeared.

Thereafter weeding and foresting processes started caused by gradual nutrient loading, dryness and burning, and the species structure changed...
drastically. All the Oxyccoco-Sphagnetea species died away. Other peat-moss associations separated, degraded and their extension decreased apace.

The third period starts with the artificial flooding in 1994. During this time, all the *Sphagnum* species extinct from the mire. Floating mires emerged, and their vegetation flourished continuously. The processes on the present-day state show that the peat-moss can reappear again in the mire in few decades and the fourth period will start at that time.

After the floating mire formation processes there is good chance for the reappearance of the *Sphagnum* species, as the spores and apparently dead vegetative parts of the *Sphagnums* can germinate from 50–60 years old, almost dead, dried peat (Clymo and Duckett 1985). We still do not know how intact was the peat after the drying and the burning, but spontaneous colonisation is still possible from the Báó-tóva, Nyíres-tó and Zsid-tó, because none of them is farer than four kilometres.

The information content of the panchromatic photos are very poor, thereby the analogous applications in the investigation of mires are quite difficult. High resolution pictures (IKONOS, Quickbird) only taken in the last few years, so long-term change detections cannot implement yet, therefore black and white photos with digital photo interpretation brings sufficient results in the investigation of mires and wetlands.

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