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RESEARCH ARTICLE

Capabilities to Use Plants Grown in Wetlands of Erzurum for Landscape Design

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ABSTRACT

Based on how a wetland is defined by the Ramsar Convention, the Erzurum province is a rich region in terms of wetlands. This study aimed to identify capabilities to use wetland plants, which are grown in running waters (rivers, streams, brooks, and estuaries), temporary wetlands, swamp lakes, and high-water table area located within the provincial confines of Erzurum, for landscape design. As a part of the study, the samples were taken from a total of 287 spots in 6 main locations to identify wetland plants. A survey was conducted for the plants identified, carried out a one to one questionnaire with 100 students of different ages educated in the Department of Landscape Architecture. Plants were evaluated with their aesthetic properties such as their color, form, tissue, richness, and fascination. Based on the survey, it was concluded that 36 of them could be used for landscape architecture on grounds of their aesthetic characteristics.

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Introduction

Wetlands are the second most biologically diverse ecosystems only to follow tropical forests. Wetlands, which serve as a convenient environment of nutrition, breeding, and sheltering for many species and types of creatures, are regarded as museums of natural wonders for not only the country they are situated at but also the entire world. Playing an important role in the lives of people residing nearby, and making contributions to the regional and national economy, wetlands play a significant and unique role among other ecosystems to maintain the balance of nature and biological diversity. Wetlands are scattered in a well-balanced manner in nature by size. Their worth particularly has to do with their location. Wetlands cover 4 to 6% of the face of the earth (Mitsch and Gosselink, 1993). In other words, wetlands cover nearly 9 to 11 million square km^2 across the world. Everywhere ranging from tropical lands to cold tundras except for Antarctica is home to wetlands (Vymazal, 1995).

The character and function of wetlands have to do with their position in the land, ground characteristics, hydrology, and climatic characteristics. While wetlands mostly make up quite a small portion of an entire land (less than 10% of the total space), the transition zone between wetland ecosystems and territorial ecosystems is highly wide. Varying by size and many other characteristics, wetlands have something in common with one another, too. Some of those characteristics are structural (water, the bottom layer, biota) while some others are functional (food cycle, water balance, and organic matter production). The analysis of such characteristics offers general characteristics and diversity of wetlands. Spatial variables in wetlands with a wide water surface such as swamps, peats, and riverbeds can be particularly large. Compositions of species that are prevailing in wetlands differ from those in territorial ecosystems, and most wetlands share floras, which abound in vascular plants, with territorial ecosystems. Wetlands are usually located where terrestrial ecosystems (forests and meadows) meet deep-water systems (lakes, rivers, streams, etc.) (Mitsch and Gosselink, 1993; Mata, 2004).

One of the most important characteristics of wetlands is their diversity of plants. These plants are used for functional

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and design purposes (Sun et al., 2019; Zhou, et al., 2020). They serve as an object of design for various purposes such as making places attractive in their natural settings, making visual and functional effects to create a fauna, making an empty pond interesting, putting emphasis, contrast, harmony, and transitions, covering concrete and plastic-filled coastlines, smoothing and concealing rough and pointed lines (Turgut, 2009). Trees, shrubs, bushes, and ground covers spring to mind when it comes to plant-based designs introduced in urban areas nowadays. However, it was historically common to use ponds of plants in large gardens. Water surfaces are served as an attraction in design (Dobbie, 2013). One must remember that designs based on aquatic plants not only offer attraction and identity to spaces but also create value for the people of a city and a city itself in many aspects ranging from climatic to educational characteristics. Most of the nationwide studies over wetlands and plants that grow in wetlands were conducted in riparian zones, large reeds, and lakes. Also, it was found out that the studies only analyzed the botanical characteristics of plants whereas they did not lead to discussions over the use of plants for landscape design, and the Eastern Anatolia was excluded from them. This study aimed to identify plants that are naturally available in wetlands within the provincial borders of Erzurum, and offer an argument about their use for landscape design. This will help to make new additions to design-oriented plants that are currently in limited numbers.

Materials and Methods

The material of this study was the wetland plants identified by Turgut and Yılmaz (2020) in Erzurum Wetlands (Karasu River, the Serçeme Creek, the Aras River, the Oltu Creek, the Tortum Creek, and Çoruh River) (Figure 1).

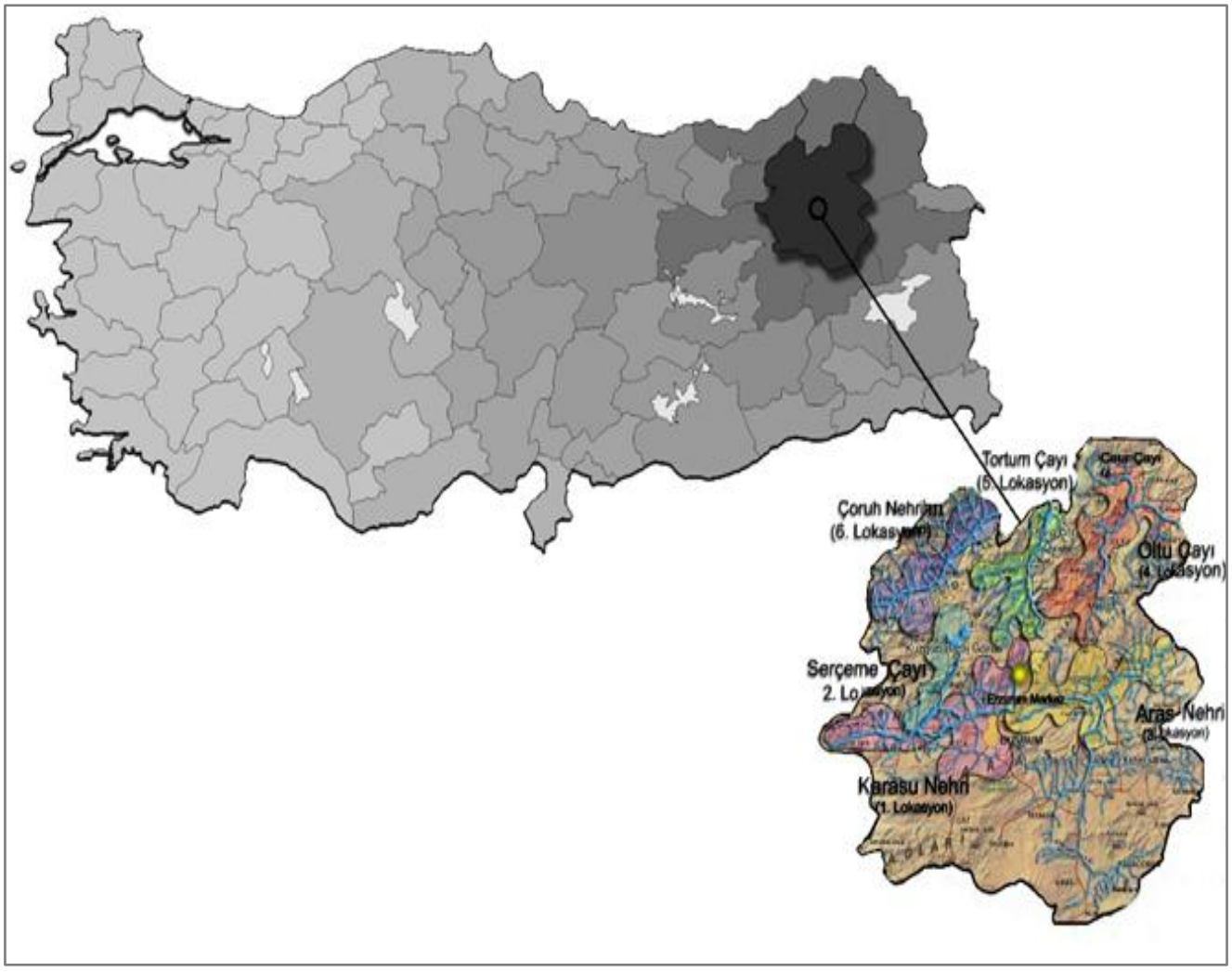

Figure 1. Study Site and Locations

Geographical Characteristics of the Site

The city of Erzurum is located between east longitudes of 40° 14' 15" and 42° 33' 35" and north latitudes of 40° 54' 57" and 39° 06' 10", and has a size of 25.066 km². The city's altitude offers a wide range from Uzundere being the lowest spot (nearly 1000m) to Kargapazarı (3288m) and Dumlu (3250m) being the highest spot. The deep valleys carved out by the river Çoruh and its tributaries, and the flatlands they have formed offer access from the city to the Eastern Black Sea towns. They offer access to the mountains of Keşiş

toward the north through the mountains of Tercan to the west, and the valley of Kelkit through the mountain of Kop and the pass of Kop, to the flatland of Erzurum through the Strait of Sansa to the southwest, and the mountain range of Munzur through the mountains of Mercan to the south. They make their way to the mountains of Şakşak and Bingöl to the south through the mountain range of Palandöken and culminate in the basin of Murat.

Method

On-site observations and reviews were mainly used for the field study. To observe plants as a part of the field study, visits were paid to wetlands at various times of vegetation to identify plants and their vegetative characteristics at the time were analyzed. The samples of plants were taken from riverbeds, riparian zones at a distance of 0 to 50 meters, brooks of rivers, high water table areas, temporary wetlands, swamp lakes, lakes, irrigation ponds, and dam reservoirs. To this end, samples were taken from 287 spots across the study site, and the coordinates of the sampling spots were located using GPS. The photos of the locations of samples and plants were taken, and their positions in the natural landscape and their aesthetic worth were underscored. The types of wetlands analyzed, general characteristics of the plants, and habitat characteristics were incorporated into plant observation cards.

A survey was disseminated among 100 landscape architecture undergraduates divided into three groups in an attempt to determine the aesthetic worth of the 43 plants identified as a part of the field study. The main reason why landscape architecture undergraduates were chosen to be involved in the study was that they previously took courses on introduction to design, learning about plants, and plant-based design. Therefore, 2nd, 3^{rd,} and 4th-grade students were chosen for the survey. A photo of each plant out of those photographed across the site was chosen and demonstrated for the students in a PowerPoint presentation. The students were asked to give a score from 1 to 5 for the photographed plants based on their color, form, tissue, richness, and fascination. A total score was calculated for each plant in consideration of all the characteristics. Scored in line with classification based on a total of 25 points, the plants were categorized by their aesthetic worth as "very poor" from 0 to 5, "poor" from 5 to 10, "moderate" from 10 to 15, "high" from 15 to 20, and "very high" from 20 to 25. Of the plants, those scored "high" and "very high" were considered to be worthy of being used for landscape design.

Based on the conclusions of the survey over the plants, aesthetic characteristics (color, form, tissue, richness, and fascination) of plants to be used for landscape architecture were highlighted, and some recommendations were offered in the final phase about what they could be used for (Tanrıverdi, 1987; Altan, 2004; Cook, 1996; Heriteau and Thomas, 1994; Nash and Stroupe, 2003; Söğüt, 1996; Uzun, 1997; Leszczynski, 1999; Lewis, 2001; Swindells, 2001; Dowling and Stephens,2002; McHoy, 2002; Anonymous, 2003; Anonymous, 2005).

Results and Discussion

As a result of the survey, it was determined that the plants got scores between 14 and 19.6. The landscape value, using recommendation, location, and total scores of plants given as a part of the survey were presented in Table 1. Based on the analysis of the survey, 36 plants were in the "high" category. However, there were not any plants in the "very high" category. The plants categorized as "high" were presented in Figure 2.

The top ten plants with the highest score in the ranking, such as *Dactylorhizaosmanica*, *Caltha polypetala*, *Gladiolus* sp., *Colchicum speciosum*, *Dactylorhizamaculata*, *Carum carvi*, *Primula auriculata*, *Butomusumbellatus*, *Iris* sp., and *Ornithogalum* sp. stand out with their flower colors. The next five plants such as *Typha shuttleworthii*, *Triglochin maritima*, *Lycopus europaeus*, *Potamogetonnatans*, and *Lemna minor* stand out with their form and tissue. Other plants placed in the middle of the list, such as *Lysimachia vulgaris*, *Pedicullariscomosa*, *Muscari* sp., *Rhinanthus angustifolius*, and *Ranunculus aquatilis* also had flowers, but their shape lowered the scores. The plants at the end of the list, such as *Mentha aquatica*, *Polygonum amphibium*, *Alchemilla stricta* had low scores due to their tissue. Besides, the plants that grow in water, such as *Sagittariasagittifolia*, *Ceratophyllumsubmersum*, *Potamogetonnatans*, and *Lemna minor* were chosen for the beauty of their leaves. It is well known that most of the aquatic plants are highly decorative due to their form, shape, or flowers (Söğüt, 1996). As a result of the study, the fact that the wetland plants do not score below 14 is following this general validity.

Survey results showed that all of the plants scored over 15 are aesthetically favorable due to their elements. Besides, it was concluded that flowering plants were deemed to be more aesthetic than others. The aesthetic effect created by planting occurs as a result of the aesthetic properties of plants and their use in a certain order (Robinson, 1992) Individual elements that are considered to be aesthetic are habitus, color, leaf structure, and fruit. Various combinations of such elements based on designing principles offer visual effects that remain intact or vary by season throughout a year. Habitus, which stands for the characteristics form of a plant, has the most important effect on the composition. Wetland plants can be used as an object in a lot of pool and gardens. These plants are used for different purposes according to the differences in the growing environment. For example, plants that grow in high water table areas can be used in riparian zones, while underwater plants can be used within the water. In these areas, plants and animals exchanging food and oxygen create life associations. This situation ensures such a design area to be sustainable for a long time. However, the extent that pools, ponds, and artificial lakes are covered by aquatic plants harms design. The use of various types of plant materials in parks, gardens, houses, schools, hospitals, and playgrounds is of importance to forging a habitable environment for urban aesthetics and functionality. Due importance must be attached to plant materials, as well as to infrastructure services to boost the visual quality (Yılmaz and Zengin, 2003).

Table 1. The total scores of plants given as a part of the survey are presented

	Plant name	Landscape value	Using recommendation	Totalscore
1	*Dactylorhizaosmanica*	FL, F	Solitaire-Group	**19.6**
2	*Caltha polypetala*	FL	Solitary-Group	**19.5**
3	*Gladiolus* sp.	FL, F	Solitary- Group	**18.6**
4	*Colchicum speciosum*	FL	Group	**18.6**
5	*Dactylorhizamaculata*	FL, T	Solitary-Group	**18.3**
6	*Carum carvi*	FL	Group	**18.2**
7	*Primula auriculata*	FL	Group	**18.2**
8	*Butomusumbellatus*	FL, F	Group	**18.2**
9	*Iris* sp.	FL	Solitary-Group	**18.1**
10	*Ornithogalum* sp.	FL, T	Group, Solitary	**18**
11	*Typha shuttleworthii*	F, C	Group, Solitary	**18**
12	*Triglochin maritima*	F, C	Solitary Group	**17.9**
13	*Lycopus europaeus*	FL, F	Group	**17.8**
14	*Potamogetonnatans*	T; F	Group, Solitary	**17.8**
15	*Lemna minor*	T, F	Group, Solitary	**17.7**
16	*Consolidaorientalis*	FL, T	Pure Group	**17.4**
17	*Orchis palustris*	FL	Solitary-Group	**17.2**
18	*Ranunculus repens*	FL	Group, Solitary	**17**
19	*Sagittariasagittifolia*	T, FL	Group, Solitary	**17**
20	*Typha latifolia*	F, C	Group, Solitary	**16.9**
21	*Geumrivale*	FL	Group	**16.6**
22	*Lythrumsalicaria*	FL	Solitary, Group	**16.6**
23	*Lysimachia vulgaris*	FL	Group	**16.5**
24	*Pedicullariscomosa*	FL	Group	**16.5**
25	*Muscari*sp.	FL	Group	**16.3**
26	*Phragmites australis*	FL	Group	**15.8**
27	*Rhinanthus angustifolius*	FL	Group	**15.7**
28	*Ranunculus aquatilis*	FL	Group, Solitary	**15.7**
29	*Typha angustifolia*	FL	Group	**15.7**
30	*Ceratophyllumsubmersum*	F	Group	**15.5**
31	*Geranium collinum*steph.	FL	Group, Solitary	**15.5**
32	*Cerinthe minor*	FL, T	Group	**15.4**
33	*Alchemilla stricta*	FL	Group	**15.3**
34	*Polygonum amphibium*	FL	Group	**15.1**
35	*Scirpussylvaticus*	F	Group	**15**
36	*Mentha aquatica*	FL, K	Group	**15**
37	*Epilobium hirsitum*	FL	Group	**14.9**
38	*Polygonum lapathifolium*	T	Group	**14.9**
39	*Veronica anagallis-aquatica*	T, FL	Group	**14.9**
40	*Typha laxmannii*	F, C	Group, Solitary	**14.5**
41	*Lamium album*	F, FL	Solitary Group	**14.4**
42	*Hordeum violaceum*	F	Group	**14.3**
43	*Stachys cretica*	FL	Group	**14**

FL, Flower, F, Form; T, Tissue; C, Color

The meaning of what wetland plants make one feel entails a particular point of view. Wetland plants are usually herbaceous and shorter in length and width compared to other plants. For instance, a pillar-shaped tree lays bare dynamism in terms of form and size while a pillar-shaped wetland plant will not create the same effect because of its size-dependent worth. This requires using wetland plants as a group rather than in a solitary manner. This disadvantage in form is out of the question for color as wetland plants can be part of designs thanks to their unlimited range of colors. Underwater plants such as *Ranunculus aquatilis*, *Sagittariasagittifolia*, and *Polygonum amphibium*, riparian and high-water-table plants such as *Typha*sp, *Butomusumbellatus*, *Caltha polypetala*, *Mentha aquatica*, and *Dactylorhiza*sp are favorable for their diverse leaves and color effects of their blooms, and they can offer visual effects that vary by season.

Figure 2. Plants with "high" and "very high" aesthetic score

Some points need to be taken into consideration for designs of wetland plants that rely on the colors of plants. For instance, should any color be used for emphasis, the principle of contrast must be adopted dramatically, or color elements could be intensively used in a way that would not cause chaos. At this point, it is of importance to make an accurate analysis of the size of the space and the impact that the environment in which plants are used would have on people. For example, the use of *Butomusumbellatus* in a small-scale park would cause a sense of narrowness in space while the use of the same plant in a large area would strike a balance in terms of color and size and make it as close as to what is natural. Based on the analysis of the same plant in terms of form, one can argue that the use of the plant in a group and a solitary fashion causes differences in perception. The solitary use of the plant in a plant-intensive space would not attract attention and go unnoticed. However, the effect of the form rather than the color would be a highlighter when it comes to its use in a group. Söğüt, 1996; argues that the size of the land where water is used requires the introduction of some standards about usage, too. To achieve harmony in scale, it is a must to use large plants or groups of plants in large areas and small-sized plants or groups of plants in small areas.

The fact that water is a habitat for aquatic plants will have a positive impact on the design, and help people feel refreshed, at ease, and sometimes dynamic or calm (Kıroğlu, 2007). The fact that water is still or running will diversify the design. The capability of floating and underwater plants to propagate is another important element for the designs of wetland plants. Most underwater plants are part of invasive groups. The extent that the surface of a well-balanced aquatic-plant pond is covered by plants is relevant from both ecological and aesthetic standpoints (Özyavuz, 2017). The extent of how full or empty water surfaces are as a mass makes different impressions on people. The combination of various plants in a chaotic tissue diminishes the attraction of the water surface. However, an intensive combination of the same plants is considered more attractive from time to time. Water surfaces are usually covered by heavy vegetation of plants in historical attractions.

While vegetation designs on riparian zones are usually intended for the prevention of landslides, they create a positive effect from the visual perspective (Seçkin et al., 2011). Root structure, speed of plant propagation, and length of vegetation play a pivotal role in plants to be used for functional purposes. However, one must create a design that takes aesthetic quality into account if such plants are to be used in an urban area. Should large water surfaces be used in an urban area, natural-like vegetation should be chosen. However, plants that are located in a transition zone between a dry and wetland are not used due to a lack of transition zones. In other words, the use of plants, which can be used in semi-arid locations namely high-water table areas, as an object of design will improve diversity. To do so, these plants can be made part of various designs through combinations of water+plant or water+rock+plant. When it comes to large water surface designs, in particular, one must remember that water would be one of the most preferred spots of any place, and some special strolling tracks and benches must be built with sufficient size and function in riparian zones to respond to user demands.

Conclusion

The aesthetic impact made by vegetation creates the outlook of space and aesthetic characteristics of each plant and its presentation in a particular order. Individual elements that are considered to be aesthetic could be habitus, leaf structure, color, and fruit. Various combinations of these elements in line with various design principles lead to some visual effects. Wetland plants offer a wide range in terms of design just like other plants do. Wetland plants can be used as an object of design not only in plant-based basins or ponds but also anywhere an aquatic habitat is favorable. Plants that grow in high water table areas serve as an object of design in riparian zones and the same goes for plants that grow in water. The cleansing characteristics of aquatic plants, how they provide other creatures with foods and habitats, and their economic worth must be underlined through studies. Some of the past studies called the aforementioned plants invasive. However, regional users, in particular, must be informed about the importance of these plants. To this end, seminars must be organized, and techniques to grow aquatic plants must be explored, and introductory cards should be designed for these plants to reach out to larger masses. The importance of conservation of aquatic plants along with their surroundings should be underlined, and their economic benefits should be demonstrated. One should underline the fact that reeds and phragmites serve as a modern and alternative construction material for roof construction, and major potential for flora tourism under ecotourism. On the other hand, wetland plants offer a great variety as an object of design. One should remember that each study on this subject matter would offer a different perspective and rendition, and offer diversity to space usage and design as they are among the most important functions of landscape architects. To this end, the use of aquatic plants should be expanded, and collection gardens should be built in urban areas.

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