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Research Article

SUSTAINABILITY OF THE URBAN COASTAL AREA OF THE ÇANAKKALE STRAIT AND RECOMMENDATIONS

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ABSTRACT. Coastal areas are regions with special ecosystems that depend on the climatic characteristics experienced throughout the year and the nature of the region. Therefore, it is very important to consider landscape planning and design principles in all settlements and uses to be carried out in these sensitive areas. Especially in urban coastal areas, if landscape planning is not implemented and necessary measures are not taken due to the high structural pressures and increasing intensity of use over time, irreversible damages or disasters may occur. Considering that the strait coasts, as coastal areas, connect different land masses and form intercontinental transition routes, it is seen that they are used intensively and for various functions. The strait coasts are among the few in the world and require special studies since they are areas of intensive use both in terms of settlement and visitors. Therefore, their strengths and weaknesses, as well as opportunities and threats, should be identified. In this context, this study reveals the characteristics of strait coasts located in urban areas through literature reviews. In the methodology of the study, a SWOT analysis was conducted to provide data for future studies. In addition, within the scope of the Çanakkale Strait urban coast, recommendations have been made from the perspective of landscape architecture for the sustainable use of the area.

Keywords: *Dardanelles, design plants, landscape design, landscape planning.*

INTRODUCTION

Coastal areas where land and sea meet are the areas that are under the most intense pressure of human settlement and are subject to degradation [1]. Therefore, coastal areas directly affect architecture, identity and social life in cities. In this respect, the protection of the coast is important for the sustainability of both urban history and livable urban environments [2]. In this context, planning and design studies with the right steps are required in settlements with coastal areas. In the protection of the coasts, not only the design of the areas, but also the principle of sustainability should be taken into account.

We can define sustainability as follows: It is an approach that aims to protect the living spaces and natural resources of future generations while meeting the needs of the current generation, and is based on balanced consumption and production with economic, social and environmental dimensions [3]. In other words, sustainability means using environmental resources in the most appropriate way, maintaining basic ecological processes, and protecting natural heritage and biodiversity [4]. Coastal areas

possess sensitive natural and cultural resources. In addition, since there are many elements that threaten these resources in these areas, use with the principle of sustainability becomes very important. Since they are heavily used for different functions, the resources of the strait coastline and the existing threats should be determined. This study was conducted based on this need.

Only a few straits in the world, like the Çanakkale Strait, connect two continents and are on trade routes of different countries. The Çanakkale Strait is also very important in terms of geopolitics, strategy and international transportation, as it is located on a line extending from the Mediterranean to the Black Sea [5]. With these qualities, it has attracted the attention of the whole world and is a frequent destination for international visitors.

This study was carried out based on the necessity of evaluating the strait coastline, which has rich resources within the urban area, in terms of landscape architecture. The study highlights the importance of coastal areas and straits through literature reviews, and aims to provide recommendations for the sustainable use of the Çanakkale Strait.

Coastal Area And Strait Coast

Coastal areas serve a wide variety of functions due to their ecological, economic, and cultural values. One of the most important coastal areas in terms of enabling different uses around the world, shaping urban settlements, and connecting different regions is the strait coastline. As stated by Çelik Çanga [6], also stated the straits, just like other natural formations, are basic destinations for tourist and recreational activities.

Straits are natural water passages that connect seas, inland seas, and continents with each other and with oceans via the shortest route. These passages are geographical formations that are crucial for maritime trade and hold significant military and geopolitical importance worldwide [7]. In addition, the strait coastline are important landscape areas with their visual and natural values. From this perspective, the major straits in the world can be listed as Messina, Oresund, Gibraltar, Singapore, and Malacca.

Turkey has two important straits: the Çanakkale and the İstanbul Straits (Figure 1). The region formed by these straits is defined as the “Turkish Straits” and has heavy national and international maritime traffic [8]. The Turkish Straits hold a strategically crucial position in global maritime transportation. The significance of the Çanakkale and İstanbul Straits stems not only from their economic and commercial functions but also from their role as vital defense links connecting the Black Sea to the Aegean Sea and, consequently, the Mediterranean Sea [9]. Historically, enemy fleets were prevented from passing through the Çanakkale Strait to avert the occupation of Istanbul.

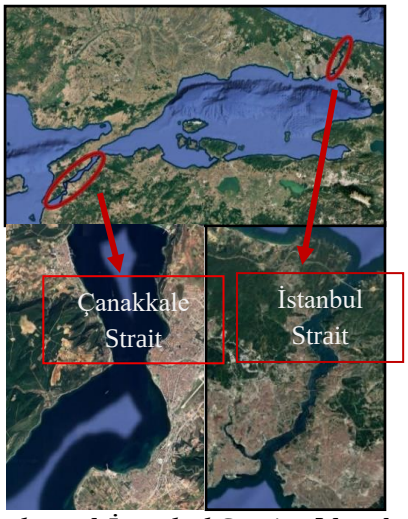


Fig. 1. *Çanakkale and İstanbul Straits [developed from 10].*

Erol [11] emphasizes that the straits of Istanbul and Çanakkale, with their narrow structures, promontories surrounded by winding hills, and sudden changes in course, are natural waterways rarely seen anywhere else in the world. These characteristics make both straits important on an international scale. At the same time, this situation adds a unique viewing pleasure to recreational use of the straits' coastline. Known worldwide as the Turkish straits and frequently visited, these regions have been the subject of songs and poems and have contributed to our country's cultural identity throughout history with their various uses. Due to their importance, the use of the straits' coastlines is increasing, and they are also becoming a focus in terms of settlements.

One of the most important characteristics of cities located on the shores of straits is their high visual quality and landscape diversity. For this reason, social and recreational areas in these cities are generally concentrated along the coastline. Thus, social activity and interaction are quite high in areas located on the shores of straits [12]. In addition, industrial, transportation, port, and tourism facilities located along the coastline provide indirect benefits to users due to their economic and functional contributions to urban life, while rest, walking, and recreation areas designed for all members of society provide direct benefits [13]. However, these multidimensional uses and characteristics of the straits accelerate the process of construction along the strait coastline.

The strait coastline are more easily affected by human-induced interventions compared to inland areas. The roads, parks, and infill areas constructed in these zones are among the leading examples of such interventions. The fundamental reason why coastal areas are affected by these interventions is that, compared to the inland parts of the land, these areas have a more variable and dynamic structure in terms of natural conditions [14]. This situation stems from the fact that the shores of the strait are constantly exposed to factors such as wind, waves, salinity, sunlight, and humidity, and these factors are subject to change. Therefore, landscape architecture approaches that preserve ecological balance and enhance aesthetic value should be adopted in the planning and design process of the shores of the strait.

Landscape architecture plays an important role in the protection and sustainable use of strait shoreline areas. In the studies to be carried out in these areas, sustainable designs should be created that appeal to all segments of society, evaluate the natural and artificial characteristics of the area together, and contribute aesthetically and

functionally while preserving the ecological balance. In this process, the use of the strait shoreline and the characteristics of the region should be taken into account in the selection of species and the creation of compositions in planting designs.

In order to create aesthetic and functional designs using plants, which are the main material in landscape architecture projects, plants must be used according to planting design elements and principles. At the same time, it should be taken into account that plants are living elements, and changes that will occur over time should be considered [15]. Additionally, the functions that plants provide from an architectural and engineering perspective influence their spatial use in designs [16]. In order to provide users with comfortable, safe, and healthy living spaces in strait coastal areas, it is essential to make the most of these characteristics of plants.

MATERIAL AND METHOD

The Çanakkale Strait, which connects the Sea of Marmara and the Aegean Sea, extends in a northeast–southwest direction between the Biga and Gallipoli Peninsulas [17]. The coastal area in the city center on the Biga Peninsula side of the Çanakkale Strait has been designated as the main material for the study (Figure 2).

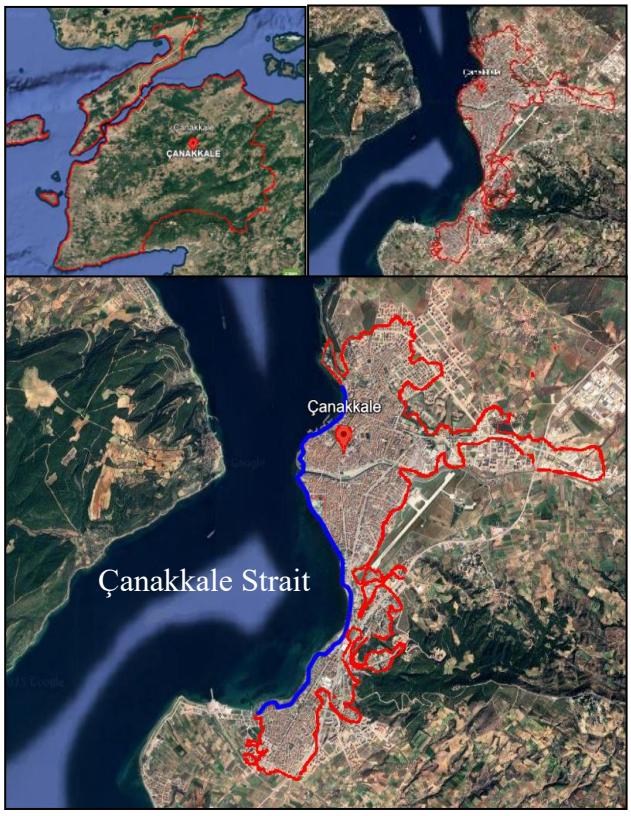


Fig. 2. *Study area [developed from 10].*

The Çanakkale Strait is a passageway stretching between the European continent and the Asian continent. The European side has a coastline of approximately 78 kilometers, while the Anatolian side, located on the Biga Peninsula, has a coastline of 94 kilometers. The total length of the strait measured from the sea surface is approximately 68 kilometers. Its narrowest point is located between Çimenlik Castle in the city center

and Kilitbahir Castle on the Gallipoli Peninsula, and is 1,200 meters wide. The average depth of the strait is approximately 60 meters [18].

In the methodology of this study, the importance of the strait shoreline within the urban settlement was revealed through literature reviews, and the focus was directed toward the shores of the Çanakkale Strait. The strengths and weaknesses, opportunities, and threats of the urban use of the Çanakkale Strait shoreline were evaluated through a SWOT analysis from the perspective of landscape architecture [19, 20, 21, 22]. In these areas, the measures that need to be taken in terms of landscape architecture and the plant species suggestions suitable for the area for sustainable planting designs were identified. The measures that should be taken from the perspective of landscape architecture were determined specifically for the Çanakkale Strait shoreline.

FINDINGS

Characteristics of the Use of the Urban Coastal Area of the Çanakkale Strait

The urban shoreline of the Çanakkale Strait is an important open space and recreation area for both the local population and visitors to the city. The natural landscape formed by the mountains sloping down to the strait, the scenic values stretching along the coastline, and the region's historical and cultural heritage enhance the area's appeal. Architectural and structural elements from different periods give this area a historical identity. The strait's coastal strip, with its walking paths, seating areas, and coastal views, meets users' needs for relaxation and recreation while also offering tourists the opportunity to experience Çanakkale's history and cultural atmosphere [12].

The Çanakkale Strait stands out for its historical identity and strategic location, which has led to the construction of defensive structures throughout history. The castles located along the shores of the strait are key elements that define the region's identity, both militarily and culturally (Figure 3). The Çimenlik (Kale-i Sultaniye) castle on the Anatolian side and the Kilitbahir (Kilid-ül Bahir) castle on the European side were built by Fatih Sultan Mehmet to prevent the passage of fleets that could threaten the security of Istanbul. Many other castles were also built in the strait during earlier and later periods [23]. Additionally, the Trojan Horse, built for a film symbolizing the city's history and located in the urban coastal area of the Çanakkale Strait, enhances the tourist appeal of the urban coastal area.



Fig. 3. *Fortresses as important historical structures located in the Çanakkale Strait [developed from 24]*



Fig. 4. *Urban strait coastline (2025)*

In some parts of the urban coastline of the Çanakkale Strait, the coastal area has been expanded through infill works. Residential areas are dense along the urban coastal zone. In addition, the areas include functions such as squares, ferry piers, a port, parking areas, hobby–exhibition areas, a marina, cafes–restaurants–tea gardens, children's playgrounds, sports areas, resting areas, walking–cycling paths, viewing terraces, and beaches, as well as private property areas. Green space within the urban coastal area is limited, and there are only a few plants in certain places, mainly for providing shade (Figure 4 and 5).



Fig.5. *Urban strait coastline (2025)*

Climate Characteristics of the Çanakkale Strait

The shores of the strait have special conditions due to their geographical location and the influence of the sea. These conditions directly affect the planning of the coastal landscape, the plant composition to be used, and the intended uses of the area.

Therefore, the climatic conditions of these areas must be taken into account in landscape designs to be implemented on the shores of the strait.

Çanakkale's climate is the Marmara climate, which combines the characteristics of the Mediterranean and Black Sea climates [25]. According to the data of the General Directorate of Meteorology [26], based on measurements taken in the province of Çanakkale between 1929 and 2024, the average annual temperature has been determined as 15.2°C. The average minimum temperature is 10.9°C, while the average maximum temperature is 19.8°C. The duration of sunshine is highest in the summer months, and the annual average daily sunshine duration is 7.2 hours. The number of rainy days increases particularly during the winter months. The annual average number of rainy days is 83.9, and the annual average precipitation amount is 623.2 mm [26]. The average humidity in Çanakkale is 72.6% [27]. The average wind speed is 6.14 m/s [28].

In his study, Doğaner [29] examined the climatic characteristics of the Çanakkale Strait. Since there are no high mountainous areas along the strait coastline that could block the cold air currents coming from Central Anatolia and the Balkans, severe cold conditions can be effective during the winter months. For this reason, frost events are frequently observed in the region. The wind regime is influenced by local geographical conditions. Northern winds dominate the region, and the northeasterly (poyraz) wind, in particular, maintains its influence throughout the year. While the poyraz is observed more frequently in the summer months, it increases its speed in winter and can continue blowing for long periods without changing direction. Although this situation occasionally affects maritime transportation and coastal tourism negatively, it also provides coolness along the coastline during summer and enhances the feeling of refreshment for people [29].

SWOT Analysis of the Urban Coastal Area of the Çanakkale Strait

The SWOT analysis conducted to determine the strengths, weaknesses, opportunities, and threats of the urban coastal areas of the Çanakkale Strait in terms of landscape architecture is presented in Table 1.

Table 1. *SWOT Analysis of the urban coastal areas of the Çanakkale Strait in terms of landscape architecture:*

Strengths	**Weaknesses**
High visual landscape quality created by the natural landforms and the strait scenery	Increasing construction pressure in urban coastal areas and narrowing of the coastline
Contribution of historical structures to the urban identity	Risk of natural disasters (storms, floods)
Reflection of different natural events on the landscape; the sun creating a seasonal visual spectacle on the opposite shore	Unplanned and aesthetically incompatible constructions
High social and recreational potential provided by walking paths, resting areas, and the coastal promenade	Being exposed to natural factors such as wind, humidity, waves, and salinity
Creating tourism and economic value	Limited green areas and insufficient vegetative shading

Providing international waterway transportation, port, and marina functions	Needing maintenance and repair due to strong wind exposure
Offering opportunities for sustainable landscape arrangements compatible with the coastal ecosystem	Seasonal use limitations due to cold weather and wind in winter
The high attractiveness of coastal areas in terms of tourism	Vehicle traffic along the coast negatively affecting recreational areas
Opportunities	**Threats**
Providing opportunities for sustainable and ecological landscape projects	Climate change
Possibility of energy generation through different currents and wind effects in the strait and the potential for scientific activities	Pollution caused by continuous heavy-tonnage ship traffic
Ability to provide wind and sun control through planting designs	Coastal erosion and loss of natural habitats
Supporting local economic development	Unplanned construction and high population pressure
Enhancing urban identity value	Natural disasters (storms, floods, landslides)
Designing sustainable and landscape-oriented spaces	Decline in landscape quality due to insufficient maintenance and repair
Providing opportunities for projects that encourage the use of local plant species	Lack of landscape design and ecological planning
Developing projects that support plant and ecological diversity	Negative impacts on natural landscape due to increased construction from transportation, port, etc. uses
The presence of different cultural textures on both sides of the strait	Deterioration caused by humidity, wind, and storm effects
Increasing tourism and cultural activities	Rapid change of local identity leading to its loss

CONCLUSIONS AND RECOMMENDATIONS

The urban coastal area of the Çanakkale Strait serves a multifaceted function, both in terms of contributing to urban identity, recreational and social spaces in city life, and in terms of its importance for transportation and trade. However, over time, increased development in the coastal area has disrupted the balance between natural and built areas, altered the natural shape of the shoreline, expanded the transportation system, and consequently negatively impacted the natural landscape and ecological balance along the strait's coastline. However, the natural structure of the straits has significant visual and cultural landscape value and is unique in the world. Today, while these areas meet the transportation, walking, recreation, and socialization needs of city dwellers, it is imperative that their development be ensured through sustainable landscape planning and design practices.

As a result of the evaluations, the natural landforms, visual landscape value, historical identity, and recreational diversity of the Çanakkale Strait constitute the strong aspects of the area. However, increasing construction pressure, the limited presence of green spaces, climatic factors, and the impact of wind are its weak aspects. The opportunities of this area lie in its suitability for the development of sustainable and ecologically based landscape projects. The most significant threats, on the other hand, are unplanned construction and the loss of natural habitats. This assessment emphasizes the necessity of developing sustainable, identity-oriented landscape designs that are compatible with local ecological conditions in the planning of urban areas along the strait coastline.

The protection of coastal ecosystems, balancing the effects of wind, sun, and humidity, and enhancing user comfort are key objectives that necessitate careful and thoughtful implementation of planting design along coastal areas, ensuring both functional and aesthetic considerations are met. In this context, the selection of appropriate plant species and the balanced use of design elements will enhance both the visual and ecological quality of the coastal landscape.

The elements of planting design used in planting design projects are form, line, texture, color, and size [30, 31]. Plant designs created with these elements in mind gain aesthetic, functional, and sustainable characteristics [32]. In addition to these elements and principles, the functions of plants should also be considered in ensuring sustainable landscape design along coastal areas. These functions are divided into two categories: engineering and architecture. The engineering functions of plants include temperature and humidity control, erosion control, climate control, noise and dust control, wind control, and air pollution control [16, 33]. The architectural functions of plants include providing visual control, seasonal aesthetic effects, physical control and privacy, screening, creating a backdrop, forming spaces, and softening the hard textures of building elements [16]. By taking these characteristics of plants into account, designs created along the shores can achieve both environmental functionality and visual balance.

In line with the specified ecological conditions and design principles, some suitable plant species that can be recommended for the urban coast of the Çanakkale Strait are presented in Table 2. These plants are species that will contribute to the sustainability of the coastal landscape both functionally and aesthetically.

Table 2. *Plant species suitable for use in urban strait coastal planting design [created by taking advantage of 34, 12]*

Plant name	**Family**	**Type**	**Native range**	**Leaf characteristic**	**Element characteristics**				**Functions**
					Size	**Form**	**Color**	**Texture**	
Albizia julibrissin	Fabaceae	A	E	Y	5	7	1,8	1	1,3,5,6,12
Arbutus unedo	Ericaceae	B	D	H	3	3	1,2	2	1,2,10, 13

Callistemon citrinus	Myrtaceae	B	E	H	2	7	1,8	2	1,2,12,13
Cercis siliquastrum	Fabaceae	A	D	Y	3	5	1,8	2	1,2,12,14
Chamaecyparis lawsoniana	Cupressaceae	A	E	H	5	2	1	3	1,3,6,7
Chamaerops humilis	Arecaceae	A	E	H	4	4	6, 7	3	1,3,6
Cotoneaster horizontalis	Rosaceae	C	E	Y	1	8	1,2	2	2,10, 13
Crataegus monogyna	Rosaceae	A	D	Y	4	5	1,2	2	1,2,7,12, 13
Elaeagnus pungens 'Maculata'	Elaeagnaceae	C	E	H	2	7	5	2	2,7,11
Fagus sylvatica	Fagaceae	A	D	Y	5	5	1, 4	2	3,5,14
Fraxinus excelsior	Oleaceae	A	D	Y	5	5	1,4	2	3,5,8,14
Jasminum officinale	Oleaceae	D	E	Y	2	8	1, 9	1	1,4,12
Laurus nobilis	Lauraceae	B	D	H	3	3	1,4	3	2,3,7
Lavandula angustifolia	Lamiaceae	C	D	H	1	7	6	1	1,2,9,12
Myrtus communis	Myrtaceae	B	D	H	3	5	1	2	1,2,4,6,13
Nerium oleander	Apocynaceae	C	D	H	2	7	1,8	3	1,2,3,6,7,12
Passiflora caerulea	Passifloraceae	D	E	Y	2	8	3,8	1	1,4,12,13
Phillyrea latifolia	Oleaceae	B	D	H	3	7	1	2	2,3,7
Phoenix canariensis	Arecaceae	A	E	H	5	7	1,4	3	1,3,6
Pistacia lentiscus	Anacardiaceae	B	D	H	3	5	1,2	2	2,3,7
Quercus coccifera	Fagaceae	A	D	H	2	7	1,4	3	3,7,10
Quercus rubra	Fagaceae	A	E	Y	5	5	1	3	1,3,5,14
Spartium junceum	Fabaceae	C	D	Y	2	7	4	1	1,3,10,12
Syringa vulgaris	Oleaceae	B	E	Y	2	5	1,8	2	1,2,12,
Tamarix tetrandra	Tamaricaceae	B	D	Y	4	6	1,8	1	1,7,10
Yucca filamentosa	Asparagaceae	C	E	H	2	7	1,9	3	1,10

*Type: A: Tree, B: Shrub, C: Bush, D: Groundcover / climber; Native range: D: Native, E: Exotic; Leaf characteristic: H: Evergreen, Y: Deciduous; Size: 1:0-1m, 2:1-3m, 3:3-5m, 4:5-10m, 5:10 m and above; Form: 1: Columnar, 2: Pyramidal, 3:Oval, 4: Conical, 5: Round, 6: Weeping, 7: Irregular, 8:Spreading / horizontal; Color: 1:Green, 2:Red, 3:Blue, 4:Yellow, 5:Variegated, 6:Blue-green, 7:Gray-green, 8:Pink, 9:White;

Texture: 1: Thin, 2: Medium, 3: Coarse; Functions: 1:Accent, 2:Hedge plant, 3:Background formation, 4:Enclosure, 5:Providing shade, 6:Street/road plant, 7:Windbreak, 8:Dust and noise control, 9:Wayfinding, 10:Erosion control, 11:Soil improvement, 12:Effective with flower display, 13:Effective with fruit display, 14: Autumn color effect.

Although the study focuses specifically on the Çanakkale Strait, it will serve as an example for other strait cities with similar characteristics. Therefore, the following recommendations should also be taken into consideration:

- Since ecological-based landscape planning is essential along the urban strait shoreline, plant species compatible with the coastal ecosystem should be preferred.
- Native plant species should be prioritized to reduce maintenance costs and ensure sustainability.
- Exotic species should also be included to ensure aesthetic diversity. Native species should be placed in a way that supports exotic species.
- Layered planting should be done in the area. Trees, shrubs, and herbaceous plants should be used.
- The amount of green space in the area should be increased.
- Seasonal plant diversity should be ensured, and the visual continuity of the coastal vegetation should be maintained through the use of plants with different textures and colors.
- Priority should be given to plants that can provide shade and windbreaks for user comfort.
- Landscape designs that are compatible with the structures (such as castles) and do not obscure them should be created and implemented around historical and cultural structures.
- Materials appropriate to the identity of the strait should be used throughout the area.
- Regular maintenance work should be carried out to ensure the sustainable use of the area.
- Social awareness should be increased, and environmental and nature education should be provided on-site at the coast.

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