

LAND HISTORICAL EVALUATION OF THE ERDŐSPUSZTÁK REGION OF EASTERN HUNGARY BY USING GIS METHODS WITH SPECIAL REGARDS TO THE RELICT HARDWOOD FOREST OF NAGYCSERE

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ABSTRACT. The relict hardwood forest of Nagycsere in the South-Nyírség region of Hungary is a forest fragment of the previously continuous Erdőspuszták (Wooded plains). This hardwood forest owns a significant nature conservation role in the examined area, however the unfavourable sub-processes of the global climate change has a clear effect on it. These negative processes hasten quick intervention, an active nature conservation attitude. Besides the knowledge of the present situation, information about the past is also required to the best possible habitat restoration activities. For the sake of getting acquainted with the past circumstances we surveyed historical maps of the region. By our results we would like to develop the nature conservation management strategy of the protected forest.

Keywords: nature conservation, land use, land historical examinations, GIS technology, hardwood forest

INTRODUCTION

The nature conservation importance of the hardwood forest fragments remained in Eastern Hungary is considerably significant as these forests are the last refuges for the olden flora and fauna of the region (Juhász and Vas, 1996). The hardwood forests previously ran along the past rivers however due to the regulation of the water-ways the forests were cut from the natural water resources and soil water became the main water supply for these plant associations (Gencsi, 1994). By now there are only a few of these forests fragments that are endangered by the continuous increase of the annual mean temperature, the decrease of the amount of precipitation and the unfavorable, erratic distribution of rainfalls in the last few years. For our examinations we choose the Erdőspuszták (Wooded plains) region of Eastern Hungary. Our main point of interest is a relict hardwood forests fragment only a few kilometres far from Debrecen, near to the settlement Nagycsere. Nonetheless this valuable forest is protected by fence from the harmful human effects the constant drying out affects this wood as well. Considering its nature conservation significance something has to be done for preserving it although for the conservation of biodiversity population and species protection is not enough there is a need for a complex land protection (Bánszegi et al., 2000) and the rehabilitation of the area could also be necessary (Halassy, 2001). The re-shaping of the dilapidated habitats is possible through restoration ecology actions. The target of the restoration ecology interventions is to restore the previously existing, more favorable natural status of a certain area (Choi et al., 2008). However the lack of knowledge according to the conditions that refer to the original circumstances besides the lack of

financial sources often complicates this activity (Török and Tótmérész, 2005). For the restoration of a habitat it is necessary to be familiar with the previously existing circumstances and the then façade of the area (Pallás, 1975). The land historical examinations support this activity by evaluating the present and the previous circumstances that can be observed on maps of the territory from different eras. To map the present situation we used a topographical map of Hungary from the 1990s, and as in our faculty department we follow the changes in the flora and fauna of the area for years now we can use our former results as a basis that promotes our present study. To get acquainted with the preceding conditions we used historical maps because the landscape historical examinations of a certain territory actually mean the evaluation of the land use changes what could be performed by surveying former maps of the examination area. For this job the I-VII. Military Surveys are the most appropriate sources in Hungary that started in the middle of the 18th century and were created with proper accuracy according to the past technological standards (Lukács et al., 2004). Considering the similar structure and scaling of the military maps, these sources are the most suitable for landscape historical examinations. From the altogether seven military surveys we considered the I. (1782-1785), the II. (1819-1869) and the III. (1872-1884) Military Surveys the most appropriate for our job. To join the map sections we used Adobe Photoshop CS4 programme while for the GIS delineations and calculations we applied the ESRI ArcGIS 9.3 software. By the conclusions and recommendations based on our results we would like to contribute to the long term preservation of the examined area as a habitat for the natural flora and fauna.

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MATERIALS AND METHODS

Considering the outstanding nature conservation value of the hardwood forest of Nagycsere therefore the significance of preserving it, we wanted to carry out our examinations only in this forest fragment at the beginning. For the sake of investigating in depths how the changes in the land use affected the natural environment nearby Debrecen thus to understand the background of the processes that pass off in the hardwood forest of Nagycsere, we extended our examinations to the Erdőpuszták of Debrecen which territory involves the relict forest of Nagycsere as well.

Site description

The present area of the Erdőpuszták is some 20 000 hectares (Juhász et al., 1993) of which the significant part is within the administrative border of Debrecen. The area is the part of the Nyírségense flora district within the Alföld flora region (Juhász, 1994). Its annual mean temperature is 9.6-9.7°C, the annual mean sum of precipitation is approximately 580 mm. The soil of the territory is the sediment of the river Tisza from the Pleistocene era therefore the soil character is mainly sandy with loess. The characteristic natural wood associations of the Erdőpuszták are the oak-ash-elm hardwood forests (*Fraxino pannonicae-Ulmetum* Soó in Aszód 1935 corr. 1963) (Kevey, 1999), plain oak forests, oak woods with lily of valley and also willow and alder moors. Though the present wood composition of the Erdőpuszták is far from the natural status, Pedunculate oak (*Quercus robur* L.) is only some 14 % of the total wood stock (Szemerédy, 2002).

The relict hardwood forest of Nagycsere with its 38 hectares area is still the refuge for the preceding flora and a reminder of the previously possible conditions (Juhász, 1996). This is a fragment of the previous oak-

ash-elm forests existed in the deeper therefore more wet part of the Erdőpuszták (Juhász and Vas, 1996). At the fringe of the forest and next to the glades thick shrub level forms a connected plant stock. This diverse shrub level with the old trees is a real resource for the woodpeckers and other birds live in hollows, as well as for warblers, thrushes and nightingales, and also for other animals like amphibians and mammals attached to deciduous woods. The hardwood forest of Nagycsere with its rich feeding possibilities and hiding places functions as a green island between the forests of Robinia, poplar and pine with barren ecological conditions. The forest of Nagycsere maintains a diverse fauna and ensures the natural species supply for the nearby habitats with less favourable ecological state (Juhász, 1992). After all it is easily understandable that this relict forest owns a significant role in a nature conservation point of view.

Land historical examinations

During our examinations we used the proper map sections of the I. (1782-1785), the II. (1819-1869) and the III. (1872-1884) Military Surveys for the sake of getting acquainted with the previous circumstances. From these historical data sources the I. Military Survey served as a basis, we compared the land use changes during the examination period to this map. To describe the present situation we used a detailed topographical map of Hungary from the 1990s. During the field work to record reference points (Tab. 1) we used a Garmin Legend HCx GPS device with NaviGuide and TopoGuide maps. To cut and then join the appropriate map sections we used the CS4 software of Adobe Photoshop. For the georeferencing and data procession we applied the ESRI ArcGIS 9.3 software. During our work we used EOVS (Unified Hungarian Projection Scheme) coordinate system.

Table 1

The reference points and their coordinates recorded for the different map sections

Reference point	Referred map	EOV coordinates	
Protestant Great Church, Debrecen	I., II., present day	843988	246312
Small Reformed Church, Debrecen	I., II., present day	844065	245959
Reformed Church, Vámspércs	I., II., present day	864626	246387
Reformed Church, Hajdúszoboszló	I., II., present day	826594	235935
Bridge, Hajdúszoboszló	III.	826864	233665
Railway Station, Debrecen	III.	844189	245038
Crossing, Vámspércs	III.	864636	246441

RESULTS AND DISCUSSIONS

The certain digitalized map sections created by processing the historical maps, the present topographical map sections and the Digital Base Map of Hungary are demonstrated on Fig. 1.

The sizes of the different cultivation branches that were calculated by the ESRI ArcGIS 9.3 software on

the basis of the georeferenced maps in the examined four eras are indicated in Tab.2. From the table data the land use changes during the examined period are clearly visible.

During the era of the I. Military Survey the administrative area of Debrecen was bigger than nowadays by far as the region of Hortobágy was

attached to Debrecen administratively awhile. Examining the changes in land use by applying the present day borders, it can be stated that the different cultivation branches were well separated. From the Western direction, from the region of Hortobágy mainly arable land occupied the examined area with small grass segments, a few rills and only with one settlement that laid approximately at the present place of the settlement Nagymacs. Arable land gave place for pastures in front of the olden city of Debrecen about the line of Tóció stream and to the East of it. In this era the Big Forest of Debrecen and the Forest of Apafa

were well separated from each other and from the city as well. To the East of Debrecen there was a clear margin between the pastures and the Erdőpuszták of Debrecen which latter run to the administrative border of Debrecen. As the clearings (plain parts) that wedged in between the wooded fragments moved constantly in time according to the forest management activities, we determined the total part of the Erdőpuszták as forest cultivation branch. We featured only one pasture separately within the Erdőpuszták as that can be found on all the four military surveys and that is bigger than all of the other plain parts.

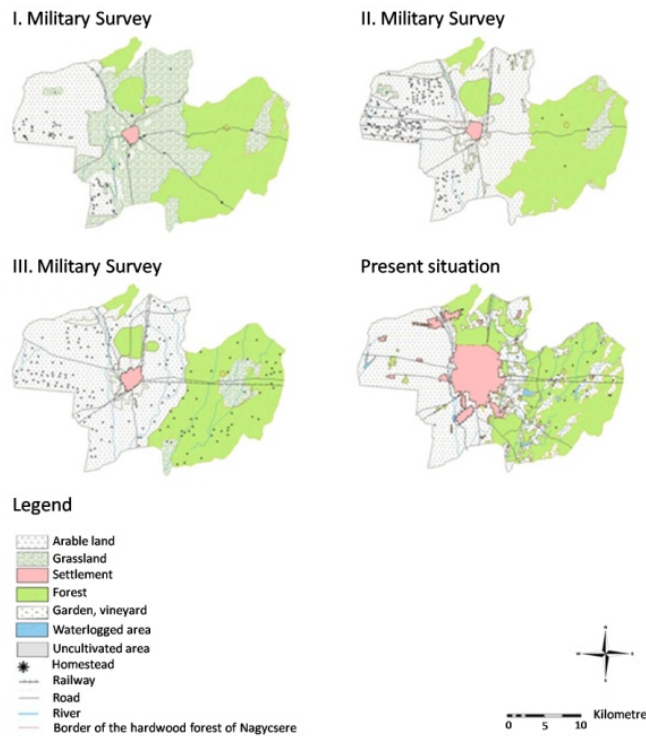


Fig. 1 Map data created for the examination area by the I., II. and III. Military Surveys and present maps

At the outskirts of Debrecen there were vineyards everywhere, however as from the I. Military survey a standard legend was missing we contracted the vineyard and the garden cultivation branches and gave a common sign to them together. As we could not determine the correct cultivation branch of the area of the latter Railway Station of Debrecen we indicated it as uncultivated area.

The present settlement part of Debrecen called Józsa did not exist in the era of the I. Military Survey. Only two smaller homesteads are identifiable there. Nagycsere and Haláp also did not exist as settlements those days only a pile is indicated on the map.

According to the I. Military survey the most important rill was the Tóció stream besides what only minor rills mainly as temporary waters and long stretched swamps were delineated. Stagnant waters were indicated only along the Tóció stream.

The road-network was composed only of some superior roads and more inferior roads. These lower class roads ran along the arable land parcels at the Western part of the examination area, while elsewhere this kind of order cannot be observed. The road that now leads to the hardwood forest of Nagycsere previously kept far to the North and touch at the examined forest segment.

The homesteads characteristic to the surroundings of Debrecen were placed nearby sweep wells next to arable lands.

The biggest change to the II. Military survey was the significant decrease of pastures for the benefit of arable lands. According to our calculations the size of pastures decreased from 37,55 % to 5,77 % while arable land increased from 23,12 % to 53,82 % (Tab. 2). This incredible change is supported by the clear and standard legend of the two maps and the roads along

the parcels that appeared at that time. The doubling of the vineyard and garden cultivation branches is also a

conspicuous change what is partly the result of the appearance of Józsa as a garden suburb.

Table 2

The changes in the size of land use categories over the examination period within the administrative borders of Debrecen (own compilation after ESRI ArcGIS 9.3 calculations)

Land use category	Size of the land use category / Date of data collection (year)							
	1782-1785		1819-1869		1872-1884		1995-2007	
	ha	%	ha	%	ha	%	ha	%
Arable land	10724.49	23.12%	24966.44	53.82%	24773.89	53.41%	22438.24	48.37%
Grassland	17415.59	37.55%	2678.39	5.77%	2474.24	5.33%	0.00	0.00%
Forest	16960.55	36.56%	17103.74	36.87%	16954.85	36.55%	17824.78	38.43%
Garden/vineyard	866.42	1.87%	1260.24	2.72%	1529.85	3.30%	142.23	0.31%
Uncultivated area	34.52	0.07%	0.00	0.00%	108.75	0.23%	0.00	0.00%
Waterlogged area	32.88	0.07%	0.00	0.00%	0.00	0.00%	403.67	0.87%
Built in area	351.4	0.76%	377.04	0.81%	544.27	1.17%	5576.93	12.02%
Sum	46385.85	100.00%	46385.85	100.00%	46385.85	100.00%	46385.85	100.00%

The uncultivated area discussed before was assimilated by the city what were not growing significantly during this period. However, if we look at the increase and localization of vineyards and gardens, we can see a settlement size close to the nowadays size of Debrecen. In the North-western part of the Big Forest of Debrecen a clear-felling happened possibly as the previously continuous forest became broken on a large spot. Although we still indicated this spot as forest as because a shrub stock was indicated on the map there and we know from literature sources that Robinia started its propagation that time (Wellmann, 1961) therefore we concluded the exist of this treeless spot temporary.

The appearance of the forest homesteads also happened in the second part of the 19th century, on the II. Military Survey all together tree homesteads and the settlement of Haláp was indicated. Notwithstanding the separate indication of Haláp we delineated it on Fig. 1 as a homestead also due to its then size.

Rills were still a few in the era of the II. Military Survey, the Tóció stream was invariably the most important flowing water in the examined area. Besides, smaller streams occurred along the Western and Southern borders of the territory. We did not indicate stagnant waters during this era because the forest swamps and other forest stagnant waters are also the part of the forest cultivation branch according to the map data so separate indication of these watered plots could have been meaningless.

To the period of the II. Military Survey the development of the road-network is clearly visible. Railway also appeared in the territory. It is worth to mention the quick increase of the numbers of homesteads to the Northwest and Southwest of Debrecen. It is noticeable that homesteads appeared en masse along the precisely planned roads that proceed from the city radiately. The then route of the present road heading to the hardwood forest of Nagycsere became much alike to the nowadays actual situation.

The bends of this road straighten out and the route of it drawn to the South, bypassed the present area of the hardwood forest of Nagycsere.

The III. Military Survey followed the II. Military Survey rather soon therefore a considerable change did not happen. The size of arable lands, grasslands and forest decreased slightly. The area of vineyard and garden cultivation branches reached their maximum over the four different examined eras. Likewise to the I. survey an uncultivated area with some 109 hectares appeared at the South-western edge of Debrecen. Later this place also became built in. The vineyards and gardens indicated on this map near to Debrecen are similar to the garden suburb of the present city. It is conspicuous that Debrecen started to develop, the direction of its expansion is Eastern, North-eastern.

New railways appeared, the routes of the public roads started to resemble to the nowadays situation.

During the era of the III. Military Survey numerous homesteads appeared in the territory of the Erdőpuszták as well.

The III. survey indicated a lot of rills in the examination area from which we endeavoured to delineate the most important ones. This survey also did not mark any stagnant waters therefore we could not demonstrate waterlogged areas on Fig. 1.

To our time grasslands disappeared totally from the examination area and the size of vineyards and gardens decreased significantly as well. The growing city occupied the unused pastures and previous vineyards and gardens. With the ceasing or at least moderating agricultural activity the total size of grasslands also decreased and a great number of homesteads became abandoned due to the changes in the population's life style. It is interesting how the size of waterlogged areas grew. The background of this phenomenon dates back to 1976 when the development plan of the Erdőpuszták became completed. This development plan contained proposals on the progress of mental and physical recreation facilities in the Erdőpuszták

therefore welfare lakes were created in the territory mainly for sporting and fishing (Szemerédy, 2002).

CONCLUSIONS

According to (Choi et al., 2008) historical information is undoubtedly a valid source for guiding future restoration. We can conclude therefore that the reviewed land historical examinations own practical importance by supporting the planning and carrying out of nature conservation management and restoration activities. As (Török et al., 2003) states by citing Jordan et al., ecological restoration is crucial in the preservation of biodiversity, which opinion also strengthens the significance of our results.

By evaluating the surveyed data it is clearly visible that the original landscape transformed totally and this process brought along the alteration of the flora and the fauna as well. During the examined near 220 years the façade of the landscape changed completely. The more eye-catching process is the increase of the built in areas during which the size of the settlement became all together fifteen times bigger. The total disappearance of the grasslands is also very conspicuous that can be interpreted mainly by the increase of arable lands and secondly by the development of the settlement. As the flora and fauna of a grassland is always more diverse than an agricultural parcel with a monoculture it is not difficult to understand that this alteration was seriously

harmful for the natural environment. The judgement of vineyards and gardens is ambiguous from a nature conservation point of view. Namely on one hand these are areas with strong human influence where the original ecosystem was significantly altered but on the other hand these areas are still more natural than the built in areas. According to the map data the vineyards and gardens became the parts of the city what is more disadvantageous from a nature conservation view than the mere exist of these areas. The changes in the size of the forested areas are also contradicted as for the first sight the growth of the forested areas is noticeable. Although if take a closer look to Fig. 1 we can remark that the previously continuous forest became disjoint. What is also a problem in a nature conservation view that forests with natural or near- natural conditions are hard to be found (Dömsödi, 2006). In case we examine the wood stock by tree species we can conclude that the extent of natural forests is insensible considering the total size of the examination area. According to Szemerédy (2002) the native Pedunculate oak (*Quercus robur* L.) is only some 14 % of the total wood stock while more than the half it is composed of Robinia (*Robinia pseudoacacia* L.) (Tab. 3) because after Robinia appeared in the middle of the XIX. century (Wellmann, 1961) it occupied the place of the former woods, mainly of oak forests.

Table 3

Proportion of tree species in the Erdőspuszták of Debrecen (Szemerédy, 2002)

English name	Scientific name	Area (ha)	Proportion (%)
Robinia (Black locust)	<i>Robinia pseudoacacia</i> L.	4221	57
Scots pine & European black pine	<i>Pinus sylvestris</i> L. & <i>Pinus nigra</i> Arnold	1297	18
Pedunculate oak	<i>Quercus robur</i> L.	1018	14
Hybrid poplar	<i>Populus spp.</i>	625	8
Native poplar	<i>Populus spp.</i>	130	2
Other	-	107	1

Albeit from a land use view the planted forests of the Erdőspuszták with trees to equal distance to each other and without shrub and herbaceous levels are also belong to the forest cultivation branch it is evident that for nature conservation only the previous woods can be regarded as real forests (Szmorad et al., 2003). In case changes will not happen soon in the management approach of forestry in the region, the remained near-natural forests could become endangered or even can disappear definitively.

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