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Landscapes assessment and reclamation principles
of the oxbow-lakes in the Lower-Tisza-valley

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**The applicant met the requirement of the PhD regulations of the
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Background

Oxbow-lakes belong to semi-natural wetlands, which are rare in Europe as well. Oxbow-lakes can be found along Tisza's active floodplain and in the saved pages; these are at different ages and their sludge-filled conditions are also different. Social and economic impacts have affected oxbow-lakes to varying degrees, therefore their natural conservation values and conditions are either different or heterogeneous. However, oxbow-lakes are not only valuable for nature conservation purposes, but also from the point of view of land use and water management. The role of the oxbow-lakes are outstanding in case of recreation and impoundment. Oxbow-lakes offer opportunity for multiple purposes and usually an oxbow-lake can be used for complex and variable aims. On the other hand, different uses of land and water can cause lots of problems and conflicts. Beside these, due to sludge-charging, gradual aging, contamination and harmful effects of chemical materials, oxbow-lakes are increasingly intensified and accelerated. Solutions of these various problems and also problems concerning land use need coordinated land-analysis and rehabilitation planning. Oxbow-lakes are considered wetlands in Hungary; from the perspective of landscape architecture and land use, a comprehensive analysis has not been made yet. An approach which deals with landscape architecture and land use-analysis give a base for rehabilitation plans and interventions. The reconstruction of oxbow-lakes are important not just from the point of view of nature conservation, but also from the perspective of water, environmental protection, and landscape-aesthetics.

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Head of Ph.D. School

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Supervisors

Objectives

I summarize the *objectives of my research* in four points:

- to define the characteristics of oxbow-lakes' landscape architecture, and also to define the characteristics of land use;
- to explore the factors that threat oxbow- lakes and the problems and conflicts of land use;
- to define the types and characteristics of oxbow-lakes;
- to define the principles of the restoration and landscape rehabilitation of oxbow-lakes.

To define the tasks in connection with goals:

- terminology, oxbow-lakes' characteristics (water bodies, oxbow-lakes' bank characteristics);
- to review the national and international literature, to analyze the principles and methods of oxbow-lake analysis;
- to overview the implemented rehabilitation interventions;
- the history of landscape development of the research area;
- field visits and exploration of current conditions;
- to define the elements, methods and reclamation principles of landscape analysis.

Material and Method

The research area is the Lower-Tisza-Valley, which situated from Csongrád to the Southern border of Tisza, the 94.2 kilometers long area of Tisza (between 159.6-253.8 river kilometers). In the Lower-Tisza-Valley there are ten oxbow-lakes: Serházzugi- oxbow, Dögfenék, Labodár, Osztorai- oxbow, Mártélyi- oxbow, Körtvélyesi- oxbow, Atkai- oxbow, Sasér, Nagyfai- oxbow, Gyálai- oxbow.

Sasér is the continuation of the Atkai-oxbow in its active floodplain, but due to its natural conservation importance and location, Sasér is – also in the water-management – a self-managed water area.

The active floodplain area of the Lower-Tisza-Valley is very narrow, which at some spots gets wider. The widest area is the area of Körtvélyesi- oxbow, where it reaches 3-4 km, but there can also be so narrow areas, where the distance between the dyke and the river is below 100 meters. The first step in the oxbow-lakes' land-analysis is to designate the research area.

In the Lower-Tisza-Valley ten oxbow-lakes can be found, which were created during the Tisza's river control, between 1855 and 1892. Today these ten oxbow-lakes are in different conditions, also there are significant differences in their sizes and usages. The analysis of the oxbow-lakes in the Lower-Tisza-Valley give a comprehensive overview of oxbow-lakes' landscape conservation and landscape rehabilitation tasks.

In my research - as a landscape-architect - I analysed the topic from the perspective of land use, landscape-ecology and landscape characters. I supported my arguments through the application of the example of Körtvélyesi-oxbow. The basic method of landscape architecture analysis is field visits.

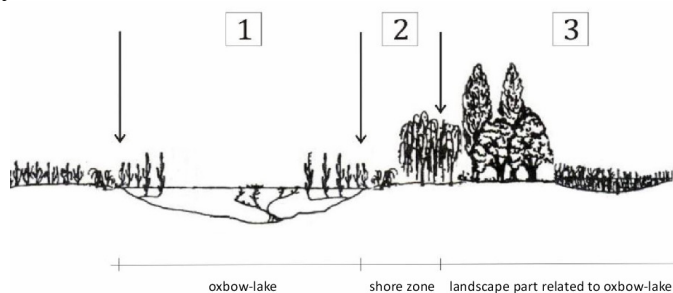
The field visits were preceded by the exploration of the research works, reading literature and investigating the practical background, during that I worked on and studied professional books, scientific articles and studies. For my dissertation I used the hydrobiological, water and landscape literature, as well as the updated laws and plan history. I reviewed the current landscape rehabilitation principles, practices, and the antecedents of design and methodology of oxbow-lakes. From the Hungarian publications I primarily had a look at the researches of PÁLFAI, DÉVAI, ARADI, FEKETE, LÁSZLÓ. For being able to determine the definitions and principles of the practical side of landscape architecture, I used works by CSEMEZ and CSIMA. In connection with surface water researches, I used works by BOROMISZA and BÁTHORYNÉ NAGY.

Results

(1.) The definition of the oxbow-lakes and their related landscape parts from the point of view of landscape architecture

As part of my research I summarized the terminology associated with oxbow-lakes, which are well applicable in the landscape architectural practice. I named the artificially generated cut-offs oxbow-lakes in my research. The oxbow-lake - in my understanding – is the bed section of a former river, that is not or only intermittently is in connection or mingled with the river. I named backwaters (morotva) those water areas where naturally overdeveloped curves were separated, that the silt completely or partially separates from the river. Before the elaboration of the landscape assessments and reclamation principles for the validation of the landscape architecture aspects, I determined the methods of the the oxbow-lakes' spatial borders, the landscape part that are related to oxbow-lakes, and the oxbow-lakes's structural units. The oxbow-lakes from the aspects of landscape assessment can be divided into three structural units:

- the water space (water body) of the oxbow-lake
- the shore zone of the oxbow-lake
- the landscape part related to oxbow-lake, condition of which is closely affected.



Schematic diagram of the oxbow-lakes' structural units

The water space of the oxbow-lake includes the oxbow bed and the mass of water. The bed is a natural depression, which includes the water of oxbow-lakes or these are established field units, the shoreline of which is regularly flooded upto a determined limit by the water. The shoreline is bordered by contact of the land and water surface. The shore zone that includes the land and waterfront landscape zone, it is separated by the oxbow-lake's water and the related landscape part (those related land use that can not be directly connected to the oxbow-lake's water body). In this interpretation the shore zone includes the bed's riparian zone habitats and the land habitats that are connected to separated border shorelines. The assessment of the connected landscape parts are primarily important in case of oxbow-lakes. The designation of the landscape parts that are connected to the oxbow-lakes depends on the size and the location of the oxbow-lakes. In this landscape part, those land uses appear which have direct impact on and influence the oxbow-lake's state to the greatest extent. Due to the oxbow-lakes' formation (horseshoe shape) it often closes around an area, these inland areas – called the island or buzzing – I examined these landscape parts as related parts of the oxbow-lakes. During the landscape assessment and reclamation intervention, the oxbow-lake and the related landscape parts have to be interpreted, examined, and treated together with landscape parts that involve oxbow-lakes. In case of the active floodplain, the river valley also has to be considered. The landscape part which includes the collection of the three structural units, and habitats mean the oxbow-lakes' landscape ecological unit, which have to be treated and interpreted altogether during the landscape assessment and reclamation.

(2.) The summary of the oxbow-lakes' natural and social landscape factors in the Lower-Tisza-valley

As a basis to the detailed characterization of the oxbow-lakes, I summarized the oxbow-lakes' natural and social landscape factors in the Lower-Tisza-valley. The Tisza-valley, the floodplain and the active floodplain's facilities have an impact on the oxbow-lakes – these influence the oxbow-lake's current and potential use. The most important *natural landscape factor* is water, which formed the landscape and the habitats. Currently in the active floodplain water movements, inundation in the saved side water supply are those factors that are the most underlying. Other important natural factors are relief (floodplain landforms, geomorphological conditions) and the vegetation coverage. For the description and analysis of the current status of oxbow lakes in the reserach area, I found the knowledge of the area of landscape-history and the study of anthropogenic impacts on oxbow-lakes important. For understanding the phenomena of the landscape part, I determined that the earlier interventions affected the current status of the oxbow-lakes, and also the social landscape factors. I separated three periods in landscape-history: period before river control; period of the river-control - the oxbow-lakes' development – and the period of the the XX. century's landscape factors. In the first period, before river control flooding were significant, which influenced decisively the use of former landscapes. The second period begins with the control of the Tisza, when significant changes have occurred. The third period is the time after World War II, when the collectivization of agriculture was completed, and the areas were largely owned by co-operatives. At this time the social landscape factors (eg. the floodplain forest plantations, the Tisza's small water control, inland drainage, the distribution of the coastal area, built-up growth) had a significant impact on the development of the oxbow-lakes' current state.

(3.) The detailed assessment elements of the oxbow-lakes in the Lower-Tisza-valley

Through field visits and background research I determined the characteristics of the oxbow-lakes in the Lower-Tisza-valley, and the oxbow-lakes' detailed *assessment elements from the point of view of landscape architecture*. The detailed assessment elements aimed primarily at the oxbow-lakes' land uses and the landscape's ecological characteristics. Among the oxbow-lakes' characteristics I examined the oxbow-lake's bed, the water body, the shore zone's characteristics and the related landscape part's landscape uses. The detailed assessment elements include: the bed morphology; the oxbow-bed's sedimentation and filling up; the volume of water; the water cycle; water balance; water level control; the operation schedules; the bed and shore fortifications; the direct water use of the oxbow-lakes; the water quality; the vegetation coverage of the surface; the successional stage of the oxbow-lakes; structures in waterside and the directions to the oxbow-lakes. During the characterization of the oxbow-lakes' shore zone, I separated four shore zone types:

- Wide, semi-natural vegetation shore zone,
- Narrow, semi-natural vegetation shore zone,
- Narrow, disturbed shore zone,
- Modified, degraded or lost shore zone

In overall I can say about the oxbow-lake's shore zone that the low rate of the natural coastal areas is typical, and on the saved page transformed and narrow habitats can be found. The shore zones which are covered with semi-natural vegetation are typical in the active floodplain area of oxbow-lakes. Beside the exploration of the oxbow-lakes' certain characteristics, there was an important aspect of the characteristics of the oxbow-lakes from the point of view of landscape architecture and from the review of water and landscape

uses. Due to the favorable conditions of oxbow-lakes, their many-sided landscape uses, as well as water surface and also the coastal area has a high landscape potential. The spatial order and size of different land use affect the landscape structure of the active floodplain and saved page. From the landscape structure's view, the dominant land uses, the size and mosaic pattern of the semi-natural and the cultivated landscape parts; the appearing borders, and the meeting of the separate land uses are determining.



Land uses along the oxbow-lakes.

(4.) The threats, the land use conflicts and problems of the oxbow-lakes in the Lower-Tisza-valley

During the usage of oxbow-lakes both in active floodplain and saved page, we can encounter with significant loads, land use conflicts and problems. I built the exploration of the threats that influence the oxbow-lakes' state, the environmental loads, the land use, and the natural conservation problems into my research. During my research I tried to explore the relationship and connection between the oxbow-lake's state and the land use.

In the saved page oxbow-lakes the following things cause conflict: the modified surrounding areas, lack of buffer-areas; the loss of natural habitats; the pollution resulting from various use, load uses and the inadequate water supply. *In the case of the active floodplain oxbow-lakes* the following things cause conflict: the accelerated siltation due to the deposition of flood sediment; occurrent failure of the inundation; the invasive plants' conquest of place; the habitats' degradations.

(5.) Types and characteristics of the oxbow-lakes in Lower-Tisza-valley – standardization from the perspective of the oxbow-lakes' landscape architecture

As a summary of the assessment results, I separated certain types of the oxbow-lakes, and I also determined their characteristics. The research in this area points out that the water usage of oxbow-lakes, which were formed at about the same time and the landscape uses of the related landscape parts may be significantly different and complex. The oxbow-lakes of the Lower-Tisza-valley were formed at around the same time, however their landscape transformation and their current states are significantly different from their formation. I made the standardization on the basis of the land uses and the utilization of oxbow-lakes, because I found that these are the factors

that influence the oxbow-lakes' current states and the opportunities of reclamation the most. The landscape uses along with the oxbow-lakes influence the oxbow-lakes' water uses and the water quality too. The landscape uses of landscape parts which are related to oxbow-lakes are often independent from the water surface, but these affect it, and benefits from its favorable conditions. Due to favorable facilities, such as landscape diversity, varied land uses, and different landscape structures are the characteristics of oxbow-lake.

The location of oxbow-lakes is crucial in determining the utilization of the oxbow-lakes. Besides the position in relation to the dyke, the former landscape activities, their proximity to the settlements and conservation of nature (strictly protected) determine the landscape uses of the surrounding area's oxbow-lakes. During the process of my assessment, the landscape uses, which appeared in the environment of oxbow-lakes, provided the basis of standardization – in comparison with landscape transformation. I determined five types, and I summarized their main characteristics and problems. The five types are:

- Saved page oxbow-lakes in complex, intensively used landscape part;
- Saved page oxbow-lakes in simple, intensively used landscape part;
- Active floodplain oxbow-lakes in complex, extensively used landscape part;
- Active floodplain oxbow-lakes in simple, extensively used landscape part;
- Active floodplain oxbow-lakes in which is solely used in natural conservation landscape part.

I found that the saved page oxbow-lakes, which lie near to the settlements are the most modified ones, and these are in the worst

condition. The causes of these bad condition are the intensively used landscape areas, the proximity of the built up areas, the complex and ignoring uses of oxbow-lakes.

(6.) The reclamation principles of the oxbow-lakes and the related landscapes parts

Due to the different landscape uses, variable problems can arise, which require different reclamational tasks. Based on literature, test results and reclamational practices of oxbow-lakes, and also based on national and international case studies, I determined the oxbow-lakes' objectives, tasks and aspects from the perspective of reclamation of landscape architecture.

Corresponding to the landscape reclamation terminology, I divided the rehabilitation into technical and biological reclamation tasks. The landscape reclamation may include the floodplain ecosystems and the interconnection of the saved page's wetlands, for these reasons I determined the flooding principles of the former wetlands. Through landscape stability the primary tasks in case of the active floodplain oxbow-lakes are the water retention and to maintain water conditions. The reclamation should be directed to maintain water quality and quantity at an optimal level.

For the sake of maintaining the water body, the water supply of oxbow-lakes and planning the water exchange opportunities may be necessary. The reclamation of detailed tasks – on their own can not be considered as oxbow-lake's reclamation – are: the treatment and elimination of the oxbow-lakes suffering pollution; the stop of the accelerated, harmful, successional fill up processes; the elimination of damages. Through the oxbow-lakes' restoration, the main task of the landscape's reclamation – besides maintaining the water quality and quantity at an optimal level – finding the optimal landscape uses and preserving the stability of the landscape are the most important tasks, which are characteristic in case of saved page and active

floodplain, but due to different landscape structure it requires different tasks. In order to find the optimal landscape diversity, I determined the principles of landscape use in connection with oxbow-lakes types, in which the target tasks are: the preservation of the landscape potential; the protection of the many-sided land uses, which are connected to the oxbow-lakes; the regulation of the landscape uses along the oxbow-lakes; finding and planning the optimal use water and the land corresponding to the facility and the current state; arrangement of the related landscape parts; the protection of the valuable natural habitats and communities; the conservation of biodiversity and opportunities of its restoration; the protection of landscape values; the restoration and protection of the natural and visual landscape factors.

(7.) The application of the assessment and reclamation methods – The tasks of the Körtvélyes-oxbow's reclamation

The aims of making a case study were: the application of the assessment elements and methods revealed in the research; the detailed examination of the landscape history, landscape utilizational and habitats in the study area; detailed drafting of the tasks of landscape reclamation to a sample area. The Körtvélyes-oxbow's uniqueness is due to the horseshoe-shaped surroundings around Körtvélyes- island's remaining natural floodplain habitats. I revealed with the developed examining methods the Körtvélyes-island's characteristics, its threats, and with proposals I defined the possibilities of the potential reclamation. With the examination of the sample area, I supported the practical application of the investigational and reclamational methods.

In recent years the oxbow-lake had the following problems: sludge discharges, water space decrease, the reason are the inadequate water conditions (loss of flooding, evaporation, leak-losses), pointwise and

diffuse contamination sources in the water collecting area. In the Körtvélyes-inland the failure and desiccation, as well as the conquest of invasive plant species could have been seen in the floodplains for years. The condition of the oxbow-lake improved after the sludge-dredging, but the issues of water supply and water quality still remain and the Körtvélyes-inland's main problem is dominance of the invasive plant species. Thanks to natural conservation maintenance certain habitat patches are improving, but overall the giving up of traditional land use cause deterioration of the area's state. In the reclamation got key role the former water system, the water governance and the former land uses.

Outlook

The results of the research can also be utilized for landscape architectural practices. The results can be incorporated into: the regional and municipal planning and regulation, the conservation and management, the ecological network planning, in the landscape architecture education. The landscape reclamation interventions can appear as the conceptual, strategic and programmatic recommendations or as landscaping, environmental-forming, and maintenance suggestions.

The preferred means of the oxbow-lakes' preservation, restoration, and improvement are the regulatory, planning and action systems, which appear at various levels. The reclamation of the oxbow-lakes at the urban or regional levels can appear in the environmental programs of settlements, in settlement plans, in developmental concepts, in the programs of natural conservation maintenance. Landscapes assessment and reclamation principles and methods of the oxbow-lakes can help the description of the regional or urban spatial planning, the discipline-specific parts of work; in exploring the facilities; the description of the landscapes assessment elements. The reclamation principles should be enforced in the regional or urban spatial planning during the implementing.

The oxbow-lakes' protection can appear as a priority in the plans, the reclamation includes the building codes; the regulation of the uses; the operation schedules; the restrictions; the denotation of the buffer area and the regulation of its usage. The oxbow-lakes and the related landscape parts appear as recreational potential in the developmental plans; on the other hand the case of the semi-natural area appear as part of conservational, educational and presentational plans. In case of the protected oxbow-lakes the regulations, maintenance, management tasks for the oxbow-lakes's protection and survival can appear in the natural maintenance plans, for which the research principles serve as a basis.

The oxbow-lakes' reclamation - depending on the degree of interference – have a direct and indirect impact on the oxbow-lakes' landscape system. In the research area the assessment methods of the applied landscapes and their potential application part is the environmental impact assessment, which is related to the oxbow-lakes.

The reclamation principles can be applied in planning the description of the tasks related to Water Framework Directive directives, Vásárhelyi-Further Development Plan, Danube Region Strategy, National Rural Development Strategy; EU agriculture and rural developmental assistance or strategical programs.

Possibilities of the persistent research include: the methods and principles applied for other oxbow-lakes in other areas, or the analysis, and rehabilitation of similar conditions of water.

The author's publications joining with the dissertaion's topic

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