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THESIS OF PhD DISSERTATION

Environmental historical research of floodplain management demonstrated through two sampling sites on the Great Plain of Hungary

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I. INTRODUCTION

Floods, inland waters and droughts mean the greatest environmental problems among natural disasters today in Hungary. These threats to agriculture are separated only in time (Várallyay, 2006). The area of the Great Hungarian Plain is especially suffering from both abundance and lack of water.

Water is becoming an increasingly valuable resource, therefore its more efficient utilization is essential. Solutions based on interventions that work in harmonization with natural processes of the watercourses and not against them would be much cheaper and more durable. Although reconnection of a river with its floodplain and sustainable management of the floodplains seem to be limiting factors for human activities, it establishes the basis of a more fruitful coexistence. Still, revitalization of floodplains is not realizable without becoming acquainted with their antecedent state.

OBJECTIVES

Main objectives of the research described in my doctoral dissertation were as follows:

- Reviewing the literature of floodplain management, identification of the so-called 'fok' formations (known as crevasse splays in earth sciences) in the alluvial environment.
- Representation of floodplain management on two selected sample sites through the approach of environmental history. Sites are located on the protected sides of the Tisza River and of the Hortobágy-Berettyó main channel.
- Introducing the history of the studied floodplains in the longest possible period of time by comparing written sources and maps of the areas.
- Tracing changes and human impacts in the depositional environment through sedimentological analyses of former riverbeds identified in the written sources and maps.
- Detailed description of the sampling areas' surface. Even a half-meter elevation difference can cause significant divergences on these lowland landscapes.
- Representation of interventions which are applicable in a long term to dealing with the main threats even on areas that are flood-controlled but are not relieved of the effects of water. As regards to the fact that during extreme floods the filling up of reservoirs

being constructed in the project named Improvement of the Vásárhelyi Plan (Vásárhelyi-terv továbbfejlesztése, VTT) is still not in harmony with the natural processes of the river.

II. LITERARY ANTECEDENTS

Ethnographic exploration of the Sárköz region by Bertalan Andrásfalvy was the first research on floodplain management (Andrásfalvy, 1970, 1973, 1975). It was him to publish the highly controversial issue of the so-called 'fok' management (in Hungarian), or floodplain management, as defined later broadly. Hypothesis range from the human-constructed and consciously used 'fok' to naturally formed riverbeds causing damaging floods (Molnár, 1991-1994, Deák, 2000, 2001). The middle course approach is represented by Károlyi and Nemes (1975), i.e. 'fok' was of natural origin, while also advantageous regarding utilization of floodplains.

Designation and names of these formations on the maps are not uniform (Fodor, 2001). I could identify them as the channels running from the river to the floodplain (known as crevasse splays in the earth sciences) and the attached network of watercourses. During floods, water flows out through the breaches from the main channel, down the small alluvial fan on the natural levee, and reaches deeper parts of the floodplain via the network of short channels incised into the fan.

According to my opinion, most of the beds defined as 'fok' were developed naturally, but this term includes both conscious usage and nature-like but human-made versions.

III. RESEARCH METHODS

Methods and sources of historical geography (Frisnyák, 1990) and historical ecology (Sümegi, 2003) were applied for the studies of floodplain management and former environmental conditions.

One of the two sampling sites was designated in the surroundings of Szeged-Tápé, near the conjunction of Tisza and Maros rivers, while the other in the fields of Ecsegfalva village, along the Hortobágy-Berettyó main channel.

Written sources and manuscript maps from both sites were collected and examined.

Raster digital elevation models of the sites were created and then applied in geomorphologic examinations as well as in the preparation of the reconstruction models.

Sedimentological analyses were carried out on several riverbeds having been part of floodplain management.

IV. RESULTS: SAMPLING SITE OF TÁPÉ

The first written reference of the surroundings of Tápé village originates from 1138. The first mentioning of the name Vár Pond that had also been included into detailed researches is dated by 1247. From the beginning of the 18th century besides its former name the term Holt-Tisza has also been used in parallel (Inczefi, 1971).

Based on the maps drawn in the 18-19th centuries it is doubtless that Vár Pond was a determining element of the landscape around Tápé until the beginning of the river regulations. However it is also unquestionable that because it did not have a strict basin, its size altered significantly during wet and dry periods, occasionally it could dry out completely.

On the basis of the cadastral proceedings of 1776 the floodplain was divided on the created elevation model as follows: bottom floodplain under 77 metres, low floodplain between 77 and 78.5 metres, high floodplain between 78.5 and 79.8 metres, flood-free terrains above 79.8 metres. While 56.67 percent of the total area lies between the level lines of 77 and 79 metres, only 12.94 percent can be found above 80 metres. On the lower terrains a half-meter difference in elevation means one and a half – two thousand hectares territorial difference. Therefore prior to the regulations, on the one hand even a small flood wave threatened or inundated large areas; on the other hand it was the vast spread of water that assured flood-free position of higher terrains.

Sedimentological analyses were carried out on samples originating from the riverbeds of Holt-Tisza and Csíkos Creek, the territory of Vár Pond and also from the verge of the flood-free terrain of Lebő Hill (Lebő-halom).

On the basis of the results the following conclusions could be drawn:

- In its active period the riverbed of Holt-Tisza was suitable for carrying off not only its own water but also the inflowing floods in its complete width. Although because of gradual silting-up its size decreased, annual floods on the major part of the riverbed vanished only after river regulations.
- Until embankment the riverbed of the Csíkos Creek was similar to that of the Holt-Tisza. Profile of this sampling point, lying one and a half meter higher on the low floodplain could also get underwater but in flood-free periods it was mostly dry. Calcareous alluvial soils consisting of two layers were formed here.

- On the southern part of Vár Pond sedimentary processes were also present. After the termination of its riverbed-function, shallow lake- or marshy characteristics evolved gradually. Following regulations significant influence of ground water resulted in soil-forming processes typical of meadow soils to become determinant (**Figure 1**).
- Owing to the permanent establishments, on the Pleistocene surface of Lebő-halom – covered with sand and some intercalated loess – a remarkable so-called tell settlement developed. From soil formation that started after abandonment low-humic chernozem soil was formed, being under agricultural cultivation up to now. The profile prepared on the verge of the flood-free terrain is located three metres higher and differs completely from the above described riverbeds in its structure.

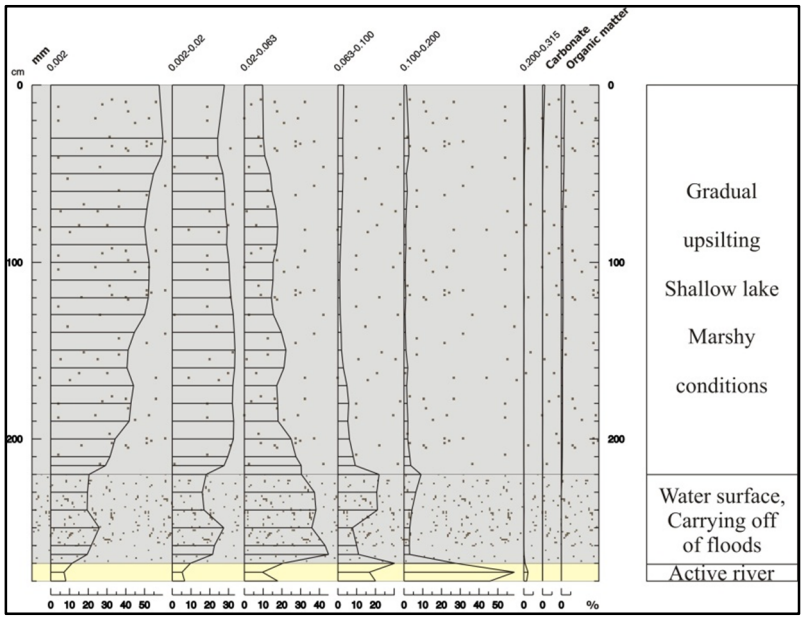

Figure 1: Sedimentological results of VT I. profile (figure of the author)

V. RESULTS: SAMPLING SITE OF ECSEGFALVA

Fishing activity connected to the Berettyó River has already been mentioned in a written document of 1261, while the first record of the fish ponds around Ecsegfalva is dated back to 1326. The charters of Ecsegfalva from 1466 and 1754 are extremely rich in place names (Benedek, 2000, 2004). Besides detailed description of the surrounding fields and fish ponds these sources also contain several references to land management in the area.

The document of 1754 represents an important link between earlier charts and the manuscript maps having been published some years later. Among ponds identified both in the

written sources and on the maps the Ecseg Pond and Kiri Pond were permanently water-filled, while Besenyő Pond and Kerek Pond did not possess a significant open water surface, but they were covered with reed and bulrush, and occasionally they also dried out.

On the elevation model the floodplain was divided according to the maps of 1809 and 1830 into the following categories: bottom floodplain under 83.6 metres, low floodplain between 83.6 and 84.5 metres, high floodplain between 84.5 and 85.3 metres, while flood-free terrain above 85.3 metres. 78.2 percent of the total area lies between the level lines of 83.5 and 85.5 metres. Here a half-meter difference in elevation means three-five hectares territorial difference. Similarly to the fields of Tápé, a small flood wave could threaten or inundate large areas. Vast spread of water also assured flood-free state of higher terrains. Lowest located terrains formed part of a long and meandering, connected bed system that was linked to the channel of Berettyó at several points.

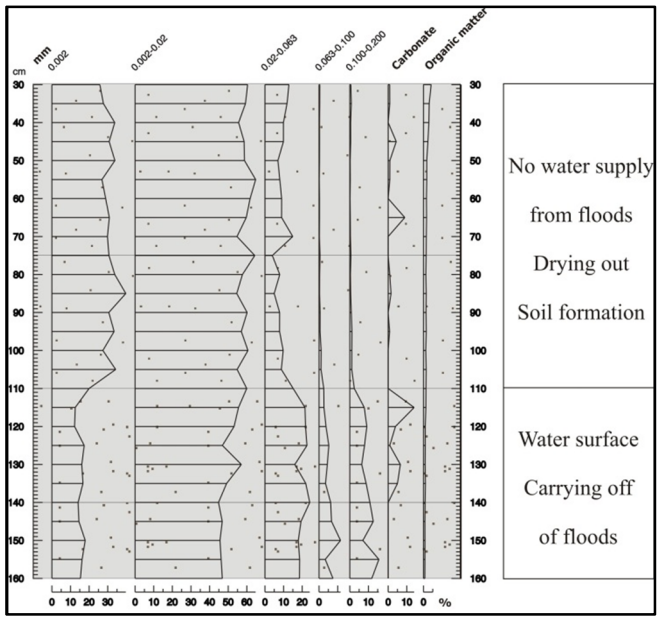

Figure 2: Sedimentological results of ET I. profile (figure of the author)

Sedimentological analyses were conducted on the samples taken from the bed of Ecseg Pond (**Figure 2**). Based on the results the following can be concluded:

- Long expanding bed of Ecseg Pond, similar to creeks around Tápé played a key role in carrying off excess water till embankment.
- After considerable floods environment with stagnant water evolved in its bed.
- Sediment from the pond shore was washed off into its bed and because of the lack of repeated floods it accumulated there.

- Besides meadow characteristics, effects of salinification were also detectable in the soil formation processes.

VI. RECOMMENDATIONS

Based on geomorphologic, sedimentologic and landscape-historical results plans were worked out on the reconstruction of floodplains. Considering recent conditions, these plans might be worth realizing.

Because of industrial activity reconstruction of the former creek network is suggested instead of complete inundation of the bottom floodplain in the Tisza-Maros angle. With reconnection of the former riverbeds a unified small yazoo watercourse running parallel with Tisza could be created that could also form part of a green channel network. Other low-lying terrains would be available for species with high water demand and water tolerant species or for grassland management.

class intervals (m)	extent of area (ha)	storage capacity (m^3)
82,5-83	137	683875
83-83,5	1951	9753525
83,5-84	3136	15677513
84-84,5	4489	22445763
84,5-85	5265	26326863
total	21146	74887538

Table 1: Minimal water storage capacities

In the surroundings of Ecsegfalva a more extensive inundation (**Table 1**) would be a feasible solution in the case of the channels running near the protected areas of the Körös-Maros National Park. Former riverbeds on the left side of Hortobágy-Berettyó main channel run deeper than the surrounding area and create part of a unified water network. Within this area even low floodplain inundation would be realizable without endangering inhabited land. A unique buffer zone could develop between fragmented sites of the National Park along channels spreading mostly on unprotected area.

THESIS POINTS HIGHLIGHTING THE MOST IMPORTANT RESULTS

1. Special hydrological object of floodplain management, the so-called ’fok’ was identified as crevasse splays and the attached network of watercourses as known from earth sciences. Natural origin of these objects was proved but their conscious utilization was not excluded.
2. On the basis of written sources and maps the elevation model of the two sampling sites in the surroundings of Szeged-Tápé and Ecsegfalva was created and the floodplain (in the state preceding the river regulations) was divided. Altitude values and extension of bottom, low and high floodplains, as well as of flood-free terrains were determined.
3. Through the comparative analysis of written sources and maps the 700 year long history of the Vár Pond near Szeged-Tápé and of the Ecseg Pond in the surroundings of Ecsegfalva was presented. Variance was detected in the names of the hydrologic objects regarding the two sites. While in the neighbourhood of Ecsegfalva medieval names are still in use, place names around Tápé are mostly younger than 200-300 years.
4. Relying on sedimentological analyses beds and their surroundings known from the written sources of both sites were proved to have been available for floodplain management until embanking. Based on the changes in the depositional environment no unambiguous sign was found indicating artificial cleaning of riverbeds.
5. In the surroundings of Szeged-Tápé reconstruction of the former creek network is suggested, while other low-lying terrains would be available for planting of species with high water demand and water tolerant species or for grassland management.
6. In the area of Ecsegfalva between the protected sites of the Körös-Maros National Park regular inundation of bottom and low floodplains is proposed with the restoration of floodplain management.
7. Based on the results of the dissertation on the contrary to the application of emergency flood water reservoirs laid down in the Improvement of the Vásárhelyi Plan (Vásárhelyi-terv továbbfejlesztése, VTT) annual bottom floodplain inundation is suggested on the protected sides of floodplains in Hungary.

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