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LANDSCAPE CHANGES ALONG THE TISZA RIVER IN THE SOUTH TISZA REGION OF HÓDMEZŐVÁSÁRHELY

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Summary – Before the river regulations of the 19th century the landscape around Hódmezővásárhely was basically determined by waters, large bodies of reeds, and higher grounds like pastures and fields. It consisted of relatively homogeneous hydrological units which established the ground for the diverse cultivation on the flood plains. The area has been suitable for people to settle down since the Neolithic era. Nature has supported the livelihood of these people and the diverse landscape also guaranteed their protection. By the end of the 19th century the partial or complete separation of the final recipient of the river system by dikes has accelerated the transformation of the hydrographically divided landscape. In today's flood plain surrounded by dikes the ecological water demand is of essential interest for nature conservation. At the same time in the flood-controlled areas the different types of groundwater appearing on the surface cannot reach the recipients and thus occasionally cause floods, while droughts can also persist in the area for longer periods. There is a need for a comprehensive development concept handling the artificially divided landscape as one unit; one which aims a complex development of the former hydrological unit, and serves as means of flood and groundwater security, furthermore facilitates the preservation and maintenance of natural systems.

Key words: historical landscape changes, land cover changes, flood plain, river regulation

1. INTRODUCTION

Before the regulation of rivers, the landscape around Hódmezővásárhely was essentially determined by waters, large bodies of reeds, meadows, hooks, brooks as well as higher pastures, fields and islands. Water-related place-names, i.e. more than 25% of the total geographical names near the settlement of Hódmezővásárhely (brook, hook, lake, meadow, flat, plane, bed, bend, canal, dike, island, well etc.) are all evidences on that. Other names can be associated with different landforms and ancient settlements (Bodnár 1983). The partial or complete separation of the final recipient of the river system by dikes has accelerated the transformation of the hydrographically divided landscape.

Our objective was to understand the functioning and the changes of the natural and the modified landscape as well as the factors inducing these changes in order to provide scientific background for urban development policies as well as for rural and regional development programs. These aim at preserving nature with a view also to optimise land-use activities. In this study we wish to establish a basis for the future analysis of landscape changes applying geoinformatical methods and for the modelling of ancient hydrographical situations.

2. STUDY AREA AND METHODS

On the basis of old maps, landscape monographs and the recognisable morphological signs Hódmezővásárhely and its surroundings were relatively homogeneous hydrological units before the river regulations. Our research concentrated on the area (Fig. 1) where the courses of development of the dike-divided landscapes vary significantly. The boundary of the drainage area was the Kórógy river in the north and the Száraz brook in the south. The waters of Mágocs and Újváros were channelled to the Tisza river by the Kórógy river through the Mágocs brook. It also fed the once extensive Kék lake through some hooks. The water surplus of the lake was syphoned by the Ludas brook and also by the Téglás and Kenyere brooks. The recipients of the *dűlő's* waters between Rárós and Mártély were mainly the Kenyere brook, the plane areas of the Kenyere and Pap brooks, the flat territories of the settlements of Palé and Solt, the Hód-lake and the Nagyrét meadow. Furthermore several unnamed and empty river beds demonstrate that the north-west areas were directly related to the Tisza river and its flat territories. The pastures around the settlement of Vásárhely had their own recipients (lakes and flat lands). In case of heavy rainfalls their water moved towards the town to the Csomorkány flat lands or it was led to the Hód-lake through the Kis-tó bend, the Cirják-brook and the Sarkaly-brooks.

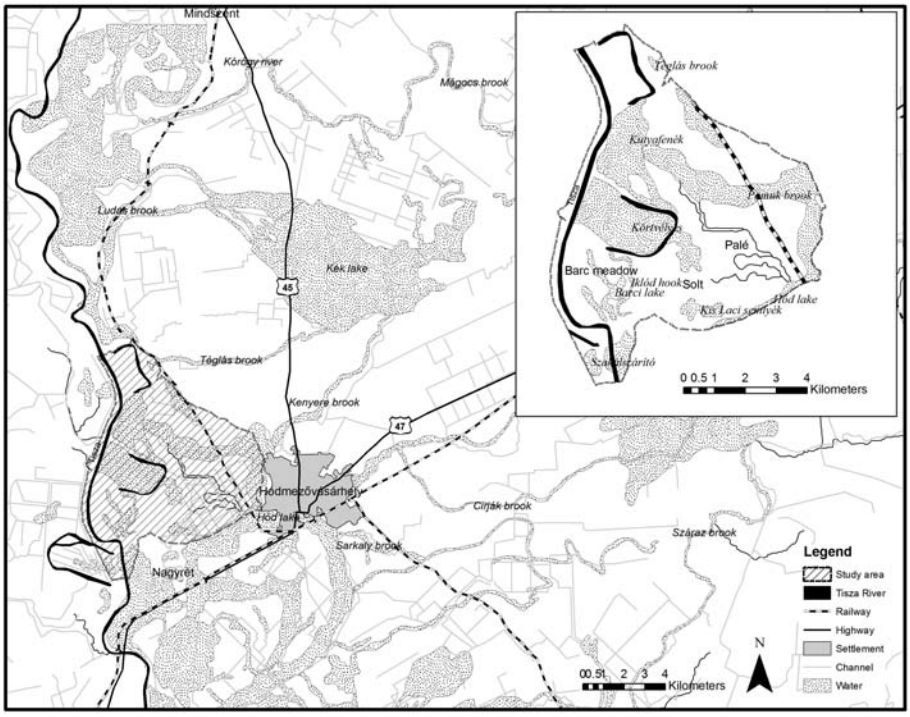

Fig. 1 Study area

We analysed the landscape changes in the sample area shown in Fig. 1. Our goal was to examine the nearly 150 years of dramatic landscape change in an area where a complete scale of human impacts can be traced. By doing so we have gained insight into

land use which consolidates the preservation of natural structures and at the same time has transformed the landscape as the result of human activities. The almost 60 km^2 sample area is part of the Mártély Nature Conservation Area of the Kiskunság National Park and includes the areas surrounding Hódmezővásárhely. The north-east and south-east boundaries of the area are the Mártély-Hódmezővásárhely and the Bodzás roads.

During the analysis of the land-use changes we relied on the related literature, numerous historical maps (1st, 2nd, 3rd military surveys), remote sensing imagery (LANDSAT TM from 1987 and 2000) and aerial photos from different time periods (1964, 1987, 2008). We gathered and analysed the spatial information in GIS and synthesized it with the ArcGIS 9.2 software.

3. RESULTS

3.1. Segmentation of the Vásárhely area, land use before the 19th century river regulation

The brooks, the cuts called „*fok*" and the channels carrying water in and out of the area provided the basis for a differentiated use of flood plains. The fertile meadows were grazed, the pastures mowed, the reed was cut in the lower areas and there was fishing on the lakes. The higher parts, the mounds were free of water even in times of floods so they served as valuable arable lands and they ensured the security of the animals.

The „*fok*" serving as the basis of farming in this area are described as of both natural and anthropogenic origin. Szeremlei (1900) and Bodnár (1983) considered both the „*fok*" and the brooks to be natural formations, while according to Bellon (2003) the „*fok*" are natural or artificial channels grooved into the high walls. Andrásfalvy (1975) defines the „*fok*" as artificial establishments created with the aim of breaking through the mounds at the river banks. According to Mezősi (2008) the „*fok*" are probably of natural origin, which were used, cleaned and deepened by the people.

Bellon (2003) described four levels of farming on flood plains. The *river level* served as the source of drinking water for both people and animals. The *second level* is the area of floods with meadows, pastures and high-water forests. The *third level* is the area free of floods, on the boundary of which settlements and farming systems were established. The fourth level is the area of sand and loess ridges, which functioned as dry meadows therefore these were the first areas to be used as cultivated arable lands.

Similar zoning was characteristic of the areas surrounding the towns in respect of farming, which in many cases is still living in the geographical names, even though the land use today usually has nothing to do with the ancient function any more. The common pastures immediately edging the interior area of the town were called „*nyomás"* or „*belsőség"*. These areas functioned as pastures used by peasants. The *farm areas* were situated immediately over the „*nyomás"* areas and were essentially used as arable lands and plots of peasants. The expression "*desert areas"* was first used for the disappeared or ruined villages, then from the middle of 18th century for the fields over the farming areas and exterior pastures. Around 1670 only 13 of the 31 of the villages situated in Csongrád county was populated (Herceg and Kruzslicz 2000). In 1850 the desert and „*nyomás*" areas were divided among the population possessing plots and houses, so the characteristics of pastures gradually disappeared because of the cultivation and the growing numbers of the farm buildings. The "*meadow areas"* connected to the river Tisza received some special

characteristics from the extensive lakes, „*fok*" and brooks, which manifested in their flora and fauna, the possible ways of land use, the life style of the inhabitants and the ways of transport. The regulation of the river Tisza put an end to these differences.

3.2. Changes in land use in the 18th to 20th centuries

The relevant maps of the *First Military Survey* made in 1784 show the situation before the river control. The Tisza had a spacious open flood plain, so after floods the river left behind extensive areas temporarily or constantly covered in water. The system of „*Kopáncsi-sík" (Kopants Sik Toó, Nagy Sík-tó)(i.e. Plain of Kopáncs)* and *Hód-tó* (*i.e. Hód-lake*) appears as a coherent water surface, and the bed of New-Tisza deepened in 1779 is indicated with the wooden bridge of the Old Road to Szeged. The Hód-lake was situated south of the town in an approximately semicircular form. Old Vásárhely and the village Hód (ruined in about 1450) were settled on the northern shore (Szeremlei 1900).

As during the Turkish rule there was no synchronised protection activity the greater floods regularly deluged the region. Later together with the strengthening of the public administration the county established and maintained dams in order to protect deeper areas and secure transport, or they ordered the establishment or maintenance of these. The dams established and maintained by the settlements were usually built on the shores of lakes or directly next to the arable lands to be protected. The regulation of the river Tisza started in the 1840's, though at first it was an undertaking of the landowners concerned because of the situation of their lands. Later the management of the operations was handed over to companies of flood protection and inland water control.

The *Second Military Survey* was carried out in 1864. There is a striking change in land use, as it became more mosaic-like and heterogenic. This change was possible due to the growing proportion of the areas becoming free of floods, which consequently could be included in cultivation. The beds of the cuts dug at Atka (1863) and at Körtvélyes were indicated on the map. The operations of the cuts at Mártély and Nagyfa were not started yet then. Consequently an interesting split character of the landscape can be observed. The area of water surfaces, brooks, marshlands and wet meadows markedly diminished around Vásárhely, most of them even disappeared. At the same time in the north of the Tisza-bend at Körtvélyes water is more dominant in forming the image of the landscape. After starting the operations of river control and inland water protection the bed of Hód-lake started to dry out as well. In 1857 some of the shores could already be ploughed.

Neither the size nor the stability of the established flood protection system was sufficient to deal with the extended height of floods. Before the operations of river regulation the sweep of floods did not threaten the town itself (with the exception of the year 1838), but in the following years the settlement and its inhabitants got into serious danger several times (Szeremlei 1900).

The operations of river regulation started with digging the cuts into which the water of the river was channelled, so the new bed was formed into a mother bed. The cut at Mártély was established between 1889 and 1891, and between 1901 and 1902 it was deepened by excavation. Between 1903 and 1904 the „dead" dams in the flood plain were removed as well. The digging of the cut at Körtvélyes started in 1863, and it was gradually extended. Between 1894 and 1895 the peak under the lower estuary was cut, in 1904 the upper bed of the dead bend was filled in (Bodnár 1983).

On the basis of the analyses on the differences between the land use demonstrated by the second military survey in 1864 and the present-day one it can be ascertained that the

approximately one-and-a-half-centuries long development of the landscape resulted in significant modifications in the area (Fig. 2).

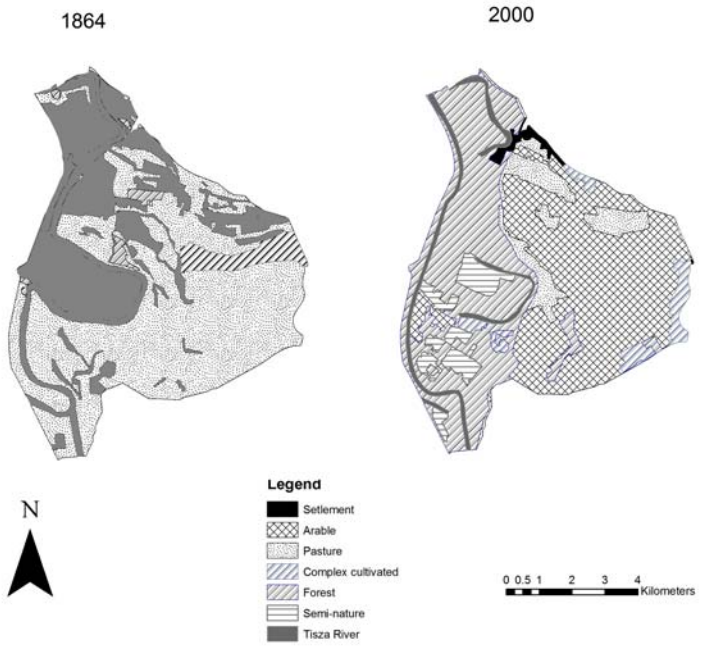

Fig. 2 Land cover changes between 1864 and 2000

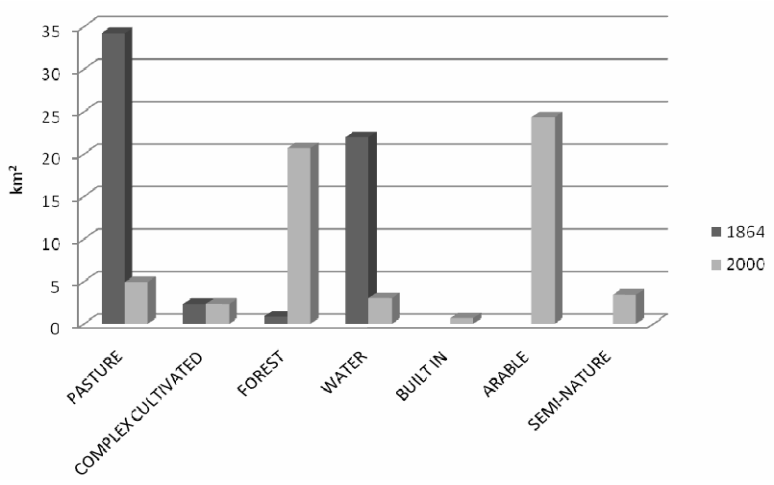

Fig. 3 Land cover changes between 1864 and 2000

By 2000 only half of the original ways of land use was observable (52%), furthermore the structural proportions of the types notably changed (Fig. 3). The area of pastures decreased by approximately 50% (from 58% to 8%). The area of forests (mainly in the protected areas) increased by 33%, water surfaces were diminished by 32%. The most

spectacular new form of land use is the crop production in arable lands in the place of the former pastures and meadows.

4. CONCLUSION

By forcing the Tisza between dams the ways of the development of the river and the landscape previously forming a unit and shaping together were separated, and their image changed radically. The lower and deeper water surfaces disappeared and the cut bends were quickly severed. A significant part of the marshlands on flood plains, marsh meadows, water habitats and flood forests disappeared and changed by the penetration of the different forms of farming. One of the most important tasks of landscape protection is to keep the water habitats and landscape structure still in uncultivated state. The flood plain is today a green passage of high significance. The Mártély Protected Area of 2232 hectares has been protected since 1971. It has been listed in the Ramsar List of protected water areas of international significance since 1979. Since 2008 the whole territory is a Natura 2000 area.

In the narrow flood plains the abruptly ascending high water level regularly destroys part of the flora and fauna. The total original vegetation scale cannot subsist, so the quickly settling species of high tolerance come into the foreground, i.e. a constant unidirectional selective pressure is predominating. Even if more sensitive elements disappear, the framework of the former system remains, which serves as a basis of the subsequent rehabilitation (Szabó 2008).

Securing the ecological water demand of water habitats of flood plains is a basic demand of nature reservation today, and so is the conservation of the minimum necessary water level of backwaters. This is a source of conflicts every year because of the cultivation of arable lands. In order to solve these conflicts it would be necessary to establish a support system motivating the introduction of nature preserving ways of farming and compensation for the shortfalls in income due to the switch.

As an important feature among the hydrological effects of the control the increase in the eroding-capacity resulting from the higher drop of the river can be mentioned. The reaction of the water system was on the one hand the transport of an extended amount of river drift, and on the other a modification in the character of the sections. As a result of the regulation the formerly meanderingly accumulating characteristics of the river turned into mostly meanderingly eroding ones (Mezősi 2008). The result of the eroding work of the river is a significant decrease in the level of the low water mark.

In our days the most intensive process of the development of flood plains is accumulation. The flood plains are getting higher, the measure of their growth was 0.23 to 0.60 cm (0,5 cm/year) as an average during the last 120 years. This diminished the flow section by 5 to 16% (Lóczy és Kiss 2008). According to Jakucs (1982) every year 1.125 cm of river drift as an average is accumulated in the flood plains of Tisza, the distribution of which is not even. Kiss et al. (2004) analysed the process of accumulation on the flood plains of Lower-Tisza, and they received a rate of 0.3 cm/year as an average. The intensive accumulation of the flood plains is resulting in a higher level of floods; consequently the risk of floods is getting higher.

The extent of accumulation of backwaters on active or saved flood plains has significantly differed from each other since the river control operations. The parts of river bed within the dams are accumulated by the drift of the living river in a variable rate of

time augmenting the drift of lake formed in the backwater. According to the analyses of Kiss and Fejes (2000), Fiala (2000) on the section of the river Tisza at Mindszent, Sipos (2006) and Oroszi (2008) on the river Maros the depth of the river drift exponentially decreases with the distance from the living river bed, but it is also affected by morphology and factors of vegetation. According to Somogyi (2000) the types of accumulation present together before the river control have parted from each other: while on the flood plains mineralogenic accumulation is much more intensive, an accumulation of biogenic materials is characteristic of the saved territories.

Since the establishment of the flood protection dam system the different sorts of groundwater (rising, infiltrating, etc.) haven't been able to get into the receivers in a natural way so these are collected at deeper parts of the area and cause suffusions of an extent sometimes equal to floods. Groundwater is endangering not only flood plains but territories situated higher as well (e.g. 1999-2000 grade 2, 2001, 2006 grade 1).

It is obvious that any interference can be successful if the rules of the functioning of the former natural landscape are taken into consideration. There is a need for a comprehensive development concept handling the artificially divided landscape as one unit; one which aims a complex development of the former hydrological unit, and serves as means of flood and groundwater security, furthermore facilitates the preservation and maintenance of natural systems.

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