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LAKESHORE-RESTORATION - LANDSCAPE ECOLOGY - LAND USE: ASSESSMENT OF SHORE-SECTIONS, BEING SUITABLE FOR RESTORATION, BY THE EXAMPLE OF LAKE VELENCE (HUNGARY)

Zsombor BOROMISZA[1], Éva PÁDÁRNÉ TÖRÖK[1] & Tamás ÁCS[2]

[1]*Corvinus University of Budapest, Department of Landscape Protection and Reclamation, e-mail: zsombor.boromisza@uni-corvinus.hu*

[2]*Budapest University of Technology and Economics, Department of Sanitary and Environmental Engineering*

Abstract: The purpose of our study is to develop a decision-preparing assessment method for shore-restoration of medium- (0.5 km^2 – 100 km^2) - and large-sized (>100 km^2) lakes, utilised primarily for recreational purposes, by the example of a Hungarian study-area (Lake Velence). For detailed assessment of the lakeshore conditions, the legal shoreline was intersected into 100 m long sections; each assessment plot covers 50-50 m from the shoreline both towards the land and the water surface. 9 indicators were defined and divided into two groups (indicator-systems): landscape ecological conditions and land use features. The lakeshore was evaluated on basis of the assessment indicators by score-system. It was noticed that according to the two indicator-systems, the 3 integral categories involved similar quantity of plots (suitable for restoration: 11 and 16, partially suitable: 53 and 27 and not suitable: 132 and 153 plots). However, the results have made it clear that the plots, being suitable potentially for restoration, can be determined solely by combining the results of the two indicator-systems. Accordingly, just a bit more than 7% of the assessed plots are suitable, or partially suitable for shore-restoration. Though, there are relatively few plots suitable for restoration, it is still very advantageous, that there are also long, continuous sections of more hundred meters (mainly on the south-eastern shore), where all the plots have suitable features for restoration.

Keywords: lakeshore, restoration, Lake Velence, landscape planning, landscape ecology, spatial planning

1. INTRODUCTION

Having in mind the increasing recreational demand and also the connected ecological concerns, lake-restoration of many Central-European lakes is absolutely needful. To restore the lakes' ecological conditions and to increase their recreational potential, the development of lakeshore is of high significance. Shores perform dominant land use- and ecological functions as to the status of the whole lake, at the same time they are especially exposed to human pressures. Practically, every lake-utilisation form uses shores to some extent, yet, there are some utilisation forms, focusing just on the lakeshore and – in many cases – the open water surface can be accessed and used through the lakeshore. Some features, functions of lakeshores are typical for the zone concerned, also in case of a shallow lake (e.g. spawning sites of some fish-species and recreation destinations).

The exact description and assessment of the shore's attributes and processes in support of proper spatial planning, serve as basis for all lakeshore-related interventions, what needs – first of all – a system approach to a survey of the lakeshore's special abiotic and biotic features and functions. The goal of this research is to present an assessment method in order to prepare decisions on the shore-restoration of medium- (0.5 km^2 – 100 km^2) - and large-sized (>100 km^2) lakes, utilised primarily for recreational purposes, by the example of a Hungarian study-area (Lake Velence), based on the above principles.

2. LITERATURE REVIEW

Although lakes are more isolated than many other biomes (Hansson et al., 2013), the assessment of structural and functional connectivity between the water-body and the surrounding landscape has become a subject of researches. The analysis of interactions between different patches in the landscape is among

the hot topics in landscape ecology and landscape limnology (Sorrano et al., 2010; Wu, 2013). The significance of these concepts in physical planning processes is widely recognised (Leitão & Ahern, 2002), however, they are rarely applied in plans in fact. Several studies discuss the features, functions, services and pressures of lakeshores, the review of Engel & Pederson (1998), Felföldy (1981), Naiman & Décamphs (1997), Ostendorp et al., (2004), Schmieder (2004), Sebestyén (1943), Strayer & Findlay (2010) belong to the most complex approaches.

The assessment of pressures is often focused on detecting the impacts of one certain factor (eg. artificial shore-fortification, urban development, sediment removal , water-level control), referring to one biological taxonomic group, mainly to fish (Bryan & Scarnecchia, 1992; Gabriel & Bodensteiner, 2012; Jennings et al., 1999; Winfield, 2004), to macrophytes (Elias & Meyer 2003; Keddy & Fraser, 2000; Ostendorp et al., 2003; Pomogyi, 2005; Radomski & Goeman, 2001) and to macroinvertebrates (Brauns et al., 2007; Miler et al., 2013). Integrated assessment methods in some studies also point to the peculiarities of lakeshores (Boromisza, 2012a; Furgala-Selezniow et al., 2012; Perleberg et al., 2009; Rowan, 2008; Siligardi et al., 2010; USEPA, 2007).

Lakeshore restoration and the related interventions are discussed both in theoretical reviews, and in several case studies. According to the survey made in compliance with the EU Water Framework Directive, out of 312 restoration projects of relevant European wetland habitats, 99 are lake-related and in most cases they were intended to restore the natural state of the shores (Coops & van Geest, 2007). As for the objective of the interventions, lakescaping often tends to transform and improve only a few elements of the many functions that lakeshores perform. Nevertheless, both ecology and land use do benefit from the interventions, made for whatever reason. It is a key aspect to eliminate and prevent shore-erosion, being very disadvantageous for the use, applying e.g. bioengineering methods (Henderson et al., 1999; Markó, 1975). From environmental protection's view, proper management and restoration of lakeshores produce tools to restore the whole lake, similarly to the interventions, which mitigate the impact of diffuse sources of pollution, surface-subsurface run-off (sediment and nutrient transport) after Cooke et al., (2005). Several studies elaborate the theoretical aspects of developing sufficient buffer-zones (Fischer & Fischenich, 2000; Henderson et al., 1999; Molnár, 2013; White, 2010). In some cases lakeshore restoration is definitely made to restore the structure and integrity of habitats (Browne et al., 2004; Henderson et al., 1999; Ye et al., 2011).

Regarding method and means of interventions, shore-restoration – in many cases – is carried out by re-establishing the near-natural vegetation, what can be performed by water-level regulation (Cooke et al., 2005; Keddy & Fraser, 2000), active planting (Cooke et al., 2005; Xu et al., 1999), spreading sediment seed bank (Nishihiro & Washitani, 2007), or e.g. by enclosures that protect emergent vegetation (Ostendorp et al., 1995). At the Chinese Lake Taihu a large-scale restoration was performed, applying – among others – water-level regulation, re-introduction of vegetation and land use control (Ye et al., 2011).

3. MATERIALS AND METHODS

3.1. Study area

Lake Velence is one of the largest Hungarian shallow lakes with a surface area of 24.17 km^2 , the average depth is 1.45 m (Szilágyi et al., 1989) (Fig. 1). The western basin is mainly covered by emergent macrophytes, whereas for the eastern one the open water-surfaces are typical. On the western part of the lake a nature conservation area of 4.2 km^2 is situated belonging to the competence of Ramsar Convention because of the oligothrophic floating fens and endangered bird species. In the early 90's the lake's trophic state was qualified eutrophic, or eu-polytrophic, while in the last 6-7 years relatively low chlorophyll-a levels were characteristic.

The most serious interventions, that altered the near-natural condition of the shore at Lake Velence, go back to the middle of the XIX century: the railway, built on the southern shore divided the littoral region. After the water-level had been regulated, the water-level fluctuation decreased to vary in the range beyond 0.4 m, therefore the length of the shoreline became shorter (Papp, 1995). Along the southern and eastern shores of the lake, settlements were developed nearly continuously since the first half of the XX century, based mainly on recreation (Csima et al., 1996). The lake that was silted up, overgrown with emergent macrophytes and submerged aquatic vegetation by the 1960's, could not meet the recreational demands. Accordingly, large-scale sediment removal and lakescaping were carried out. The full length of the shore built with artificial shore-fortifications is approx. 17.7 km. 9.8 million m^3 sediments were dredged and 3.8 km^2 reeds were dredged and filled (Papp, 1995). The impacts of the near-natural lakeshore's alteration can be noticed from several aspects: e.g. disappeared spawning sites, altered shoreline and slope morphology, poor buffer capacity, changed visual appearance, more disadvantageous access of water-surface (Boromisza, 2012b).

3.2. Lakeshore assessment method

Lakeshore-restoration – in a broad sense –is an integrated management process that – in addition to transforming shore-fortification – includes both the landscaping and the maintaining tasks that are essential to improve and restore the lakeshore's functions. In this study a new assessment method was developed that is suitable to identify shore-sections with artificial shore-fortifications that are optimal to transform.

The research includes the following steps:

- interviews with the organisations involved in restoration – as shore-restoration can be realized solely by the co-operation between local decision-makers (settlements) and the competent authorities;
- defining near-natural shore-sections, which have no artificial shore-fortification and excluding them from further assessments;
- defining relevant landscape ecological and land use indicators;
- defining shore-sections that can be restored by a scoring-system based on the indicators.

As primary step, **structured interviews** (applicable also in social sciences) were made (Babbie, 2008). While doing so, personal visits were paid to 4 settlements along the lake (Velence, Gárdony, Pákozd, Sukoró) including local governments, competent national park management, water management and environmental protection authorities, and the local office of the Hungarian Anglers Association. Among the 11 pre-defined, mainly open questions (e.g. what kind of problems are to be faced at the lakeshore, which shore-sections are in advantageous condition), also definite questions were asked regarding a would-be shore-restoration: transformation of shore-fortifications, transformation of shore regulation, maintenance.

Detailed assessments of the lakeshore's conditions were made by intersecting the legal shoreline into 100 m long sections, in a distance of 50 m each both towards the land (riparian zone) and the water-surface (littoral zone). By this method 351 assessment plots were placed along the shoreline (Fig. 1), out of which 155, characterized by near-natural state, were excluded from further assessment, as they have no artificial shore-fortification to be transformed. During the assessments the following basic maps were used: topographic map 1:10000, and high resolution, coloured ortophoto (2009). As primary assessment method, on-site field survey was applied.

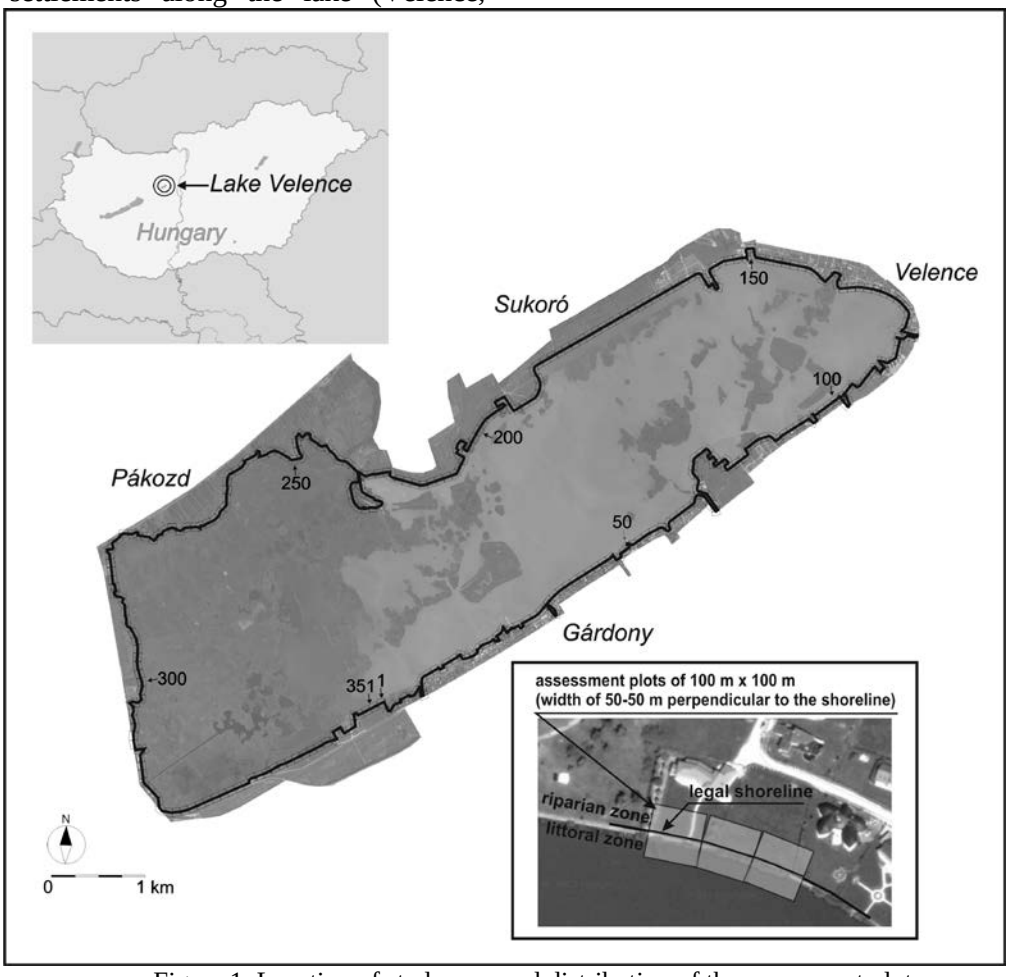

Figure 1. Location of study area and distribution of the assessment plots.

The partial researches on the study area have been carried out since 2004, covering various seasons and shore-sections. Between June-September 2011 during the field survey that included the whole lakeshore, the earlier results were made up-to-date and also completed. As secondary method, the regulations on use and urban development, stipulated in the local plans, were assessed in the same plot-distribution (Local plan of Gárdony, 2009; Local plan of Pákozd 2009; Local plan of Sukoró 2003; Local plan of Velence 2012). The indicators of shore assessment can be derived primarily from the natural landscape's conditions and land use features which give the characteristics of lakeshores. Accordingly, for the assessment method of Lake Velence, 9 assessment indicators were defined which – based on the above reasons – were divided into two groups (indicator-system) in the first phase. The first group of the indicators (4) included the landscape ecological conditions, and the second group contained the land use features (5).

The assessed **landscape ecological conditions** involved: (i) width of the zone covered with emergent macrophytes, (ii) naturalness of vegetation, (iii) vegetation zonation and (iv) typical shore-fortification. Actually, the defined indicators describe the condition, structure and changes (patch-dynamics) of the lake – as a patch in the landscape mosaic. Regarding landscape restoration, those plots were considered to be the most advantageous, where the existing shore-fortification can be transformed relatively easily from technical point of view, a reed zone is protecting the shore physically at present, near- natural vegetation is not concerned and the vegetation zonation is partially transformed. The aspects applied for assessing landscape ecological conditions are shown in table 1.

Because of the duality of Lake Velence – in the western area the interests of nature conservation dominate, while in the eastern one the demands of tourism are considered primary - it was necessary to assess also the land use-forms in addition to the landscape ecological features. While assessing the **land use features**, beside the actual use, the local plans were processed which reflected the intention of the settlements' decision-makers for the long run. The structural plan approved by the local government stipulates the land use forms, required for the future, whereas the local building code specifies the urban development, its sites, as well as the protections and restrictions. The approved local plans stipulate the required shore-use for 15-20 years what basically affects the possibility of shore-restoration. Sections, where the zone of 50 m in the riparian zone belongs to the developed area were deemed the most disadvantageous ones.

Table 1. Categories and scores of applied landscape ecological indicators

Assessment indicator	Category	Scores
Typical width of the zone covered with emergent macrophytes	< 1 m	5
	1 – 4 m	3
	4 – 20 m	1
	20 m <	2
Naturalness of vegetation	Fully transformed, altered	3
	Strongly transformed, altered	2
	Moderately transformed, altered	1
	Slightly transformed	4
	Near natural	5
Vegetation zonation	Near-natural zonation	5
	Partially transformed zonation	1
	Near natural zonation is missing	2
Typical shore-fortification	Riprap bank protection works / concrete bank protection works with moderate slopes	1
	Concrete shore-wall	4
	Other shore-fortification	3

The situation is much more advantageous in the sections of non-developed area, covering 30 to 50 m wide zones on the land, where public use must be assured. The public parks were classified into the most advantageous category, where the extent of urban development could not exceed 5 % of the area. The indicators applied for assessing land use features are shown in table 2.

All the assessed 196 plots (155 out of the total 351 plots were neglected) were classified – on basis of the above 9 assessment aspects – into the category, being the most typical at the greatest shoreline length / greatest territorial unit within the plot. The shore-sections (plots) being suitable for restoration were identified according to the two assessment indicator-systems by separate score-methods. As to the score-system, the category, being the most advantageous for restoration got the score 1 and the least advantageous one got the score 5, the scores of the remaining categories varied between these values (Tables 1, 2).

Though the possible categories often change in the same assessment indicator along one gradient, the scoring, however does not follow this rhythm in each case. E.g. as regarding naturalness of the vegetation, both limits are disadvantageous: it is really not advantageous to affect the shores, – being in fact natural – by any technical interventions, whereas for the significantly transformed,

intensively utilised shores, restoration is unreal. In this case, the transient condition and the moderate naturalness are optimal for restoration.

Table 2. Categories and scores of applied land use indicators

Assessment indicator	Category	Scores
Human disturbances	All the year round high extent	4
	All the year round medium extent	1
	All the year round small extent	2
	Seasonally high extent	5
Access of shoreline	Free access	2
	Limited access because of land use	4
	Limited access because of vegetation	1
	No access	5
Ownership relations of riparian zone	Settlement's local government' s	3
	County local government	2
	State-owned	1
	Private property	5
	Anglers' association	4
Land use	Agricultural- and forest areas	1
	Lake-dependent land use	5
	Intensive, (not lake-dependent) forms of development: residential areas, resorts	4
	Public parks	3
Regulation	Traditional land use	2
	Public space in the riparian zone	3
	Developed area in the riparian zone	5
	Protected area in the riparian zone	1

On basis of the total scores, the plots were classified into the following integral categories: (i) suitable, (ii) partially suitable and (iii) not suitable for restoration. Those plots are partially suitable, where only a section is suitable for transformation, or which can be suitable for restoration by a slight change (e.g. by the spreading of the emergent macrophytes along the shoreline).

Stipulation of the score-limits among the categories is a complex task – having in mind the assessment indicators and the quantity of their categories – being, in fact determinant for the assessment results. Considering the experiences of the interviews too, 10-10 control-plots were chosen out of the assessed ones, which (based on detailed analysis) could be unambiguously classified into the 3 result categories, regarding landscape ecological and land use viewpoints, alike. The score-limits of result categories were defined in such a way that adequate results could be achieved for these plots. This means that the score-limits, as values to be calibrated, were estimated in inverse way, based on the available information.

It was noticed, that there were not any combinations of score-limits that could give proper result for every control-plot according to both indicator-systems. However, for each and every control-plot, the expected result was achieved for one group (landscape ecology / land use) at least. This means that **designation of the plots - potentially suitable (suitable, or partially suitable), can be made by combining the results of the two separate indicator systems.** Based on the results of the two assessment indicator-systems, the final results' categories were derived (Table 3.).

Table 3. Deriving of the integral categories

		Land use		
		Suitable	Partially suitable	Not suitable
Landscape ecology	Suitable	Suitable	Suitable	Not suitable
	Partially suitable	Suitable	Partially suitable	Not suitable
	Not suitable	Not suitable	Not suitable	Not suitable

4. RESULTS AND DISCUSSION

A detailed analysis of the personal interviews does not form the subject of this study, yet, it is determinant for the result that this kind of assessment threw the light on many problems, which confirm that this research is absolutely topical. Almost every interviewee – but for one local government – deemed lakeshore-restoration necessary. The practical importance of this research is confirmed by **every interviewed organisation, which took stand for significant transformations of the shoreline,** what was expressed in maintenance and regulation issues, as well.

The analysis of the detailed lake assessment results were made first separately according to the two indicator-systems. According to the landscape ecological and land use indicator-systems the three result categories involved similar quantity of plots (suitable for restoration: 11 and 16, partially suitable: 53 and 27 and not suitable: 132 and 153 plots). Figure 2 summarizes the comparison (filled circles) of the results according to the two assessment groups of 196 plots and the distribution of total scores (unfilled circles) derived from the

combination of the two indicator-systems' scores.

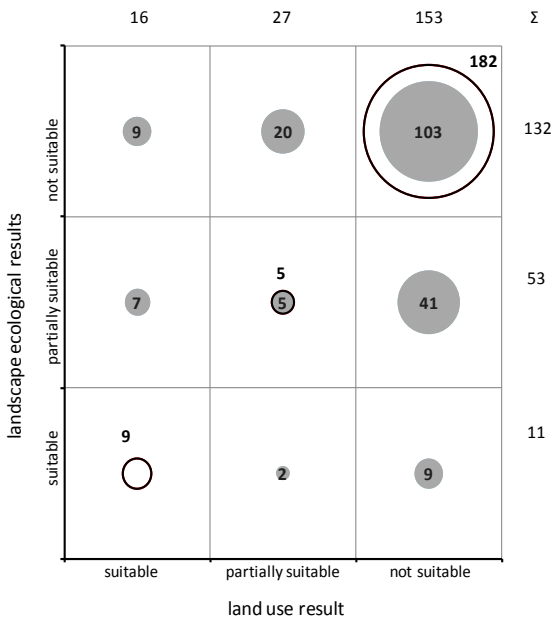

Figure 2. Comparison of the scores of the two assessment indicator-systems and the total scores derived from their combinations

While conducting the landscape ecological assessment, the ecology-related issues were processed not only at landscape scale (Farina 1998; Szabó et al., 2012), but also the interactions of land use – ecosystems were taken into account. It has been noticed that on basis of landscape ecological aspects, alone, the quantity of plots, being suitable for restoration, is very small, mainly because of the missing emergent littoral macrophytes that could substitute for the artificial shore-fortification. Thus, in a significant proportion of the plots the width of the zone covered by emergent macrophytes is not optimal for restoration, being an important limiting factor, as shown in figure 3. The impacts and the interventions made on the lake in the past 150 years, can be recognised in all the assessed features: the transformed vegetation is especially striking, the earlier typical wide reed zones disappeared, the natural vegetation zonation can be noticed only on shorter sections, habitats dominated by natural species composition are rare. The ecologically disadvantageous alterations are, in fact, due to the water-level regulation, artificial shore-fortification and intensive use of riparian zone, in addition, they draw the attention to the managing-maintaining problems of the lakeshore areas. The results are in harmony with the theory of Keddy & Fraser (2000), that the lack of water-level fluctuation – in this case the water-level is kept in a narrow range – basically reduces the transitional zones between the "real" aquatic and the terrestrial habitat zones. So, the transformed and degraded condition of lakeshore definitely calls for restoration.

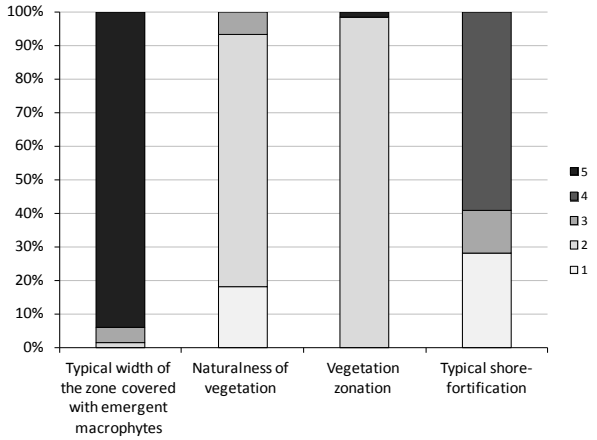

Figure 3. Distribution of the scores of landscape ecological indicators' category among the plots, not suitable for restoration

The result of the assessment – from the land use view 153 plots are not suitable for shore-restoration – definitely certifies that for intensive recreational use the intensive urban development - coupled with artificial structures – is inevitable. Efficient service for tourism, typical for the assessed shore-sections – because the spatial extent of the recreational areas cannot be increased owing to the nearby built-up sites and the railway – can be provided by intensive development of technical infrastructure and services, only. This approach is reflected in the settlements' local plans, where the areas of beaches and camping belong to the developed area. Though at certain sites – mainly at beaches – the maximum development possibility of the area is 10%, to provide the best recreational possibilities, it is the artificial shore-fortification that is dominant. It would be really difficult to communicate the restoration of these sections for the local people, and for the holiday-makers.

Figure 4 shows definitely that the intensive human use induced by the shore-sections, with artificial shore-walls, applied by masses for recreation, and the required facilities to meet human demands, do not support the shore-restoration initiatives. Whereas more than 70% of the assessed plots got the most disadvantageous score for the massive human use, the limited plots amount to 40% "only", because of the regulation serving the demand on urban development. The intensive human use limits shore restoration in 66% in Gárdony, and in 78% in Velence and the actual demand on urban development limits same in 42% in Gárdony and in 24% in Velence. This shows unambiguously that more intensive human use is more disadvantageous for restoration even on the shore-sections where recreational facilities have not been built (no resort areas, beaches, campsites next to the shore-line), however, an artificial shore-fortification already exists.

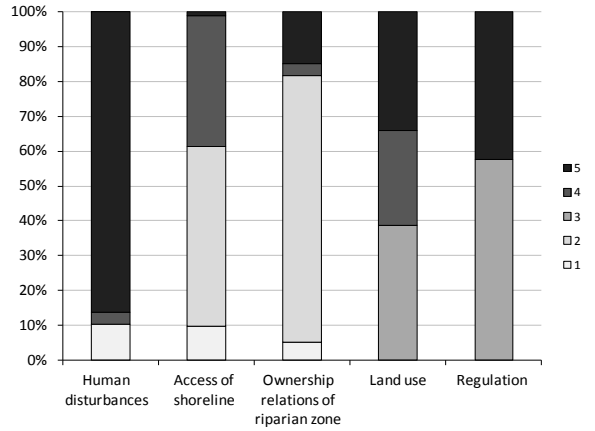

Figure 4. Distribution of the scores of land use indicators' category among the plots not suitable for restoration

It should be noted that the proportion of plots having different results regarding landscape ecology and land use is almost 45%. This confirms the conclusion based on the control-plots, i.e. no correct result can be achieved by qualifying one assessment indicator-system, only. E.g. a shore-section of the southern shore seemed to be suitable for restoration from the landscape ecological view, but the land use features showed that the shore-section concerned would be intensively developed, thus it is unreal to get near-natural shore-sections. Similarly, applying land use indicators alone, could not screen the shore-sections with high wave-exposure, to be protected by artificial shore-fortification also for the long run.

Consequently, in the second step the results of the two indicator-systems were combined (Fig. 2.). **Just a bit more than 7% of the assessed plots are suitable, or partially suitable for shore-restoration**. The high proportion of not-suitable plots is mainly due to the dominant recreational use of the lake, what is shown also by the areas along the shore being developed more and more intensively.

The transformation of shore-fortification is – in many cases – not limited by land use or by intensity of utilisation, but rather by the way as the bank protection works were technically developed in the years of 1970-80. Technically, it would be really difficult and expensive to transform the typical vertical concrete shore-walls.

Beside the quantity of plots that can be considered to be suitable or partially suitable (indirectly the length of shore-section) also their distributions are key aspects, as in the detailed analysis prior to the interventions the very part of the shoreline should be highlighted, where restoration could be realised on a longer section (Table 4.).

On basis of the results it can be noticed that – though there are relatively few plots, suitable or partially suitable for restoration – yet, **it is very advantageous and promising that there are also long, contiguous sections of more hundred meters, where all the plots have proper conditions to be restored** (first of all in the administrative district of Velence, in the south-eastern shore).

Table 4. Number of continuous sections suitable/partially suitable for restoration

	Length of continuous shore-section [m]			
	100	200	300	400
Number of shore-sections [pcs]	5	1	1	1

The plots, deemed suitable in the total score, have several common features, these shore-sections were developed by similar landscape-forming processes (Fig. 5). These are mainly areas, which have not got definite land use functions and their surface is typically covered by degraded grass. As a rule, they have concrete bank protection works with moderate slopes, nevertheless, silting-up of the riprap and consequently the spreading of the reed zone in front of the shoreline is often noticed. This process unambiguously points to smaller wave-exposure, so it is – in fact – justified to ask whether shore-fortifications are necessary on these sections.

The shore-sections, not suitable for restoration, are generally intensively utilised areas (beaches, boat harbours) protected by vertical shore-wall. In certain cases also the extensively utilised areas can be considered to be unsuitable on basis of the assessment. This may be e.g. an artificially constructed peninsula located on the southern shore, which is not suitable for restoration either on basis of its recreation utilisation, planned for the future – as stipulated in the local plan – or on basis of the present shore-fortification form.

5. CONCLUSIONS

Though many studies discuss possibility and necessity of lakeshore restoration, it is far from being easy to find some examples for actual application of same in the praxis, as lakeshore assessment method. The fact, that no similar assessment, evaluation – including also the quantity relations – have been carried out on Lake Velence, makes the evaluation of the results even more difficult. It is noteworthy that the presented method has not been applied for other lakes. Since the choice on the assessment indicators was based on the categorization and knowledge of lakeshore attributes and functions, they can be applied also for the assessment of other lakeshores.

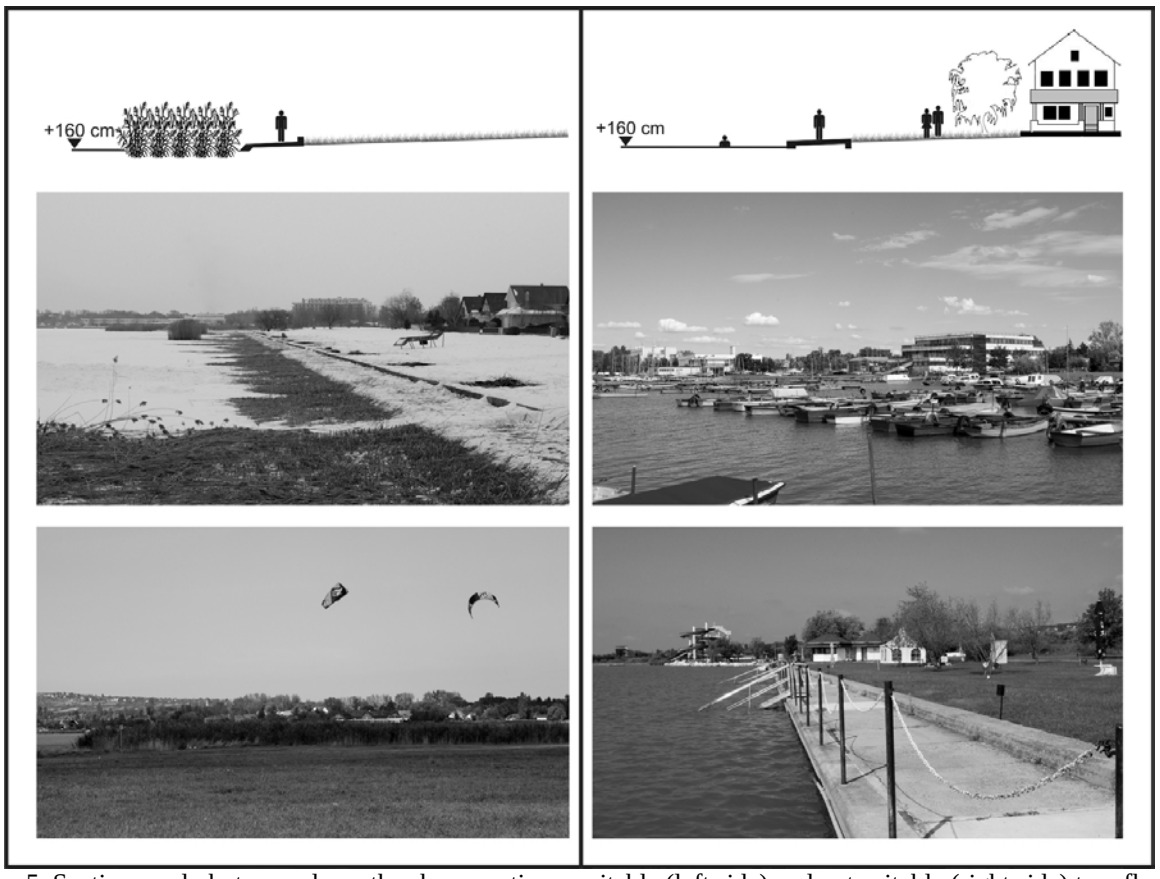

Figure 5. Sections and photos made on the shore-sections, suitable (left side) and not suitable (right side) to reflect the differences in land use, shore-fortification and vegetation.

The four-step method has definitely confirmed that the shore-sections, being potentially suitable for restoration, can be selected with due consideration of landscape ecological and land use viewpoints. By this basic assessment phase the efficiency of restoration planning is increasable. Application of the two indicator-systems together is especially of higher importance for more intensively utilised lakes. However, it must be emphasized that further, detailed assessment of these plots (shore-sections), serving as basis for technical planning, is absolutely essential.

No doubt, that – while processing the local plans – the assessment had also elements, which will be realized only in the future, but just these elements show the settlements' development tendency regarding the shore-sections – subject to their competency – looking ahead to the next 10-15 years.

At the same time, however, the assessment made it clear that – in certain cases – the investments are integrated in the local plans, yet, as the plan fails to be realized, finally, the area concerned remains in near-natural condition. Anyway, the question may be raised: if the areas, which have not been developed for more than 10 years, despite the original development intentions, can be blocked in this way, or the earlier decisions should be reconsidered by giving green light to shore restoration.

The results provided a lot of new information to have a better understanding on the effects of settlement development and lake regulation, what can be used for future planning processes, too. The long-term land use tendencies and priorities are to be stipulated by integrated approach of lake and lakeshore, alike, based on the recreational pressures of the latter. Out of the decisions made on the lakeshore, water-regulation should be revised primarily, considering the effects of climatic changes (Dávid et al., 2012), optimal land use of the lake as well as the ecological aspects (e.g. conservation of habitats), more significantly than it is made at present. The projects, connected with the shore features and sites with several functions, can be planned with this knowledge.

During future utilisation of the lakeshore the fundamental tasks to manage, regulate and maintain this zone are to be stipulated in a complex way (purposefully in the same plan) and these tasks should be enforced in the local plans. The above projects have to be completed with proper environmental education. It is not enough if the importance of shore restoration is communicated to the decision-makers, only. Also the local people and holiday-makers arriving for the week-ends in large numbers should be informed about the acceptable groundings, why restoration of the shore-sections is needful.

Urban development in the direct riparian zone is not suggested whether having in mind access, or ecology, in addition it limits the transformation possibilities of water-regulation. This must be assured by modifying the local plans of the settlements along the lakeshore, by applying setbacks, by limiting urban development and certain changes in the riparian zone. The required width of the non-developed buffer zone is affected by the shore-sections' conditions, yet, less than 50 m should not be stipulated, either regarding land use or ecology. Both riparian and littoral zones need non-developed areas to be maintained, coupled with well-crafted rules that reflect the demands of special use. It is absolutely a key issue to increase the share of public spaces (e.g. by expropriation, pre-emption). The undisturbed condition of some shore-sections must be assured for the ecological demands (with limited access on some sites), but efforts should be made to have shore-sections with free access in a spatial distribution, being more even than now. Providing a line of sight of the water-surface should be supported also by adequate regulation thereon, integrating same in the building code.

A substantial part of land use conflicts, available also at present, could be solved by shore use regulation, comprising also the spatial- and time-limits of the activities permitted in the riparian and littoral zones (e.g. spatial limits of using water-based sport facilities). The stipulations – depending on their type – can be enforced as integrated parts of local building codes, separate orders of the local government, local orders on fishing, etc.

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