

**ZSOMBOR BOROMISZA:**  
**LAKESHORES' ASSESSMENT PRINCIPLES AND METHODS**  
**FROM LANDSCAPE ARCHITECTURAL VIEWPOINT BY THE**  
**EXAMPLE OF LAKE VELENCE**

**PhD Thesis**



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## ANTECEDENTS, OBJECTIVES

The medium-size and large lakes perform numerous functions, which are determinant from landscape-ecological and land use aspects. The increased use of lakes resulted in disadvantageous change of their environmental condition at several places all over the world. Proper management of lakes is often hindered by the missing information and knowledge of their status, especially as for their most sensitive part, i.e. lakeshores. As lakeshores are determinant for the whole lake's condition, they are worth getting special attention during the landscape-developing, -protecting, and – restoration activities. The increased social demands and the ecological-environmental pressures make present subject topical. Though several national programs, plans set targets and tasks concerning lakeshores, up till now a proper method has not been elaborated to assess and evaluate them with complex approach considering landscape-ecological and land-use aspects, alike.

My research was focused on **landscape assessment and evaluation methods of lakeshores** including **medium-size** (0,5 km<sup>2</sup> – 100 km<sup>2</sup>) and **large lakes** (100 km<sup>2</sup> <) having various land-use forms and **primary recreational utilisation**.

The research had the following **goals**:

- to define general landscape features of lakeshores (functions, affecting factors),
- to define landscape architectural principles and methods of lakeshore assessment,
- to make assessment and evaluation for the shore of Lake Velence that serve as basis for landscape restoration, building-codes and maintenance.

To achieve the above targets the following **tasks** were performed:

- to review and evaluate the professional literature about the international and Hungarian assessment principles and evaluation methods,

- to define lakeshore structure,
- to systematize lakeshore features, functions and affecting factors,
- to review and evaluate the lakeshore's landscape-development processes and the present status in the study-area of Lake Velence,
- to elaborate assessment and evaluation method for Lake Velence, applying landscape architectural principles,
- to make assessment and evaluation at the shore of Lake Velence by on-site survey and available database.

For this dissertation the topic related literature of geography, hydrobiology, hydrotechny, landscaping, the effective legal rules and plan documentations were applied. To elaborate the shore-features, -functions, out of the Hungarian publications, it was the hydro biological researches of DÉVAI, FELFÖLDY, LAKATOS, SEBESTYÉN and TÓTH besides those on geo-morphology of PÉCSI that formed the basis. While making review of the landscape protection shore-functions, in the international literature the publications of OSTENDORP, and STRAYER and FINDLAY were relied on. Regarding shore-fortification affecting factors, the comprehensive publications of ENGEL and PEDERSON, KEDDY and FRASER, OSTENDORP and SCHMIEDER were made use of, in addition to considering the theoretical works of Hungarian lake regulation (LIGETI, SZAPPANOS, ZORKÓCZY). To define the lakeshore assessment principles and terms, required for landscape architectural practice, the works of CSEMEZ, CSIMA and LAPOSA were made use of.

Out of the lakeshore assessment methods, those of MCPHERSON and HLUSHAK, OSTENDORP, PERLEBERG, ROWAN and SILIGARDI and the "SURVEY OF THE NATION'S LAKES" elaborated in the USA are well applicable for Hungarian landscape architectural practice. To survey the shore- and lakebed-regulation activities at Lake Velence the works of KARÁSZI and PAPP supplied many data. While evaluating landscape-development, the studies and publications of BENDEFY, CSIMA, KÁROLYI, POMOGYI, SZILÁGYI and TOMBÁCZ were relied on. The most significant studies and plans were made in VÁTI, VITUKI, VIZITERV, at Water

Management Department of Budapest University of Technology and Economics, and at the Central-Danubian Water Authority.

## **MATERIALS AND METHOD**

Elaboration of lakeshore assessment principles was based on review and critical analysis of the international and Hungarian literature about lakeshore assessment. As the dissertation's subject is primarily the determination of assessment principles and method of lakeshores, thus, the subject of the assessment is generally the lakeshore and – as a definite example – the shore of Lake Velence. This involves determination of lakeshore structure, as well as summary and systematization of lakeshores' features, functions and affecting factors. The assessment, evaluation and on-site surveys made for the shore of Lake Velence serve to test, verify, confirm and demonstrate the assessment principles and methods elaborated for medium-size and large lakes.

The landscape-natural features of Lake Velence (regarding Velence-basin and the settlements around the lake) are mainly revealed by literature-review, archived plans, oral communications and on-site surveys. By doing so I made use of my own lake related on-site survey findings as well as the earlier study plans of Corvinus University of Budapest, Department of Landscape Protection and Reclamation. To evaluate the lakeshore's landscape-development it was necessary to make literature review for the period concerned, in addition to analysing historical maps and plans concerning lake regulation. The assessment of the lakeshore's present condition – in compliance with the elaborated method – was primarily based on field-survey and ortophoto analysis (351 pcs 100 x 100 m assessment plots, 17 assessment viewpoints, limited spatial borders). The results were demonstrated in thematic maps, tables, photo annex and theoretical cross-sections, by MS Excel 2002 and Corel Draw 12 softwares.

## RESULTS

The principles and method stipulated for assessment and evaluation of lakeshores were “tailor-made” applied for Lake Velence, same being also the independent result of the research. After having outlined the assessment- and evaluation-methodology the results regarding analysis of the lakeshore’s landscape-change and those concerning the lakeshore’s detailed assessment and evaluation were dealt with.

1. A Hungarian terminology, being well applicable in the landscape architectural practice, was elaborated and the **units of lakeshore structure were determined**. The term of lakeshore is used for the zone including both sides of the lakes’ shoreline, determined by lakeshore features, being characterized by special lakeshore functions. The zone from the shoreline towards the land is the riparian zone and that towards the water is the littoral zone, the zone between the lines of high and low water is that of the shoreline. Some land use forms do need water-surface near by, for these activities the term of lake-dependent land use is proposed. The natural features that determine the condition of lakeshores are summarized as natural landscape-ecological lakeshore features.

2. **The assessment-evaluation principles and method were defined for medium-size and large lakes with primary recreational utilisation from landscape architectural point of view.** In case of a significantly affected shore the interaction of water surface - land should be investigated in a wider zone for landscape planning. In most lakes settlement planning scale should be applied to start with, what requires a scale of at least 1:10000. Lakeshores should be divided into further units – zones, sections – in case of shores at significantly regulated, affected and intensively utilised lakes. The assessment viewpoints should aim mainly at revealing landscape-ecological lakeshore features, land use conditions and social lakeshore affecting factors. The evaluation has to define lakeshore-functions and – landscape-ecological conditions. As a result of lakeshore assessment and evaluation it is possible to define

lakeshore types. A shore-type is a characteristic of lakeshore units with varying extent, yet being homogenous in most features, besides serving as proper basis for further planning projects.

3. **The principles defined for lakeshore assessment, evaluation were applied for Lake Velence.** The assessed lakeshore is a landscape part of 50 m from the legal shoreline both towards the land (riparian zone) and towards the water-surface (littoral zone). For Lake Velence 17 assessment viewpoints were defined comprising landscape-ecological lakeshore features, land use and lakeshore affecting factors. Among the landscape-ecological lakeshore features the soil conditions of riparian zone, wave-exposure, riparian slope, shoreline development, littoral emergent vegetation, width of zone having emergent vegetation cover, riparian vegetation cover, naturalness of vegetation and vegetation zonation were surveyed. The assessment aspects of land use conditions and lakeshore affecting factors include land use, shore fortification, point source of water pollution, structures in littoral zone, linear landscape elements in riparian zone, extent of human existence, shoreline access and ownership relations in riparian zone.

4. **The history of landscape development of the shore at Lake Velence was processed from 19th century, the figures were evaluated both from landscape-ecological and land use approach.** It was found that the effects of changed near-natural lakeshore could be observed from the viewpoint of ecology, shore-morphology, environment protection, landscape aesthetics and land use. **On basis of the landscape-historical analysis the changes of the lakeshore’s landscape character was divided into 4 periods.** The first period from 1859 to 1880 had the greatest changes regarding the extension of near natural lakeshore and the extent of shoreline change. In the second period from 1880 to 1962 the water-level became more regulated and the extensive recreational land use began to develop. This was followed by the period from 1962 to 1992, when planned, large lake regulation and recreational developments were carried out. In the period between 1992

and 2011 the recreational utilisation, at the areas being involved already, became much more intensive and the quantity of accessible shore sections decreased, there are no large shore regulation interventions, the changes aim at reconstructing the earlier artificial shore-fortification.

5. It was found that – from quantity’s aspect – at the lakeshore **the lake-non-dependent, extensive land use forms were dominant**. The 22% proportion of the lake-dependent, intensive land use is an unexpected result, being advantageous from landscape-ecological viewpoint. Because of the land use, special landscape structure and maintenance activities a significant part of the lakeshore is affected by human being, occurrence of unaffected shore sections is rare. 55% of the assessment plots have limited access, and further 13% have none. Accordingly, **shoreline access can be considered to be a critical issue of recreational utilisation**. Even in the areas of near-natural lakeshore vegetation’s zonation, the proportions of the zones are not fully natural. The territorial proportion of near-natural vegetation is smaller, than it could be expected on basis of the volume of nature conservation areas at the lakeshore. It is connected with the water-level regulation first of all, caused by the filled up shore, besides, it draws the attention to the problems of use and management in the lakeshore’s area. Because of the strongly regulated water-level in a substantial part of the lakeshore the slope relations are mainly determined by the shore fortification structures, being typical for long shore sections.

6. **The shore of Lake Velence was evaluated from pressures’ aspect by means of five factors**. It has been found that 58% of the lakeshore are slightly pressured, 36% are highly pressured, 4% are pressured to critical extent, 2% are unpressured. The slight pressures, being characteristic for more than half of the lakeshore is due – in a part – to the land use attributes (extensive land use, higher human existence dominate in the seasons). Both the areas being pressured to critical extent and the non-pressured ones are present in small percentages. As for the plots being pressured to critical extent, it was outlined that these areas

were in many cases next to boat-harbours, where public roads are near the shoreline, also the point sources of pollution reach the lake here.

7. **The lakeshore was evaluated from the viewpoint of naturalness on basis of six factors**. 52% of the lakeshore are modified, 30% moderately modified, 16% heavily modified and 2% are near-natural. The high proportion of “modified” category is due to several lake regulation’s interventions and the impacts of recreational utilisation based thereon. The low proportion of “near-natural” areas is attributed to the small percentage of near-natural vegetation and to the high extent of built-up natural soils. Naturalness and pressures show unambiguous connections near boat-harbours and ship-docks, same being pressured to critical extent and also significantly modified. All near-natural areas are located in the settlement of Pákozd, whereas Velence has exclusively modified and heavily modified sections.

8. **Buffer-function of Lake Velence was evaluated through six factors**. 48% of the lakeshore have medium buffer-function, 34% have good buffer-capacity, 17% have poor buffer-function and 1% has excellent buffer-function. It was found that in many cases sections with worse buffer-capacity suffered higher pressures. The category of medium buffer-capacity is definitely characteristic for the lake regulation affected areas. Near boat-harbours the lakeshore is typically strongly modified and has poor buffer-function. The heavily modified or modified shore sections have medium, or poor buffer-function, at the same time the areas with good buffer-function are not necessarily near-natural. The low proportion of the plots with excellent buffer-capacity is attributed to the fact that the combination of clay fill-up, considered to have good buffer function, and high vegetation-cover is very rare. The evaluation was summed up for settlements, as well, and as a result, the shore-sections of Pákozd were found to have especially advantageous buffer-capacity.

9. **The shore-sections being potentially suitable to change shore-fortification were determined on basis of wave-exposure, land-use, shore-fortification and property relations.** It was found that the peninsula lying west of the rowing course in Sukoró and the shore-section in the western part of Velence's administrative district were suitable the best to restore shore-fortification. These parts are typically slightly pressured, the emergent vegetation refer to fill-up processes (smaller wave-exposure), they are extensively utilised, owned by the local government or by the state, having slope-rip rapping.

10. **On basis of land use and shore-fortification 16 lakeshore types were determined on Lake Velence.** Most plots belong to the type of "lake-non-dependent, extensive land use, near-natural shoreline". It was found that the shore-types had significant connections with the categories according to the evaluation viewpoints. Out of the 16 shore-types 12 are typically strongly altered, or modified. In some types certain activities, establishments dominate, being frequent next to boat harbours in case of 7 shore-types. The features that are advantageous to change shore-fortification belong definitely to one shore-type. Within the shore-types, sub-types were determined according to land use, shore-fortification, width of emergent vegetation's zone, and to the access. It was found that the sub-types having shore-wall were mainly advantageous regarding access, at the same time, there were hardly any emergent vegetation in the littoral zone.

## CONCLUSIONS AND PROPOSALS

The assessment and evaluation method – elaborated as result of the research, being actually tested in practice by the example of Lake Velence – is suitable for landscape architectural research of the shores at medium-size and large lakes having primary recreational utilisation. Concerning the most assessment aspects, similar surveys, revealing also quantitative relations, have not been made for Lake Velence, in Hungarian practice evaluation for a whole lake's buffer-capacity and shore-fortification's transformability is now known.

The results of my research can be utilised for the landscape architectural practice, too. The assessment-evaluation principles and methods of lakeshores can be applied in several parts of landscape architecture practice for the assessment work part of plans being of different scale and type, in compliance with WFD directives, as well as for the execution of further researching and planning projects. The lakeshore assessment and evaluation results of Lake Velence may serve as basis for further landscape architectural planning processes and landscape protection regulation for the lake's surroundings. The findings of the research can be utilised for the education of landscape engineers.

As further project, lakes should be typified from landscape architectural aspect, in addition to elaborating an assessment method for the lakeshores' visual conditions. As for the practical use of the research it is necessary to extend the assessments in time. The research can be well completed with a survey of utilization customs and demands, sustaining problems, involving all concerned parties comprehensively. Determination of land use directions and priorities for the long run needs a complex approach, considering the whole lake and lakeshore, based on the lakeshore's recreational carrying capacity. Regarding future tasks of landscape development, shoreline-restoration should be of key importance, what is justified by the changed shore-use demands, sustaining and ecological aspects. A substantial part of present land use conflicts could be solved by elaborating a shore-use order and by increasing the proportion of shore-sections in public use.

## THE AUTHOR'S PUBLICATIONS JOINING WITH THE DISSERTATION'S TOPIC

### Scientific periodicals and conference proceedings:

- Boromisza Zs. (2006): Ökológiai hálózat természetvédelmi jelentősége a Dinnyési-Fertő térségében. pp. 179. In. Kárász I. (ed.): *X. Országos Felsőoktatásai Környezettudományi Diákkonferencia*. Eszterházy Károly Főiskola. Eger.
- Boromisza Zs. (2007): Állóvizek partszakaszának környezetvédelmi szempontú értékelése a Velencei-tó példáján. pp. 120-121. In. Sallay Á. (ed.): *A Lippay János – Ormos Imre – Vas Károly tudományos Ülésszak előadásainak és poszttereinek összefoglalói*. BCE Tájépítészeti Kar. Budapest.
- Boromisza Zs., Csima P. (2008): A Velencei-tó parti sávjának értékelése a partalakítás és a tájterhelhetőség szempontjából. pp. 125-132. In. Csima P., Dublinszki-Boda B. (ed.): *Tájökológiai kutatások*. BCE Tájvédelmi és Tájrehabilitációs Tanszék. Budapest.
- Boromisza Zs. (2009): A Velencei-tó parti sávjának tájrendezési szempontú értékelése. pp. 32. In. Körmöczy L. (ed.): *8. Magyar Ökológus Kongresszus. Előadások és posztterek összefoglalói*. Szeged.
- Boromisza Zs. (2009): Településfejlesztési folyamatok környezeti hatásai a Velencei-tó parti sávjában. pp. 176-181. In. Orosz Z., Szabó V., Fazekas I. (ed.): *Környezettudatos energiatermelés és -felhasználás. Környezet és Energia Konferencia Debrecen, 2009. május 8-9*. DAB Megújuló Energetikai Munkabizottság. Debrecen.
- Boromisza Zs. (2009): Tájhasználat változás, tájalakítás hatása állóvizek parti sávjára a Velencei-tó példáján. pp. 54. In. *Fiatál agrárkutatók az élhető Földért*. Szaktudás Kiadó Ház. Budapest.
- Boromisza Zs. (2009): Állóvizek parti sávjának tájrendezési szempontú vizsgálati és értékelési módszerei. pp. 102-103. In. *Lippay János – Ormos Imre – Vas Károly tudományos Ülésszak*. 2009. október 28-30. *Összefoglalók. Tájépítészeti*. BCE Tájépítészeti Kar. Budapest.
- Boromisza Zs. (2009): Állóvizek parti sávjának jelentősége és veszélyeztető tényezői. pp. 129-134. In. Szabó V., Fazekas I. (ed.): *Települési Környezet*. DE Tájvédelmi és Környezetföldrajzi Tanszék, Debrecen.
- Boromisza Zs. (2009): Fenntarthatóság értelmezése állóvizek parti sávja esetében. pp. 54-65. In. *III. Országos Környezetgazdaságtani PhD konferencia*. Papyrusz Book Kiadó. Budapest.
- Boromisza Zs. (2010): Állóvizek parti sávjának tájvizsgálati és tájértékelési módszerei. pp. 193-199. In. Sallay Á. (ed.): *Ormos Imre Tudományos Ülésszak. LOV 2009. Tájépítészeti Tanulmányok. 4D könyvek*. BCE Tájépítészeti Kar. Budapest.
- Boromisza Zs. (2010): The planning principles of standing waters' shore zones demonstrated by the example of Velence-lake. pp. 621-627. In. Fábos, J. Gy,

Ryan, R.L., Lindhult, M., Kumble, P., Kollányi L., Ahern J., Jombach S. (ed.): *Proceedings of Fábos Conference on Landscape and Greenway Planning. Budapest, July 8-11*. Corvinus University of Budapest, Department of Landscape Planning and Regional Development. Budapest.

- Boromisza Zs. (2010): Parti sáv lehatárolási módszerek állóvizek tájértékelésében. pp. 12-13. In. Egyed A. (ed.): *Meddig lesz még Föld Napja? Doktoranduszok I. Környezettudományi Konferenciája*. Budapest 2010. április 17. Doktoranduszok Országos Szövetsége. Budapest.
- Boromisza Zs. (2010): Parti sáv értelmezési lehetőségek és lehatárolási módszerek állóvizek tájértékelésében. *4D Tájépítészeti és kertművészeti folyóirat* 19. szám. 2010. pp. 46-53. No. 19.
- Boromisza Zs., Molnár Zs. (2011): Felszíni vizekhez kapcsolódó egyedi tájértékek a Jászságban. pp. 7-19. In. Csima Péter (ed.): *Tájvédelmi füzetek*. 1. szám. BCE Tájvédelmi és Tájrehabilitációs Tanszék. Budapest.
- Boromisza Zs. (2011): Tájhasználati, tájökológiai szempontok a Velencei-tó parti sávjának értékelésére. *Hidrológiai Közöny* 91. évf. 4. szám. 2011. július - augusztus. pp. 21-24.
- Sallay Á., Boromisza Zs. (2011): Partfelmérés a délegyházi bányatavaknál. *Tájökológiai Lapok* 9(1). pp. 87-98.
- Boromisza Zs. (2012): Complex shore zone evaluation at Lake Velence, Hungary. *Applied Ecology and Environmental Research* 10(1) pp. 31-46.

### Studies joining with the topic:

- A Dinnyési-Fertő térségének tájrendezési tanulmányterve (2005). Diplomaterv. BCE Tájvédelmi és Tájrehabilitációs Tanszék (MS.). Budapest.
- Kápolnásnyék-Velence-Sukoró-Nadap-Pákozdi települések területén lévő turistaút hálózat felmérése, állapotértékelése és fejlesztési lehetőségeinek tanulmányterve (as a supervisor, 2007). Megbízó: Velencei-tó Környéki Többcélú Kistérségi Társulás. BCE Tájvédelmi és Tájrehabilitációs Tanszék (MS.). Budapest.
- Kisvízfolyások állapotfelmérése és értékelése a Velencei-tó térségében (as a supervisor, 2007). Megbízó: Velencei-tó Környéki Többcélú Kistérségi Társulás. BCE Tájvédelmi és Tájrehabilitációs Tanszék (MS.). Budapest.
- Vereb, Pázmánd, Velence és Gárdony – zöldfelületi rendszer elemeinek vizsgálata és értékelése (as a supervisor, 2008). Megbízó: Velencei-tó Környéki Többcélú Kistérségi Társulás. BCE Tájvédelmi és Tájrehabilitációs Tanszék (MS.). Budapest.
- Pákozdi, Sukoró, Nadap, Kápolnásnyék, Gárdony, Zichyújfalu – zöldfelületi rendszer elemeinek vizsgálata és értékelése (as a supervisor, 2009). Megbízó: Velencei-tó Környéki Többcélú Kistérségi Társulás. BCE Tájvédelmi és Tájrehabilitációs Tanszék (MS.). Budapest.

- A délegyházi I-es bányató (Gizella-tó) parti sávjának felmérése (as a supervisor, 2009).  
BCE Tájvédelmi és Tájrehabilitációs Tanszék - Tájtervezési és Területfejlesztési Tanszék (MS.). Budapest.
- A délegyházi V-ös bányató parti sávjának felmérése (as a supervisor, 2010). BCE Tájvédelmi és Tájrehabilitációs Tanszék - Tájtervezési és Területfejlesztési Tanszék (MS.). Budapest.
- A délegyházi II-es bányató parti sávjának felmérése (as a supervisor , 2011). BCE Tájvédelmi és Tájrehabilitációs Tanszék - Tájtervezési és Területfejlesztési Tanszék (MS.). Budapest.
- Pákozd község kultúrtörténeti egyedi tájértékeinek katasztere (as a supervisor, 2011). BCE Tájvédelmi és Tájrehabilitációs Tanszék (MS.). Budapest.

Other professional work joining with the topic:

Kiss G., Boromisza Zs., Tari A., Kiss P. (2003): *Természetismereti vízitúra a Velencei-tavi tanösvényen – túravezető füzet*. Velence-tavi Vízi Sportiskola. Gárdony.



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