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*Research Article*

# POST-EARTHQUAKE USE POTENTIAL OF ÇANAKKALE SARIÇAY RIVER AND ITS NEAR SURROUNDINGS

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**ABSTRACT.** Today, with the influence of coastal trends, these are regions where urban uses, industries, energy terminals, shipyards, second homes, tourism, recreation, maritime trade and transportation, fishing, etc. compete for location. Coastal cities are living spaces formed by the confluence of people with diverse cultural and social backgrounds. Coastal areas have been important components of the economic dynamism of the cities they occupy from past to present. Economic dynamism has a significant impact on the sensitive environment and natural resources in coastal areas. Before earthquakes, waterfronts were generally used for economic purposes such as agriculture, transportation, and tourism. After disasters, these areas; They play a crucial role in meeting vital needs such as shelter, food, and water supply. This study analyzes the potential post-earthquake usability of the Sarıçay River and its surroundings in Çanakkale. Due to the potential collapse of residential buildings following the earthquake, it is crucial to create a landscaping project that can meet the needs of the public after the disaster. The Sarıçay River offers significant potential in this regard. This study proposes innovative and resilient design proposals from a landscape architecture perspective for the post-earthquake use of the Sarıçay River and its surroundings. Specifically, the aim is to develop proposals for an earthquake park concept that will serve as a gathering place during a disaster and contribute to urban life afterward, ensuring the area is both safe and ecologically sustainable.

***Keywords:*** *Çanakkale, earthquake, earthquake park, Sarıçay river*

## INTRODUCTION

A city is a settlement where people live and where social, economic, political, cultural, and other activities are concentrated. Cities tend to have larger populations than villages and towns, more developed infrastructure (roads, water, electricity, sewage, etc.), and prominent economic activities such as industry, trade, and the service sector are at the forefront. Throughout history, cities have developed as centers of trade and administration, where people gathered, divided labor, exchanged culture and information [1].

The concept of urbanization emerged with the migration of people from villages to cities. Over time, cities became more convenient for people. Factors such as the availability of social amenities, easier access to education and healthcare, and the ease of access to roads encourage people to migrate to cities. Many factors contribute to urbanization movements. Examples include economic, political, and technological advancements. Considering the role of urbanization in Turkey, a rapid migration from villages to cities began after the 1950s. Reasons for this include unemployment in the village caused by mechanization, low earnings, seasonality of jobs, inadequate services such as education and healthcare, and the lack of socio-cultural activities such as theater and cinema, which appeal primarily to the young population [2].

The coast is where bodies of water such as the sea, river, or lake meet the land. The boundary line where water meets land is called a "shore." Shores have different characteristics, such as cliffs, beaches, or sandbars. Shores are areas where people connect with the sea and where activities such as fishing and tourism take place. The areas where rivers flow into the sea are often deltas or mouths, where the boundary between the shore and the river can be blurred. Such areas are areas where both land and water interact. They are the natural areas formed by this confluence, where the river carries water and meets the sea. In these areas, factors such as erosion and water movement influence the shape of the coast [3].

Sudden and intense vibrations on the Earth's surface caused by movements in the Earth's crust are called earthquakes. These vibrations are caused by the fracturing or movement of rocks within the Earth. Earthquakes can create significant shaking on the Earth's surface and can cause landslides, building collapses, and tsunamis. The intensity of an earthquake varies depending on the depth of the Earth and the characteristics of the location where it occurs.

Earthquakes are generally associated with the movement of tectonic plates within the Earth's crust. These movements accumulate tension as the plates rub, collide, or separate, resulting in an earthquake [4]

The purpose of this study is to determine the potential use of the Sarıçay River and its surrounding area in a potential post-earthquake period and to develop design recommendations appropriate for this purpose.

## MATERIAL AND METHOD

The main material of the research is the Sarıçay River and its immediate surroundings located in the Çanakkale Central District (Fig 1). The Sarıçay River is located in the city center of Çanakkale, at approximately 40°08'42" north latitude and 26°24'00" east longitude [5]. The Sarıçay River, with a total length of 40 km and a flow rate of 1300 m3/s, starts from Küçükburun, stretches through the Atik Hisar Dam and flows into the Çanakkale Strait [6].

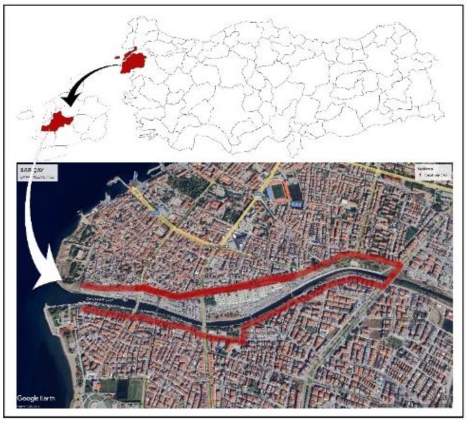

***Fig 1.*** *Location of the study area (modified from Google Earth, 2025).*

The study was conducted to create temporary shelters for earthquake victims following a potential earthquake in Çanakkale. The study area begins at the Troy Bridge and ends at the İnönü Bridge. The study area is approximately 1.79 km long.

The primary reasons for selecting the Sarıçay River as the study area were its location in the city center, its location at a location well-known to the people of Çanakkale, its suitability for earthquake tents, and its ability to meet post-disaster needs.

The research methodology consisted of four stages. In the first stage, a literature review was conducted from domestic and international sources related to the study area and topic. Additionally, surveys and photographs were taken of the study area, and information and documents about the study area were collected from relevant institutions. In the second stage, the collected data were analyzed. In the third stage, the data and the study area were evaluated together. This stage also included a SWOT analysis. In the fourth stage, design proposals were presented for the creation of various post-earthquake spaces along the Sarıçay River and its surrounding area.

## FINDINGS

### *Natural Features of the Study Area*

*Climate*

Due to its location, Çanakkale province exhibits characteristics of a transitional climate between the Mediterranean and Black Sea regions. Its general characteristics reflect those of the Mediterranean climate. Furthermore, due to its northern location, average winter temperatures are lower. The lowest temperature in February is -4.2°C, and the highest in August is +35.8°C. The annual average temperature is 14.7°C, and the average humidity is 72.6%. Sea water temperatures reach their highest levels in July and August. Rainfall is heaviest in autumn and less frequent in spring. Strong winds prevail in winter [7].

*Sunshine*

Considering the long-term average daily sunshine duration in Çanakkale province, the highest sunshine duration is in July with 11.7 hours, and the lowest sunshine duration is in December with 3.1 hours, totaling an average of 2574 hours of annual sunshine [8].

*Wind*

According to data from the İzmir 2nd Regional Directorate of Meteorology, the predominant wind direction in Çanakkale is north-northeast (NNE), with a secondary prevailing wind direction of northeast (NE) due to seasonal variations. In our province, the highest wind direction and intensity was measured in the Bozcaada district with a southerly wind speed of 175.68 km/h [8].

Average annual precipitation varies between 662.8 $m^3$ (Gökçeada) and 854.9 $m^3$ (Ayvacık). Rainfall is quite low in the summer months. The months with the highest rainfall are December, January, and February. The maximum number of days covered with snow is approximately eight [9].

*Hydrology*

Hydrological drought in Çanakkale manifests itself as a decrease in surface and groundwater resources due to long-term rainfall deprivation. An examination of meteorological data between 1929 and 2007 reveals a general decreasing trend in annual precipitation. The decrease in winter precipitation, in particular, leads to significant declines in river flows and groundwater levels in the region.

Sarıçay and its surrounding area are one of Çanakkale's important water resources and are critical for both agricultural irrigation and ecological balance. However, hydrological data in the region indicate that groundwater levels have decreased with decreasing precipitation. While a partial increase in spring precipitation has been observed, this increase is not sufficient to offset the current drought trend.

Extreme drought conditions were experienced, particularly in 1949, 1990, and 1992, leading to a decrease in surface water levels. The effects of drought on hydrological systems include irregular river flows, falling lake and dam water levels, and depletion of groundwater reserves [10].

***Cultural Characteristics of the Study Area***

Çanakkale's city center has historically been an important administrative and strategic hub. Consequently, many cultural structures, such as mansions, fountains, military structures, and religious sites, have been constructed in the city. The Sarıçay River Valley played a significant role in the city's development, and the quarries in the area provided the materials used in the construction of historical structures. Stones from these quarries were used in the construction of important structures such as Kilitbahir and Çimenlik Castles, as well as Atik Hisar Castle.

The Sarıçay region has historically been a center of economic and social life. Quarries are located in areas along the river valley, and the stones extracted from these quarries are incorporated into various architectural structures of the city. The cultural heritage preserved in the region from past to present underscores Çanakkale's significant historical position. The ancient city of Abydos, located in the city center, is located at the narrowest point of the Dardanelles and holds significant historical value due to its location at the most convenient point of passage between Asia and Europe [11].

*Population*

Çanakkale province has a total population of 568,966. The central district's population is 204,454. This corresponds to approximately 35.93% of the province's total population. The central district is the most populous district in Çanakkale province, making it the most densely populated and developed region in economic, social, and cultural terms [12].

*Economic Structure*

Çanakkale's economy, while primarily agricultural, has diversified in recent years with the development of industrial and commercial sectors. The agricultural sector accounts for 24.7% of the Gross Domestic Product (GDP), 23.5% in industrial production, and 17% in commercial production. According to 2000 data, 56% of employment is in agriculture, 9% in industry, 4% in construction, and 31% in the service sector. The unemployment rate in the province is 3.6%, below the Turkish average. Of the total 330,337 hectares of agricultural land, 81% consists of arable land, 7% of vegetables, 2% of fruit, and 2% of grape and olive groves. 65% of irrigable land is operated by the state.

Industrial activities are concentrated in the Çanakkale and Biga districts. In the Çanakkale Organized Industrial Zone, 66 of the 91 parcels have been allocated to investors. There are 997 businesses operating throughout the province, and 51 bank branches are operational. The primary sources of income are agriculture, industry, and trade. Along with agricultural products, construction materials, ceramics, olive oil, and frozen food production also play a significant role in the economy. In 2006, the province's total exports were US$484 million, and imports were US$137 million.

While Çanakkale's economic structure is generally based on agriculture, it is evolving into a more balanced and sustainable structure thanks to developments in the industrial and commercial sectors [13].

*Transportation*

The central district of Çanakkale province boasts a significant transportation network, both by road and sea. Çanakkale is located in the western Marmara Region and is accessible by both road and sea.

*Road and Domestic Transportation*

Because Çanakkale serves as a bridge between the Marmara and Aegean regions, road transportation is highly developed both within the city and between cities. The city center is located at the intersection of the D550 (E87) and D200 highways. These roads connect the province to the Tekirdağ-Istanbul line in the north and to Izmir in the south.

Çanakkale is approximately 5-6 hours away from Istanbul by road. It is possible to reach Çanakkale from Istanbul via Tekirdağ. Traveling from Çanakkale to Izmir by road is approximately 4 hours. From Izmir, the city connects to Çanakkale after passing through Balıkesir. Çanakkale is approximately 3-4 hours away from Bursa by road. The road connection between Çanakkale and Bursa is via Bandırma [14].

The main axes of urban transportation generally develop in north-south and east-west directions. Atatürk Avenue, İskele Avenue, Demircioğlu Avenue, Kayserili Ahmet Paşa Avenue, and İnönü Avenue are the city's most heavily used arteries. These streets are the main routes connecting both commercial and administrative centers. The Barbaros neighborhood, Kepez, and Eski Hastane Avenue have also become important transportation axes in recent years with the growth of residential areas.

Bus and minibus lines are used for public transportation in Çanakkale. Municipal buses operate regularly between the city center and Kepez, Esenler, Troya Avenue, and the university campus (Terzioğlu Campus). Additionally, bicycle paths that encourage cycling are becoming widespread, especially along the coastline (between İskele and Kepez).

*Sea Transportation*

Çanakkale's access by sea offers a significant advantage. The city can be reached via two main sea routes: the Dardanelles and GESTAŞ Ferries. The Dardanelles significantly simplifies access to the city center. Ferry services operate from Çanakkale city center to surrounding districts such as Gelibolu, Lapseki, and Eceabat. Sea transportation is also possible to islands such as Bozcaada and Gökçeada. The 1915 Çanakkale Bridge is an alternative transportation network connecting Gelibolu and Lapseki districts and also facilitating access to Çanakkale city center [15].

*Air Transportation*

Çanakkale has an airport, located in the city center. This airport operates flights nationwide, connecting to Ankara. Air transportation to Çanakkale offers a faster alternative than road transportation.

*Railway Transportation*

Çanakkale has no direct railway access, but it is possible to reach Çanakkale by transferring to railways in nearby provinces. Balıkesir and Bandırma provide a land connection to Çanakkale.

*Urbanization Process*

Çanakkale, a bridge between the Asian and European continents, has hosted significant cultures from the time humanity adopted a settled life to the dawn of historical times. Its dominance by diverse societies for millennia reveals the diverse traces of its diverse heritage in its architecture and daily life.

Turkish dominance of the Dardanelles began during the Ottoman period. Although the Ottomans annexed most of the Karesi Principality's territory in 1345, their control of the Dardanelles was established in 1354 with Süleyman Pasha's conquest of Gallipoli Castle. Subsequently, in 1356, the Rumelian coastline from Gallipoli to Tekirdağ was conquered. During the reign of Murad I, the entire Anatolian coast came under Ottoman rule, but complete control of the Bosphorus came after Mehmed the Conqueror conquered Istanbul and built the castles at the narrowest point of the Bosphorus in 1462. The Bosphorus subsequently assumed both the defense of Istanbul and served as the key to his plans for domination of the Black Sea-Mediterranean passage, maintaining its continuous military importance [16].

In the early years of the Republic, Çanakkale was a settlement that received limited immigration while also out-migrating to major cities. Despite being located in the Marmara Region, it was unable to participate sufficiently in the industrialization process and, due to its strategic location, assumed a more defensive function during this period. The Bosphorus bridge project, port improvements, airport expansion, and organized industrial zone decisions, which emerged from the 1980s, created expectations of economic revitalization in Çanakkale. However, the city's real development momentum began with the establishment of Çanakkale Onsekiz Mart University in 1992. The opening of the university increased the demand for housing, and especially the location of the Terzioğlu Campus determined the spatial growth direction of the city [17].

***Earthquake***

Çanakkale province and its entire districts are located within the First Degree Earthquake Zone on the Earthquake Zone Map published in 1996 by the General Directorate of Disaster Affairs of the Repealed Ministry of Public Works and Resettlement of the Republic of Turkey.

Çanakkale is located close to the western extension of the North Anatolian Fault Zone (NAFZ), one of Turkey's active earthquake zones, and therefore poses a high seismic risk (Emre et al., 2013). The region has historically been subjected to many destructive earthquakes; the Troad, Biga, and Ayvacık areas have been particularly affected by this activity. Active faults in the Aegean Sea and Edremit Bay, including the Saros-Gaziköy Fault, Etili Fault, Çan Biga Fault Zone, Sarıköy Fault, and Yenice-Gönen Fault, have produced 50 earthquakes with magnitudes >5.0 between 1950 and 2020 (Fig 2) [18].

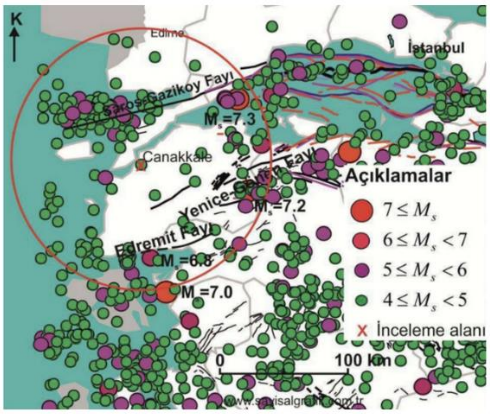


***Fig 2.*** *Active fault lines in Çanakkale [19].*

According to historical sources, the first major earthquake in the region occurred in 17 AD and caused significant destruction in the ancient Troad. In Republican-era records, the 1912 Mürefte-Şarköy (Mw 7.3) and 1935 Ayvacık (Mw 6.4) earthquakes caused structural damage in Çanakkale and its surrounding areas. More recently, the February 6, 2017 Ayvacık earthquake sequence, with aftershocks of magnitude 5.3–5.5, damaged settlements in the region, demonstrating the importance of local soil characteristics for structural safety [20].

Geologically, a large portion of the province lies within a first-degree earthquake zone, with the areas surrounding Ayvacık, Ezine, Bayramiç, Biga, and Lapseki posing a high seismic hazard. Because a significant portion of the building stock in Çanakkale's city center was constructed according to outdated regulations, the risk potential increases in the event of a major earthquake.

### *Analysis of the Current Situation of the Study Area*

The study area consists of three regions (Fig 3). A total of six bridges were considered within the scope of the study: the Troy Bridge, Atatürk Bridge, and İnönü Bridge, which are located over the Sarıçay River and are used by both vehicles and pedestrians, as well as three bridges that are pedestrian-only. These regions are as follows: Region 1, located between the Dardanelles and İnönü Bridge, is 482.75 meters long and covers an area of approximately 79,849 square meters; Region 2, located between İnönü Bridge and Atatürk Bridge, is approximately 365.26 meters long and covers an area of 53,256 square meters; and Region 3, located between Atatürk Bridge and Troy Bridge, is approximately 1,089.81 meters long and covers an area of 170,052 square meters.


***Fig 3.*** *Location of the study area (modified from Google Earth, 2025)*

### *Region 1*

The İnönü Bridge, located closest to the sea on the Sarıçay River, connects İnönü Street to Plaj Street. The bridge is located where the Sarıçay River flows into the sea. It is 14 meters wide and 115 meters long [21].

The southern bank of the Sarıçay River includes the terminus of Çimenlik Castle, the State Hydraulic Works Directorate, the Fevzipaşa neighborhood (Fig 4), the city's first settlement, and fishing shelters (Fig 5). The northern part of the river is unused land and used as a parking lot. The south bank of the river is 500 meters long. It has 994 $m^2$ of green space and 13,599 $m^2$ of hard ground. The hard ground consists of soil and concrete. There are no seating areas or recreational areas. It is used only by neighborhood residents and boat owners.

***Fig 4***. *Fevzipaşa Neighborhood* ***Fig 5.*** *Fishing Shelter*

The southern part of the river has more recreational areas than the northern part (Fig 6).

***Fig 6.*** *Walking Path*

The existing plant species in Region 1 include Spreading Juniper *(Juniperus horizontalis)*, Firethorn *(Pyaracantha coccinea)*, Fig *(Ficus carica)*, Stone Pine *(Pinus pinea L.)*, Oriental Plane Tree *(Platanus orientalis)*, Pendent Mulberry *(Morus alba 'Pendula')* (Fig 7). Flame Tree *(Photinia serratifolia)*, Japanese Privet *(Ligustrum japonicum)*, and Privet *(Ligustrum ovalifolium)* are also seen in the area, and there are green areas in places (Fig 8).

***Fig 7.*** *Existing Plant Species in Region 1*

***Fig 8.*** *Green Area*

***Region 2***

On the south bank of the Sarıçay River, near the Atatürk Bridge, there is a cafe and seating areas, fish restaurants (Fig 9), and Osnabrück Park (Fig 10), a joint project between Germany and the Osnabrück Municipality. This area provides a social interaction spot for walkers and those looking to relax. As you move towards the İnönü Bridge, seating areas (benches) and tree planting along the shore are noticeable. The area offers a rich landscape and plays a significant role in urban recreation with its green space and walking path along the shore. The northern part of the river is vacant land, used as a parking lot.

The terrain on the south bank is generally flat and has a suitable infrastructure for walking paths and recreational areas (Fig 11). However, due to its proximity to the water level, it requires regular maintenance and improvement in certain areas.

***Fig 9***. *Fish restaurants and the southern coastline*

***Fig 10***. *Osnabrück Park*

***Fig 11****. Walking paths and recreation areas*

A minibus garage is located on the north bank of the Sarıçay River, by the Atatürk Bridge. While this garage plays a significant role in the city's public transportation system, it may require different arrangements for urban use due to heavy vehicle traffic. The area east of the minibus garage, extending to the İnönü Bridge, is used as a green space and parking lot. This parking lot and garage area total 24,849 m². The parking lot is centrally located in the city and serves both private vehicles and commercial businesses (Fig 12).

***Fig 12.*** *Car Park*

The land structure in this region is designed for more functional uses compared to the south side, focusing on meeting transportation and parking needs. However, better integration of green spaces and urban amenities could enhance the area's recreational and aesthetic value.

Existing plant species in Region 2 include Star Bush *(Pittosporum tobira),* Oriental Thuja *(Platycladus orientalis),* Oleander *(Nerium oleander),* Bush Daisy (Euryops pectinatus), Tamarix *(Tamarix tetranda),* and Blue Cypress *(Cupressus arizonica)* (Fig 13). Stone Pine *(Pinus pinea L.)* and Olive Tree *(Olea europaea)* are also found in the area.

***Fig 13.*** *Current Plant Species in Region 2*

***Region 3***

Among the bridges over the Sarıçay River, the farthest from the sea is the Troy Bridge, at approximately 1,878 meters. The north side of the area encompasses approximately 25,937 square meters of green space, with a bridge connecting the two sides (Fig 14). The north side of the area includes a pedestrian path, sports equipment, a playground (Fig 15), a basketball court, and a bicycle path (Fig 16). However, seating, trash cans, and lighting are inadequate. The area features interlocking paving stones on the pedestrian paths and sports areas, concrete on the basketball court, and natural soil in the children's playground. The area also houses the Çanakkale Municipality Marketplace and parking lot (Fig 17). The market and parking lot cover approximately 55,826 square meters.

***Fig 14****. North bank of the river and pedestrian bridge*

***Fig 15.*** *Children's Playground*

***Fig 16***. *Basketball court and bicycle path*

***Fig 17.*** *Parking area near the Market Place*

The southern bank of the Sarıçay River contains approximately 18,696 square meters of green space. While part of this area has a sloped structure, it transitions to flat areas starting from the marketplace (Fig 18). The stagnant water structure in this section of the riverbed negatively impacts environmental comfort and contributes to odor problems.

***Fig 18.*** *South bank of the river*

The plant species present in Region 3 include *Quercus rubra, Yucca filamentosa, Hibiscus syriacus*, Rose *(Rosa spp.),* Palm *(Chamaerops excelsa),* Cotoneaster horizontalis, Juniper *(Juniperus horizontalis),* Robinia pseudoacacia, Olive *(Olea europaea),* Boxwood *(Buxus sempervirens),* Fig *(Ficus carica),* Horse Chestnut *(Aesculus hippocastanum),* Oriental Plane Tree *(Platanus orientalis),* Cemetery Sycamore *(Cupressus sempervirens*), Catalpa *(Catalpa bignonioides),* Oleander *(Nerium oleander),* Thuja orientalis and Inverted Mulberry *(Morus nigra 'Pendula')* (Fig 19).

***Fig 19.*** *Current Plant Species in Region 3*

***SWOT Analysis***

***Strengths***

• Located in Çanakkale's city center, it offers easy access after a disaster.

• It has sufficient open space for earthquake tents, assembly areas, and logistical support.

• The Sarıçay River can provide an advantage in meeting post-disaster water needs and environmental rehabilitation.

• Its proximity to transportation routes and existing infrastructure facilitates disaster response.

• The region's historical and cultural significance can support sustainable post-disaster rehabilitation projects.

***Weaknesses***

• The Sarıçay River poses a flood risk due to its hydrological imbalance.

• Infrastructure deficiencies may exist for temporary shelter and logistical support after the earthquake.

• According to current hydrological data, groundwater levels are declining, which could pose a problem in post-disaster water supply.

• The region's exposure to unplanned urbanization could complicate long-term post-disaster rehabilitation.

***Opportunities***

• It could be considered a pilot region for a sustainable post-disaster urban design model.

• It offers opportunities for the creation of post-earthquake gathering areas, disaster parks, and open spaces.

• Given the region's cultural and ecological characteristics, economic opportunities could be created through post-disaster ecotourism and landscaping.

• The Sarıçay region could be integrated into sustainable urban transformation projects to strengthen the post-disaster urban fabric.

***Threats***

• Due to global climate change, the hydrological balance may be disrupted, and disaster risks such as extreme droughts and floods may increase.

• Insufficient funding for post-disaster rehabilitation projects creates risks.

• Economic imbalances can arise due to rapid post-disaster migration and demographic changes.

• Rapid and unplanned reconstruction processes can damage the region's natural ecosystem.

## *DISCUSSION AND CONCLUSION*

Due to its geological structure and location, Turkey lies on the Alpine-Himalayan earthquake zone and has been subjected to numerous destructive and moderate earthquakes throughout history. This makes our country a region at high seismic risk and allows Turkey to be defined as an "earthquake country." Therefore, increasing social awareness of earthquakes and preparing for potential earthquakes at any time should be among national priorities [22].

Disaster Response Plans, in terms of space use, develop decisions regarding how and where necessary services will be provided before and after a disaster. These generally include the identification of primary evacuation routes, secondary routes, and alternative evacuation areas before the disaster, and the urgent need for temporary shelter, cleanup, food and beverages, and other essential needs after the disaster. The implementation of these activities is shaped by the urban space and spatial organization required to carry out the activity. The primary objective of such a study is to establish a disaster management infrastructure and ensure that vital activities are met at a minimum level. Thus, designated assembly areas emerge as critically important for disaster management [23].

In addition to meeting the spatial needs of areas serving a specific urban function within built-up areas, urban spaces, public spaces, and open spaces are also crucial, particularly for creating assembly areas and temporary shelters. In the initial phase following a disaster, when panic sets in and people generally move from enclosed spaces to open spaces (the moment of an earthquake or the first minutes of an earthquake, zero-minute planning), there is a greater need for easily accessible and safe open spaces. In such times of crisis, public spaces that are easily recognizable by local residents, accessible quickly and regularly, of sufficient size, and largely comprised of open spaces and parks can be considered post-disaster assembly areas [23]. Open green spaces are where people feel most safe during and after an earthquake. These spaces also provide safe havens where people can pitch tents and temporarily stay away from buildings after an earthquake [22].

According to the World Health Organization, the minimum amount of green space per person in cities is at least 9 m², with the ideal amount being 10 to 15 m². The average per capita green space in developed countries is around 20 m². For example, in the United

States, the standard for urban open green space is generally 40 m² per person, provided the urban density is 250 people/ha (400 m² for 10 people). In cities like New York, Paris, and Copenhagen, this figure exceeds 40 m² per person [24].

When planning urban open and green spaces for use after a disaster, attention should be paid to ensuring they are located at an optimum distance from residential areas, are easily accessible, are monitored, are continuous, and are of sufficient size. Therefore, it is essential to assess the adequacy of the spatial distribution of these areas in terms of their proximity and width to urban areas deemed high-risk and capable of meeting greater needs in an emergency environment, and to address any deficiencies through planning. In addition to their emergency-related functions, open spaces also serve functions such as adequately meeting the city's recreational and sports needs, improving opportunities for utilizing microclimate features, and ensuring the continuity of walking and cycling trails as alternatives to motorized transportation [24].

Disaster areas should range in size from 3,000 m² (100 tents and 400 inhabitants) to 30,000 m² (1,000 tents and 4,000 inhabitants). The size of tent areas should range from a minimum of 3.5 to 4.5 m² per person to a maximum of 7.5 m² per person. When arranging a tent area, calculations should be made considering that the tents are sized to accommodate four people, resistant to external factors, and arranged in groups of 20-25, or arranged in islands [23].

To ensure that assembly areas can serve in the event of a potential earthquake, they should include easy access, a warehouse with tools and equipment for emergency response, equipment such as blankets, stoves, etc. for those in need of shelter, storage for water and food, a helipad, a parking lot for vehicles transporting items such as tools, equipment, and food, a loading ramp for vehicles to unload and load, a sports field that can be converted into an emergency hospital in the event of an earthquake, and indoor spaces where toilets and bathrooms can be met. Care should be taken to ensure that the building includes features such as indoor spaces where mobile kitchens can be set up or sports fields, lighting systems, fountains, and communication centers [23].

Earthquake parks should not only be used after an earthquake, but also be easily accessible in our daily lives. This is why the concept of transformable parks has emerged. Transformable earthquake parks should appeal to people of all ages, providing both functional and aesthetic opportunities for recreational activities before a disaster, and can also be transformed into spaces where people can easily meet their basic needs after a disaster [22].

Creating cities safe from natural disasters is a key criterion in urban planning in Japan. Since fires following earthquakes have caused significant damage in major cities, open space planning has become a fundamental part of Japanese urban planning. Urban open and green spaces used as evacuation/shelter areas after earthquakes in Japan are often open spaces for public facilities such as parks and educational buildings. The necessary infrastructure is prepared for use in these areas after an earthquake, and storage facilities are built for use in emergencies to enable earthquake victims to continue their vital activities [22]. Additionally, a Disaster Protection Proposal, Evacuation, and Assembly Area Plan was prepared in Tokyo, Japan, based on the "Disaster Protection Green Corridor Design Designed within the Framework of the General Design Plan for Post-Earthquake Development." In this context, the Tokyo City Plan, which was implemented in May 2001 as a transformation plan under the title "Grand Design for Recovery after an Earthquake," was examined using disaster design principles. These were as follows:

- Developing roads leading to buildings as a green line with parks and waterways,
- Establishing a 1.2 km distance between areas,
- Ensuring that area residents can reach safe areas within 30 minutes on foot,

• Establishing disaster action plans, evacuation axes, and safe shelter points,
• Establishing open space reserves [23].

Çanakkale is a region at high earthquake risk due to its location on active fault lines and the large earthquakes it has experienced in the past. Therefore, it is crucial for residents in the region to be aware of earthquakes and take the necessary precautions. Furthermore, it has been determined that there is no earthquake park in the central district of Çanakkale that could be used as a gathering place in the event of a potential disaster.

The Sarıçay River and its surrounding area, designated as the study area, offer suitable physical characteristics for the potential implementation of an earthquake park thanks to its extensive terrain. The area's location in the city center and its proximity to public institutions, organizations, and educational facilities make it strategically important. Its dominance of the surrounding gardens and open spaces allows for increased usability and expansion into open spaces in post-disaster situations. The study area encompasses a surface area of approximately 146,660 m² with functional potential.

***Recommendations Developed for the Post-Earthquake Use of the Study Area***

*Region 1*

Since the northern part of the region has a more solid ground structure compared to the southern part, it provides more suitable space for immobile temporary shelter units (containers, tents, etc.) (Fig 20).

***Fig 20.*** *Region 1 (modified from Google Earth 2025)*

Zone 1, located on the coastal side of Sarıçay, offers significant open space potential for post-earthquake use, with its extensive grassy areas and the remaining vacant space on the opposite bank. This approach is similar to the Avon River Precinct, which was redesigned in Christchurch, New Zealand, following the 2011 earthquake.

In Christchurch, the riverfront was transformed in the post-earthquake period to function not only for coastal recreation but also as gathering areas, temporary shelter, emergency use centers, and post-disaster social recovery spaces. Extensive grassy areas and stepped seating terraces created along the shoreline were transformed into flexible spaces that met the need for safe open space in the event of a disaster. Flood control meadows, rain gardens, and ecological buffer zones established along the riverbanks increased the area's resilience to changes in water levels (Fig 21). These landscape elements not only reduced flood risk but also created a natural drainage system that eased the burden on post-disaster infrastructure. The extensive, unobstructed grass surfaces and unoccupied shorelines of the Sarıçay River in Zone 1, as in the Christchurch example, create an open space system suitable for daily recreational use. They also provide a multi-purpose spatial infrastructure that can be used for rapid tent deployment, temporary shelter, assembly areas, or disaster logistics in the event of an earthquake. Therefore, the Christchurch waterfront development constitutes a strong, applicable, and international reference for Zone 1, both in terms of its spatial qualities and its potential for flexible post-disaster use [25].

***Fig 21.*** *Avon River Park in New Zealand [25]*

*Region 2*

This area, located between the Atatürk and İnönü Bridges, has the potential for versatile use after the disaster with its existing green areas, walking paths, seating areas and transportation connections (Fig 22).

***Fig 22.*** *Region 2 (modified from Google Earth 2025)*

Located in the middle reaches of the Sarıçay River, District 2 offers a more intensively used coastal area, dominated by hardscape, thanks to a fish restaurant along the shore, Osnabrück Park, and a large parking lot on the opposite shore. This spatial structure bears particular resemblance to the San Francisco Embarcadero Waterfront Renewal Project. The Embarcadero is a mixed-use coastal corridor redesigned to mitigate earthquake and flood risks, featuring restaurants, public parks, wide pedestrian paths, and parking areas (Fig 23). The project's hardscape-dominated shoreline is supported by wide promenades, bicycle paths, and open-air activity areas. Despite the pressure from dense construction, a linear public open space has been created that prioritizes pedestrians, is accessible, and can serve as a safe post-disaster escape route [26]. Similarly, the parks and parking areas in District 2 of Sarıçay are capable of serving both daily recreational uses and as post-earthquake gathering areas, tent setups, emergency logistics distribution points, or temporary event spaces. Furthermore, as in the San Francisco example, the hardscape surrounding restaurants can become open plazas, and parking lots can be converted into temporary shelters and orientation centers when necessary. In these respects, the Embarcadero model provides a strong reference for District 2's mixed-use structure, its balance of hardscape and green space, and its potential for flexible post-disaster use.

***Fig 23.*** *San Francisco Embarcadero Waterfront Renewal Project [26]*

*Region 3*

This area, located in the easternmost part of the study area, has been determined to be suitable for use after a natural disaster due to its green area and hard grounds totaling approximately 100,459 m² (Fig 24).

*Fig 24. Region 3 (modified from Google Earth 2025)*

Zone 3, in line with its topography and existing usage elements, allows for a multifunctional and staged post-earthquake settlement plan. The wide, flat grass surfaces running parallel to the river, thanks to their open and unobstructed character, make them the most suitable area for tent deployment, temporary shelter units, and disaster management tents. These areas are strategically located, allowing for both the creation of organized tent grids and rapid access for disaster management teams. The parking lot in the area can be used as an operational area to regulate the entry and exit of ambulances, fire departments, and logistics vehicles during the post-earthquake period; it can also serve as a secure traffic management point for equipment and material distribution. The parking lot's hard-surface structure also provides advantages for the installation of mobile healthcare units, vehicle charging points, or temporary administrative containers. The naturally sloped topography at the rear of the area and the surrounding area of the existing children's playground, due to its more sheltered and remote location, are suitable for recovery-focused functions. This area constitutes an ideal subzone for the deployment of medium-term support functions such as psychosocial support tents, child-friendly safe spaces, mobile health points, information and registration units, and hygiene and shower units in the post-earthquake period. Thus, Zone 3 becomes a holistic and tiered disaster support area, housing shelter and administrative units with its flat grassy areas, logistics and vehicle traffic with its parking lot, and recovery and social support services with its natural sloped section.

The tiered use potential of Zone 3 is similar to the Yodogowa Riverside Park in Osaka, Japan, where river floodplains and large grassy surfaces are effectively used in disaster management. This park, which stretches along the Yodogowa River, allows for both tent installation and recovery-focused support services to be organized within the same open space system, thanks to its flat grassy areas and natural sloped topography in the background (Fig 25). While the flat areas of the park are considered the primary zone where temporary post-disaster shelter and management tents are located, the sloped areas serve as a more protected sub-zone where psychosocial support, health services, and child-friendly safe spaces are created. Furthermore, the wide driveways and designated parking areas around the park facilitate unimpeded movement of ambulances and logistics vehicles, facilitating disaster management coordination. Due to this multi-layered structure, Yodogawa Riverside Park, planned in Zone 3, sets a strong international benchmark in terms of tent layout, management area, recovery units, and logistics functions [27].

***Fig 25.*** *Yodogawa Riverside Park in Osaka City [27]*

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