

# PUBLIC PERCEPTIONS AND AESTHETIC PREFERENCES OF LAKESHORE LANDSCAPE: THE EXAMPLE OF LAKE VELENCE (HUNGARY)

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## Abstract

Earlier, intervention programs and tourism development projects in the lakeside area of Lake Velence have led to the diversification of lakeshore landscape and shoreline. In the current study, we investigated the public aesthetic preferences of varying lakeshore landscapes, driving factors (which cause preference deviation and visual discomfort), and judgments of perceived beauty of 14 lakeshore scenes. The study also examined the differences in preferences of lakeshore landscapes between experts and waterfront residents. The results indicated that landscape characteristic and maintenance state have a significant impact on the receptor's preference. In the investigation of lakeside landscape preference with different natural degrees, both the near-natural lakeshore and the natural lakeshore are lacking attention and attraction. Though natural ("wild") lakeshore beneficial to the birds and other wildlife, overgrown riparian / aquatic plants and rigid shoreline caused visual fatigue and boredom feel. These findings provide a reference for the forthcoming lakeside intervention projects and land-use decisions.

**Keywords:** aesthetic preference, landscape character, lakeshore landscape, landscape perception

## 1. Introduction

### Background

Standing water bodies received many alterations and pressures during the 19-20 centuries (Schmieder, 2004), which are strongly related to the intensive use of lakeshore and waterfront development (Furgala-Selezniow, G. et al., 2012). Shoreline expansion, embankment construction, dynamic changes in land use, and other human intervention activities in waterfront areas, have produced huge effects on the

characteristics and visual quality of the waterfront landscapes. After the 1960s studies on the restoration of lakes and lakeshore got more interest, and many restoration interventions have been implemented (Cooke, G. D. et al., 2005). Restoration is regarded as a beneficial change both from aesthetical and ecological aspects. However, poorly designed new landscape elements and features can lead to negative landscape and visual effects, such as the development of structures and recreational facilities, as well as the invasion of new elements in the environment (Institute & I.E.M.A, 2013).

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To explore the interaction between waterfront landscape features and landscape preferences, valuable information could be provided for decision-makers and planners. Determining the similarities of landscape preferences among different participants, contributes to the development of general guidelines for the planning and design of waterfront areas and bank restoration.

### **Landscape aesthetics and Landscape preference**

Landscape aesthetics is commonly investigated for many years (Aoki, 1999; 2013). Concerning public preferences and participation for the waterfront landscapes, there are many studies carried on urban waterways (Moran et al., 2016) and urban streams (Hu et al., 2019). Yet, few studies focus on the aesthetic assessment of lakeshore landscape (White et al., 2010). Early landscape assessment was mainly based on expert evaluations, predictive programs, and the landscape perception of the public (Palmer, 1983). Over the past two decades, some research has argued that compared with the expert evaluation method, the evaluation method based on public preference has higher reliability (Daniel, 2001).

Landscape characterization and classification plays an important role in landscape assessment (Carys Swanwick et al., 2002), it has continued to develop over the last ten years as an important approach for making judgments and provides objective appraisal criteria based on the physical features of the landscape (U.S. Department of Agriculture, 1974). Early studies have shown that people's aesthetic preferences are mainly due to the impact of vegetation (species of plants, plant color, seasonal effects) in the environment, followed by the environmental atmosphere etc (Tyson, 1998). Therefore, we further evaluate the landscape preference of different lake landscapes with similar vegetation cover and different landscape characteristics.

Approaches that utilize photography and internet surveys to evaluate how the visual quality of landscapes and preference are viewed in some of the national parks from a public perspective has been applied (Sevenant & Antrop, 2009; Ziółek et al., 2019). Primary assessment of landscape preferences is generally taken on the basis of photos of the selected viewpoints (Wu et al., 2006). In some cases, different types of landscape photos will be collected for evaluation, like artificial structures, agricultural landscapes, and wild landscapes (Wu et al., 2006). Those photos should be collected at the same location, unified perspective, same season (Institute & I.E.M.A, 2013). Afterward, based on the survey of observers' preferences to evaluate and rank the visual quality and landscape aesthetic value (Arriaza et al., 2004). Studies aiming to assess landscape preferences through statistically methods are widely used in urban parks (Maikov, 2013) urban stream (Hu et al., 2019) and varying rural landscapes (Sevenant & Antrop, 2009). Those studies proved, the preference results can be presented more accurately through statistical analysis.

### **Current research and goals**

In the last 10 years, due to the planning contents, intensified recreational developments, and initial restoration project formulated by the local authorities, the Lake Velence (Hungary) surrounding areas changing is remarkably (Boromisza et al., 2014; Papp, F., 1995). These changes not just affect the ecological conditions and land use of the lakeshore, but strongly influence the aesthetics and visual connections. It also results in the regionalization and segmentation of the lakeshore landscape. Hence, there are currently several different types of revetment sections and diverse landscapes along the lake.

The goal of the research was to explore the implications of various lakeshore landscape restoration practices on aesthetic preferences, and the characteristics of landscapes in relation to people's reactions and perceptions.

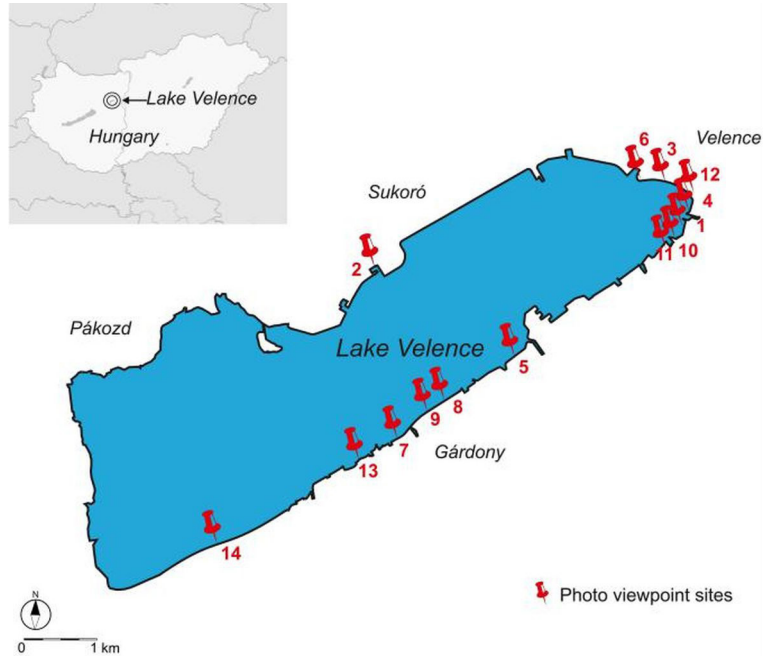


Fig.1. Location and scene points

By utilizing the prevalent method of asking waterfront residence and experts to vote on various lakeshore photographic scenes, we comparatively investigated 14 diverse lakeshore environment scenes. The main study objectives included: (1) A survey of the preferences of various lakeshore landscape – focusing the varying revetment types and ecological condition lakeshore sites; (2) To investigate the interrelation between environmental indicators and the public's preference; and (3) Examination of preference differences of lakeshore landscape between different participant groups.

## 2. Materials and methods

### 2.1 Study area

Lake Velence is one of the largest Hungarian shallow lakes with a surface area of 24.17 km<sup>2</sup>, the average depth is 1.45 m (Szilágyi F., Szabó Sz. & Mándoki M., 1989) (Fig. 1). The western basin is covered by emergent macrophytes, the eastern basin is dominated by the open water-surfaces. On the western part of the lake a nature conservation area

of 4.2 km<sup>2</sup> is situated belonging to the competence of Ramsar Convention. The most serious interventions, that altered the semi natural condition of the shore at Lake Velence, go back the middle of the 19th century: the railway, built on the southern shore divided the lakeshore region (Papp, F., 1995). Meanwhile, along the southern and eastern shores of the lake, settlements and recreation projects were developed almost continuously. By the 1960s, large-scale sediment removal and lakescaping had fundamentally changed the characteristics and ecology of lake and shore zone (littoral and riparian zone), finally resulted in algae blooms, increased surface runoff in the shore zone and a loss of shore habitats. Large scale bank protection works and lake basin control works carried out first of all in the region of Velence and Agárd, mainly based on placing the rip-rap on the embankment and vertical embankment wall construction. The full length of the shore built with artificial shore-fortifications is approx. 17.7 km, accounting for 63% of the total length of the shoreline (Papp, F., 1995). To address the above-mentioned challenges and social demands,



Fig. 2. Three scene photograph comparison groups of the second part. P1-P3=scene group1: a concrete revetment with partly sand slope, a shore with wooden groyne and timber piles, a natural beach with wooden groyne; P4-P6=scene group2: a shore entire edge provided metal railings, a rip/rap bank slope with openly grassland, a shore restricted by aquatic plants and wooden fences on both sides of the pavement; P7-P9=scene group3: a rock slope revetment with unobstructed pavement, a rock slope revetment with obstructed pavement, a concrete revetment without sloping breakwater

a large scale restoration intervention project has started for the “sustainable restoration of Lake Velence’s shore walls”, realized in 2018-2021, supported by European Union Funds.

### Photograph selection

Bank protection works and recreation development of Lake Velence have been mainly concentrated on the regions of Gárdony, Agárd, and Velence basin since the 1960-70s. The development program of Lake Velence produces the eastern and southern regions rich in land use, varied revetment types, and diverse lakeside landscapes. These areas can also be defined as the developed areas of Lake Velence, where the shore zones are the most popular recreation destinations and the most active waterfronts for tourists. Accordingly, the range of study scenic points is mainly focused on the southern shore zone of the lake and the bay of Velence.

The preferences survey of the Lake Velence lakeshore landscape was assessed based on

photographs of the selected site. The photos were taken with a PENTAX K100D camera, in between July to August 2011. During this period, a total of over 100 images along the entire shoreline taken. We selected 14 high-resolution representative lakeshore photos as the basis for this investigation (Fig. 1.). The 14 images / survey scenic point selection was made to represent different shore character units, define in previous studies (Boromisza et al. 2014). The points were divided into four comparison viewpoints groups. The first three scene groups conducted a public preference survey on landscape scenes of different revetment types, and the last viewpoint group was to investigate the impact of different natural degrees of lakeshore on public perception and visual amenity. In addition, the perspective view of each group of comparative photos, the visual horizons, the distance between the shoot point and the water surface are similar (Svobodova et al., 2014).



Fig.3. Comparison scenes of the third part :P10=an artificial shore background completely covered buildings, P11=a semi-artificial shore with partial buildings background, P12=a semi-natural shore with metal fences, P13=a near-natural shore with the unobstructed pavement, P14=a natural shore partial covered with aquatic plants

## Questionnaire survey

We collected the public's preference judgments, opinions, and perceptions of the Lake Velence lakeshore landscape through an online questionnaire survey. We separately sent the online questionnaire to three different groups (outdoor enthusiasts, the local residence, and experts), mainly through social media communities. Additionally, we also sent it to several individuals by email. The contents of the questionnaire completed in July 2019, and all responses collected in October 2019. It divided into three sections:

The first part is a brief inquiry about the occupation background of the respondents and where they live. The second section was designed to investigate the public preferences of nine varying lakeshore landscapes, which with similar vegetation-covered but different revetment types and characters. It consisted of three groups, each of which contains three different comparison scenes (Fig .2). Participants need to choose from three different scene photos one of the best. Besides, the third part was regarding the preferences survey of the different extent of human influences of the lakeshore landscape(Fig.3). It contained five pilot sites. Participants will choose the best and the worst of the five sample photos.

Behind each preference survey item will be accompanied by a brief interview, in which the respondents will be asked about the reasons for their choice, as well as their opinions.

## Respondents

Respondents composed mainly of three groups. (group1) The neighborhood residents and community groups living near the lake. They are most concerned about the changes and renew of the lakeshore and most affected by the changes of lakeshore landscape; (group2) The experts: the students in landscape architecture, the architects, and urban planner; (group3) Visitors and outdoor sports enthusiasts, including bikers, kayakers, and hikers. The number of respondents who participated was 72. The actual valid responses were 65 (29 residents, 27 experts, 9 outdoor enthusiasts).

### 2.5 Data processing and Analysis

To evaluate the perceived scores and preferences results of Lake Velence lakeshore landscapes, Excel software (Microsoft Corp.) and SPSS software (v25.0, IBM Corp.) was used to perform the descriptive statistics, a general preferences analysis, correlation analyses and crosstabs analysis.

A Pearson correlation analysis was performed to examine the relationships and relevance between public preference judgment consensus and landscape indicators. Previously, we have established and measured an applied landscape assessment indicators of partial study scenes by field survey (Table1). Identify and characterize the landscape indicators based on the following considerations: the physical states (vegetation coverage area, human activities, the extent of human influences, density of riparian plants) and the condition of the landscape(visual range, naturalness, functionality, accessibility, maintenance).

Table 1: Measurement of environmental indicators of five survey scene sites

Indicator	Scene points				
	P10	P11	P12	P13	P14
Naturalness	highly artificial	semi artificial	semi artificial	near natural	natural / "wild"
Visual range	openness	semi openness	semi openness	semi openness	closure
Vegetation coverage(%)	10	30	40	60	80
Aquatic plants	no	no	middle density	low density	high density
Accessibility	free access	free access	inaccessible	limited	limited
Human activity	high extent	high extent	high extent	low extent	low extent
Maintenance	well maintained	well maintained	poorly maintained	well maintained	poorly maintained

To compare the preference differences between the experts (n=27) and waterfront residents (n=29), we used a Crosstabs analysis (Table 5) followed by the Chi-square test to examine the perceived votes of two participant groups. The results of Crosstabs perform shown that the cells have expected to count less than 5 in each group. Therefore, we used a follow-up to Fisher's Exact Test to verify it again.

### 3. Results

#### Lakeshore landscape preferences with similar vegetation coverage and different revetment types

We evaluated the landscape preference of diverse lakeshore landscapes with similar vegetation-covered and different landscape characteristics. The potential predictors of the shores landscape preference of Lake Velence are mainly related to the types of revetment, the shoreline types (soft shoreline or hard shoreline), accessibility, landscape functionality, environmental atmosphere, applied construction materials and so on.

As table 1 shows, the P3 (a natural beach with curved wooden groyne) in the first group is the most popular one (57 % of participants prefer P3), fewer respondents chose P1 (28%), and the least favored was P2 (11%). Most of the respondents believed that scene P3 is the most natural and untouched one, the shape of the revetment is distinctive and the materials were natural. The perceptual reviews also pointed out that P3 is more attractive because there is a lovely beach, well-crafted, and makes people feel to be invited. P5 (a rip/rap bank slope with open grassland) received the highest perceived votes of group 2, nearly half of people (48 %) like point 5, 26% prefer P4, and the rest of 18% prefer P6. The general positive feedback about P5 including: it close to the water, has a good vision, no fences, a large grassy area with good usability, as well as a calm environmental atmosphere. In group 3, most of the people vote P7 (60%), followed by P8 ( 14 % ) and P9 (12%). In comparison with the other two scenes, the shore condition and revetment type of P7 (a rock slope revetment with unobstructed pavement) have more advantages, due to

Table 2: Preference results of three comparison scene groups by vote

Scene points	Group1				Group2				Group3			
	P1	P2	P3	Invalid	P4	P5	P6	Invalid	P7	P8	P9	Invalid
Votes	18	7	37	3	17	31	12	5	39	9	8	9
% within group	28	11	57	4	26	48	18	8	60	14	12	14

Note:n=65. P1=a concrete revetment with partly sand slope, P2=a shore with wooden groyne and timber piles, P3=a natural beach with curved wooden groyne; P4= a shore entire edge provided metal railings, P5= a rip/rap bank slope with openly grassland, P6=a shore restricted by aquatic plants and wooden fences on both sides of the pavement;P7=a rock slope revetment with unobstructed pavement, P8=a rock slope revetment with obstructed pavement, P9=a concrete bank without sloping breakwater(Fig.2).

the greater safety the rock breakwater prevents the spread of water on the sidewalk, and accidentally falls) and better visual perception (the unobstructed shoreline and the rocks component looks more natural than the concrete embankment).

The changes in contents (such as color, texture, volume uncoordinated and occlusion of the visual zones)and features in the environment may influence visual amenity and landscape aesthetic value(Institute & I.E.M.A, 2013). Nevertheless , The perceived votes and the general perception statements reveal that these slight deviations and small-scale elements have no significant negative impact on the visual amenity and aesthetic preferences, in the case of P2 (temporary hut exist in the lakeshore), P5 (multicolor beach umbrellas in the environment) P6 (wooden fences in the landscape ) and P8 ( boats exist in the lakeshore). However, those elements may partially block the visual range or caused

an obstructed pavement and grassland, and leads to a loss of landscape accessibility and functionality.

### Lakeshore preferences for varying levels of human intervention

According to the extent of human influences and different intervention levels, five representative photos from different locations along the Lakeshore were selected for evaluation, which divided into five typical types, from an artificial lakeshore landscape transition into a natural/“wild” lakeshore P10=artificial lakeshore, P11=semi-artificial lakeshore, P12=semi-natural lakeshore P13=near natural lakeshore P14=natural/“wild”lakeshore). Each of the pictures showing a different degree of naturalness and landscape features (Fig .3). As table 3 shows, the most popular landscape scene was the semi-artificial lakeshore (41% of respondents prefer P11), followed

Table 3: Perceived votes of five varying comparison lakeshore scenes

Scene points	Favorite		Least favored	
	votes	% within group	votes	% within group
point10	17	26	13	20
point11	27	41	1	1
point12	2	3	24	37
point13	16	25	3	5
point14	3	5	24	37
Count	65	100	65	100

Note :P10=an artificial shore background completely covered buildings, P11=a semi-artificial shore with partial buildings background, P12=a semi-natural shore with metal fences, P13=a near-natural shore with the unobstructed pavement, P14=a natural shore partial covered with aquatic plants

Table 4: Correlations between perceived votes and landscape indicators (scene point 9-14)

	1	2	3	4	5	6	7	8
1 Perceived votes								
2 Naturalness	-.46**							
3 Visual range	.81**	-0.03						
4 Vegetation coverage	-.40**	1.00**	0.02					
5 Aquatic plants	-.79**	.88**	-.42**	.86**				
6 Accessibility	.82**	-.78**	.39**	-.75**	-.96**			
7 Human activity	.46**	-1.00**	0.03	-1.00**	-.88**	.78**		
8 Maintenance	.79**	-0.05	.73**	-0.02	-.51**	.64**	0.05	

Note: N=65 \*\*P<0.01. \*\*Correlation is significant at the 0.01 level.

by the artificial lakeshore (26%) and the near-natural lakeshore (25%). However, both the natural / "wild" lakeshore (37% of participants dislike P12) and the semi-natural lakeshore (37%) are the least favored lake landscape scenes (37%). Thus, the degree of naturalness and human intervention have a significant effect on aesthetic preferences in the lakeshore landscapes of Lake Velence. Both highly artificial shores and highly natural shores may be negatively evaluated because of the visual enclosure of the views and limited visual connections. Compared with a natural lakeshore completely covered with aquatic plants, respondents preferred an artificial lakeshore with a neat appearance, accessibility, and well maintained.

### Correlations between public preferences and landscape indicators

To find out the influences of lakeshore landscape characters on aesthetic preference judgments, investigate the correlations between landscape features and perceived votes (scene point 9-14) is required. As table 2 shows that the perceived scores are significant positive correlated with accessibility ( $r=0.82, p<0.01$ ), visual range ( $r=0.81, p<0.01$ ), and maintenance state ( $r=0.79, p<0.01$ ). However, it is negatively

correlated with naturalness ( $r=-0.46, p<0.01$ ), aquatic plants ( $r=-0.79, p<0.01$ ) and vegetation coverage ( $r=-0.4, p<0.01$ ).

The results reveal that the degree of naturalness, aquatic plant coverage, and vegetation coverage does not significantly affect aesthetic preferences in the lakeshore landscapes of Lake Velence. In particular, the natural / "wild" lakeshore type has dense vegetation and riparian plants. It provides a good condition for the habitat and the species of the lake, but the overgrown riparian plants may block the visual range, visual connections. To a certain extent, the closure of the visual zone caused visual unpleasantness. This result is coinciding with an earlier study, it pointed out that riparian plants can have mixed effects on the waterfront landscapes: the riparian plants can increase the visual attractiveness of the waterfront landscape but may also produce perceptions of an unsafe atmosphere (Purcell et al., 2002). Additionally, the following landscape characteristics could produce positive landscape preferences: a wide field of vision, access to the edge of the water, well planned, well organized and good maintenance.



Table 5: Scene points \* Participants Crosstabulation

		Waterfront Residents (%)	Experts (%)	Total (%)
Scene group 1	point1	21.4	32	26.4
	point2	10.7	12	11.3
	point3	67.9	56	62.3
	Count	28	25	53
Scene group 2	point4	14.8	41.7	27.5
	point5	55.6	45.8	51
	point6	29.6	12.5	21.6
	Count	27	24	51
Scene group 3	point7	62.5	82.6	72.3
	point8	20.8	8.7	14.9
	point9	16.7	8.7	12.8
	Count	24	23	47
Scene group 4	point10	6.9	3.7	5.4
	point11	20.7	22.2	21.4
	point12	3.4	3.7	3.6
	point13	41.4	48.1	44.6
	point14	27.6	22.2	25
	Count	29	27	56

Note: cells of each group have expected count less than 5.

### Differences in preference and perception of lakeshore landscape between experts and waterfront residents

According to the professional background and residence of the participants, we selected two groups of most representative participants (experts and waterfront residents) and analyzed whether there are differences in their preferences for the lakeshore landscapes (Table 5). Experts, competent to quantify the aesthetic value of the landscape, because their judgments of the value of the landscape are based on the intrinsic value and physical attributes of the landscape (Vouligny et al., 2009). However, the evaluation criteria for residents are generally related to feelings, living experiences, and their knowledge of the place. (Vouligny et al., 2009)

A summary of the participants' perceptual statements in subsequent interviews indicates that waterfront residents are more concerned about the functionality of landscape, accessibility, maintenance, recreational area, and pay less attention

to visual beauty, while experts pay more attention to the design, aesthetic and order of the landscape. Such as the survey point P4 (Table 5), 41.7% of experts like it because it looks well maintained, clean, and orderly, contains features of contemporary landscape and architectural design. However, waterfront residents rarely voted for P4 (14.8%), mainly because they considered that it is impossible to carry out any water sports and leisure activities on this site. Similarly, in the P8 (a rock slope revetment with colorful boats), 20.8% of waterfront residence and 8.7% of experts voted it, which also points out that experts are concerned about the visual impact and landscape beauty, while residents are more pay attention to recreation and practicality.

The results of Fisher's Exact Test of all the 4 viewpoint groups display that the difference between these two groups of participants was not statistically significant ( $p_1=0.71>0.05$ ,  $p_2=0.07>0.05$ ,  $p_3=0.32>0.05$ ,  $p_4=0.98>0.05$ ), which reveals that landscape preferences were roughly similar between the waterfront residents and experts (Fig.4).

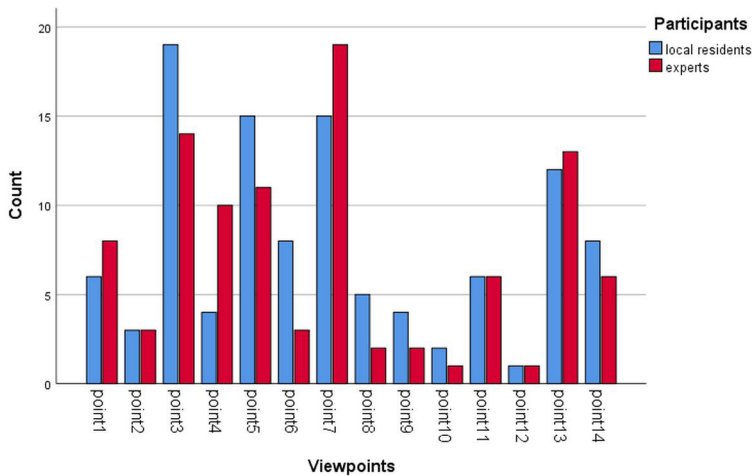


Fig.4. The perceived vote count of all 14 lakeshore scenes between experts and waterfront residents

#### 4. Discussion and conclusions

Lakeshore landscape preferences investigation and assessment help us have a better understanding of the public’s preferences and demands of lakeshore residents.

Our study revealed that the main effect factors of preferences were related to the maintenance state, hydrophilicity, functionality, accessibility and construction materials in the environment. Otherwise, the scale of building, vegetation coverage, and the extent of the visual range, can also affect the evaluation results of the aesthetic preference in lakeshore landscapes . What are the acceptable range and comfortable proportions of building scale and riparian vegetation cover in the lakeshore landscapes for the public? further discussions are required in the future study.

In the 14 lakeshore scenarios, the preferences between experts and waterfronts residents have no significant deviation. However, the responses indicate that the availability and well maintenance of lakeshore landscape are the main demands of residents and experts. These findings could remind designers and decision-makers of issues that may be overlooked in the planning processes, as well as the necessity of subsequent management and maintenance,

which also provides new insights for our future research. Regarding the different opinions and preferences between the people who had a different gender and live environment, can discuss it more specifically in the future.

The promotion of shoreline landscapes needs diversified design solutions according to the partition and its characteristics (Hartig & Staats, 2006), specially for the semi-natural lakeshore and the natural/“wild” lakeshore, which are the least popular and most overlooked types of lakeshore. The impacts of the semi-natural lakeshore 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 et al., 2014). A fair balance between wild environment and human control is demanded in waterfront landscape (Hu et al., 2019). Regarding the subsequent management and renewal of the Lake Velence lakeshore, we need to pay attention to the shoreline changes and material used during construction. Meanwhile, it’s necessary to promote regular manual intervention and long-term maintenance of the elements of the lakeshore landscape, mowing of bank, revetment reparation, turf cover, and conservation of special plant species.

The evaluation of lakeshore landscapes and public aesthetic preferences are complicated due to the diversity of influencing factors and the different backgrounds of participants. Nevertheless, the evaluation method of public participation is a good detection method for the lakeside landscape design, provide valuable opinions and references to the relevant authorities and designers.

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