Analysis of Location According to Suitable Criteria for Earthquake Park in Van/Turkiye City Scale

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Abstract
Title - Analysis of the earthquake park according to the appropriate criteria

After disasters, it's critical to attend to people's basic requirements. In addition to serving the city's recreational requirements on a regular basis, open green spaces in cities can be crucial in providing for residents' basic needs, particularly during emergencies like earthquakes. Site selection is crucial in this situation to prevent earthquake parks from becoming a secondary threat in the event of a disaster.

The study aims to determine the parks that can be earthquake parks in Van's/Turkiye İpekyolu, Tusba and Edremit districts and to choose the most suitable area. The AFAD (Disaster and Emergency Management Presidency)-designated emergency assembly, evacuation, and shelter areas as well as additional parks that satisfy the required requirements were discussed in these districts. These areas were evaluated with the integrated study of MCDM (Multi-Criteria Decision Making) Methodologies AHP (Analytical Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solutions) methods in site selection for the earthquake park. The top factors to consider when choosing an earthquake park's location were chosen. The power of each area was graded using these standards. For the creation of an earthquake park in Van, a total of six ideal alternative park locations, two in each district, were identified. Atatürk Park, located in İpekyolu Neighborhood, has been suggested as the most suitable park to be converted into an earthquake park, with its justifications.

In future studies on earthquake-oriented urban planning, the method used for site selection of earthquake parks is believed to offer substantial benefits to the relevant stakeholders.

Keywords
Urban open green space, Earthquake park, Multi-Criteria Decision Making, Van City

1.Introduction

Earthquakes are among the disasters that cause the most loss of life and property. It is a system that covers the whole of disaster management, risk, and crisis management. Risk management needs to be done to completely or partially eliminate the danger that may turn into a disaster in a settlement and minimize the damage (Tezgider, 2008). The main task of crisis management is to predict and prevent a possible crisis and, if this is not achieved, to ensure that the process is overcome with minor damage. Measures taken to minimize the damage in the event of a disaster against unavoidable types of disasters; The whole of the work carried out for the correct orientation of the disaster victims and their evacuation to accessible, safe places at the time of panic, and the fulfillment of needs such as search and rescue, aid, treatment, shelter and nutrition after the disaster, are evaluated within the scope of disaster management (Büyükkaracığan, 2016).

The devastating effects of earthquakes are observed in all parts of the world, especially in underdeveloped and developing countries. The most significant deficiency that causes deaths is that disaster management has never been done, done incompletely or not done correctly. One of the biggest reasons that increase the vulnerability of cities in the face of disasters is the neglect of occupancy and vacancy rates in unplanned or incorrectly planned urbanization processes and the inadequate urban open green spaces in the face of the density of building blocks in cities (Zengin Çelik et al., 2017).

According to the news of The Guardian magazine, people fleeing the fire caused by the great Kanto earthquake in Japan took shelter in wide open green spaces, causing the administrations to understand the importance of open green spaces in disaster management. Especially in recent years, great importance has been given to disaster management in Tokyo, and open green spaces have the priority they deserve in studies on this (Sarıçam, 2019).

In order to minimize the effects of physical and psychological destruction caused by earthquakes, it is critical to provide the survivors with their vital needs in humanitarian conditions as soon as possible after the earthquake. At this point, when we look at the solutions produced worldwide, the importance of urban open green spaces is remarkable. Establishing these areas as earthquake parks with some interventions to be made during or after the design stage means creating crisis solution points that will be vital in disasters. However, the main purpose of these areas is to meet the first vital needs by ensuring the safety of people in natural disasters and reducing or eliminating risks. For these areas to be safe against secondary threats caused by earthquakes, it is necessary to pay attention to site selection at the planning stage.

Various studies have been carried out on the emergency assembly area, a temporary shelter area, and earthquake parks. While Maral (2016) examined the planning of post-disaster temporary settlements from an upper scale, Çınar et al. (2018) examined the factors in planning post-disaster emergency assembly and temporary shelter areas. Aman (2019) focused on the location selection criteria for assembly areas in the Marmara earthquake. Gerdan and Şen (2019) evaluated the adequacy of emergency assembly areas, and Koçan and Sürün (2020) developed an earthquake park design for the Burhaniye district of Balıkesir province. Gökgöz et al. (2020) evaluated the emergency assembly areas with the AHP method.

1.1. The Need for Gathering After an Earthquake

During an earthquake, people instinctively leave the building and go to open areas to feel safe, survive the effects of the great shock, get together with their relatives, and communicate. Every individual should have an area close to their home or workplace as a precaution against security problems such as damage to buildings, continued aftershocks, or gas leakage after a disaster (Allan and Bryant, 2010). Immediately after the earthquake, it is necessary to ensure that people move away from the areas where this trauma is experienced and to protect them from possible aftershocks (Atalay, 2008). Open and green areas that became active after the earthquake; gain a different meaning by meeting the needs of earthquake victims, such as gathering, temporary shelter, first aid, and basic food (Komar, 2021). These areas can be assembly areas if they are accessible quickly and easily after the disaster, if there are no secondary disaster risks such as liquefaction, fire, or tsunami, and if they are sufficiently large and safe areas.

Areas that can meet the needs in the event of an earthquake; are emergency assembly areas, temporary shelters, and earthquake parks. Temporary accommodation areas, which can be confused with emergency assembly areas, are designated for the protection and shelter of people who had to leave their living spaces after disasters, from the dangers that may occur in the continuation of the disaster, and from adverse climatic conditions. During these stages, tent and container cities are areas where all necessary planning and applications are made to ensure that the living conditions are kept at the most humane levels (Tüzün, 2002).

-**Emergency meeting areas**: It creates a meeting point in a situation that requires individuals to leave their homes quickly. These are the preliminary evacuation areas where information exchange is provided, including the rescue

teams, until the temporary shelters are ready. Çınar et al. (2018) and according to Coburn and Spence (2002), the criteria sought are as follows:

• Accessibility: Access to the assembly areas from the building blocks should be easy, and the maximum walking distance should be 500 meters or 15 minutes.

• Connection with road axes: Assembly areas should be arranged in areas with high accessibility and continuity with other assembly areas.

• Usability and multifunctionality: Existing open green areas, playgrounds, sports fields, school gardens, carpet pitches, and open car parks can be considered assembly areas, but the areas should not be less than 500 m2.

• Ownership: It is a priority for the selected areas to be public lands, not to create any obstacle based on ownership for the dense groups of people who will head to the areas in the event of a disaster.

• Areal size: It is suggested that the places expressed as "Pre-Discharge Area" should be a minimum gross of 1.5 m2 / person.

-**The criteria sought in temporary accommodation areas are as follows** (Hosseini Milani, 2015; Çınar et al., 2018):

• The width of the main roads in the temporary shelter areas should be at least 15 m, and the width of the byways should be at least 10 m,

• The presence of a security-controlled guard at the entrance of the center,

• Asphalt or cobblestone paving of the main roads of the neighborhoods to be established,

• Accommodation of a single family in tents other than the container and collective tents,

• Placing the containers on the sub-basement at the height of at least 30 cm,

• Tent or container, electrical installation of all accommodation units,

• The tents or containers are made of materials that are resistant to climatic conditions and fire situations,

• At least 45 m2 per person should be allocated in the settlement area, including infrastructure, tent and container areas, social areas, markets, warehouses, and security areas.

• The size of the selected area should be at least 3.5 m2 per person in the shelter in hot climates where meals are made outdoors and 4.5 - 5.5 m2 per person in cold climates where meals are made inside the shelter.

• The land's topography should allow easy drainage, and the site should be located above the flood level. Ideally, the site slope should have a slope of 2-4% for good drainage and no more than 10% to avoid the risk of erosion and high excavation costs during the construction of roads and buildings.

• Drainage ditches should be dug around tents or other shelters and along roadsides, especially if there is a risk of flooding.

• Areas adjacent to commercial and industrial areas subject to noise, odor, air pollution, and other disturbances should be avoided.

• Areas close enough to blocks or rows of shelters should be identified for sanitation and waste management. The residential area of the camp should face the prevailing wind to avoid odors coming from the toilets.

• In order to facilitate the management and control of communicable diseases, camps should have no more than 10-12 thousand people or be divided into independent units with no more than a thousand people present.

• At least two access roads should be provided to the area to reduce the risk of loss of access to the area for safety reasons or other road problems.

• The chosen location should be located at a reasonable distance from a plentiful source of good water and ideally on high ground where gravity can distribute the water. No one should have to walk more than 500 meters to a water point, and at least one water point should fall for every 250 people.

-**Earthquake parks:** according to the definition by Koçan and Sürün (2020), are the areas where people can escape and take shelter after earthquakes, meet with their family members, and are planned for sheltering in cases such as the inability to use the houses during and after the first panic moment. In addition, these areas have the function of meeting the recreation needs of the city in ordinary times. According to Coburn and Spence (2002), the areas reserved for earthquake parks should be equipped to allow people to stay outside for hours. According to Balcıoğlu et al. (2011), Çavuş (2013) and Sarıçam (2019);

• Generator: Generators of sufficient power should be available in earthquake parks to ensure the flow of electricity, and these generators should be located near the administration buildings.
• Ramps: Ramps, which will be used as skateboard and skating rinks during daily life, can be used for loading and unloading aid vehicles arriving in times of crisis.
• Sound system: In order to make announcements in the event of a crisis, ready-made sound systems should be available.
• Sports facilities: An anchored football or volleyball field will be used as a sports field during normal life, allowing large tents to be easily set up in case of disaster.
• Administrative center: It should be established for purposes such as recording the inputs and outputs in the park during the disaster and subsequent crisis and ensuring the most effective use of the park. In this center, an internet network should be installed that will provide uninterrupted Wi-Fi for the park and the software system programmed to keep the registration data.
• Laundry and dishwashing room: There should be a large number of fountains that will allow the installation of washing machines and dishwashers in a part to be determined in the area.
• Missing meeting area: An area should be set up where there will be boards for the reunion of family members who have lost each other and for the hanging of missing notices.
• Service units: WC shower areas with dirty and clean water installations should best serve the intensity that may occur during the crisis. Care should be taken to ensure that WC areas are one for 25 people and shower cabins for 50 people. Hot water supply in showers should be designed to be provided by solar energy systems.
• Car parks: There should be car parks designed so vehicles carrying aid materials can easily access the area, responding to the visitors who will use the park in normal daily situations and the density that may occur in the event of a disaster.
• Helipad: There should be a helipad to be used in cases such as transporting the injured and delivering aid materials in emergencies. This runway should be located outside the usage area of the disaster victims, with the lighting systems connected to the generator.
• Flashers: With flashers to be installed in positions that can be seen from many points of the city, it should be easier for disaster survivors who lost their sense of direction in a panic to find their way.

1.2. Purpose of the Study and Definition of the Problem

Considering the many functions undertaken by emergency assembly areas, temporary shelters, and earthquake parks before and after an earthquake, it is seen how vital these areas are to plan, design and comply with the criteria before a possible earthquake. Many functions of earthquake parks, such as first aid, storage, collection, and distribution, play a key role during and after the disaster for the earthquake victims' collection, nutrition, and temporary shelter needs.

Various studies have been carried out regarding the earthquakes in Van, but no studies are specific to earthquake parks. In his study, Talas (2015) focused on central and local government's role, responsibilities, and behaviors within the scope of disaster management during and after the earthquake in Van in 2011. In her study, Bayındırlı (2016) examined container city life after the 2011 Van earthquake and observed the changes in the daily life of the people who started to live here and the new habits they acquired. In her study, Yılmaz (2018) revealed the organizational deficiencies and problems faced by the teams during and after the disaster and developed solutions for this. Kaymaz (2021), on the other hand, examined the importance of urban parks in urban settlements in his study.

The city of Van is in a very vulnerable position in terms of earthquakes in terms of its unplanned construction, the soil structure of the land on which it is established, and its location between fault zones. In this context, the city of Van has not made much progress in disaster management, although it has suffered great losses due to devastating earthquakes, has been examined. However, as a result of the investigations, it has been revealed that despite the great difficulties experienced by the disaster victims after the severe earthquakes in 2011 and the 11-year period that has passed, there has not been a serious

study on disaster management in the city. Moreover, there is no earthquake park in Van. In this case, it turns out that emergency assembly areas, temporary shelters, and earthquake parks for Van are considered as a multi-criteria optimal settlement problem for city planning. This study aims to reveal the suitable parks in the central districts of İpekyolu, Tusba, and Edremit of the city of Van in terms of predetermined criteria for the location of areas that can be earthquake parks to determine the ideal alternative among them. In addition, unlike other studies on earthquake parks, it aims to use AHP-TOPSIS integration to select an ideal site location in Van, apart from the earthquake park installation criteria.

2. MATERIALS AND METHOD

2.1. Material

This study was carried out in the central districts of Van city/Turkiye, İpekyolu, Tusba, and Edremit. The emergency assembly, evacuation, and shelter areas determined by AFAD and the parks of certain sizes determined in these districts constitute the main material of the study (Figure 1). Photoshop CS6 and Google Earth Pro programs were used to evaluate the spatial analysis for the study area. The MCDM program and the Decision Radar TOPSIS Calculator (Balaei, 2022) program were used to apply the AHP and TOPSIS methods in the evaluation studies for field selection.

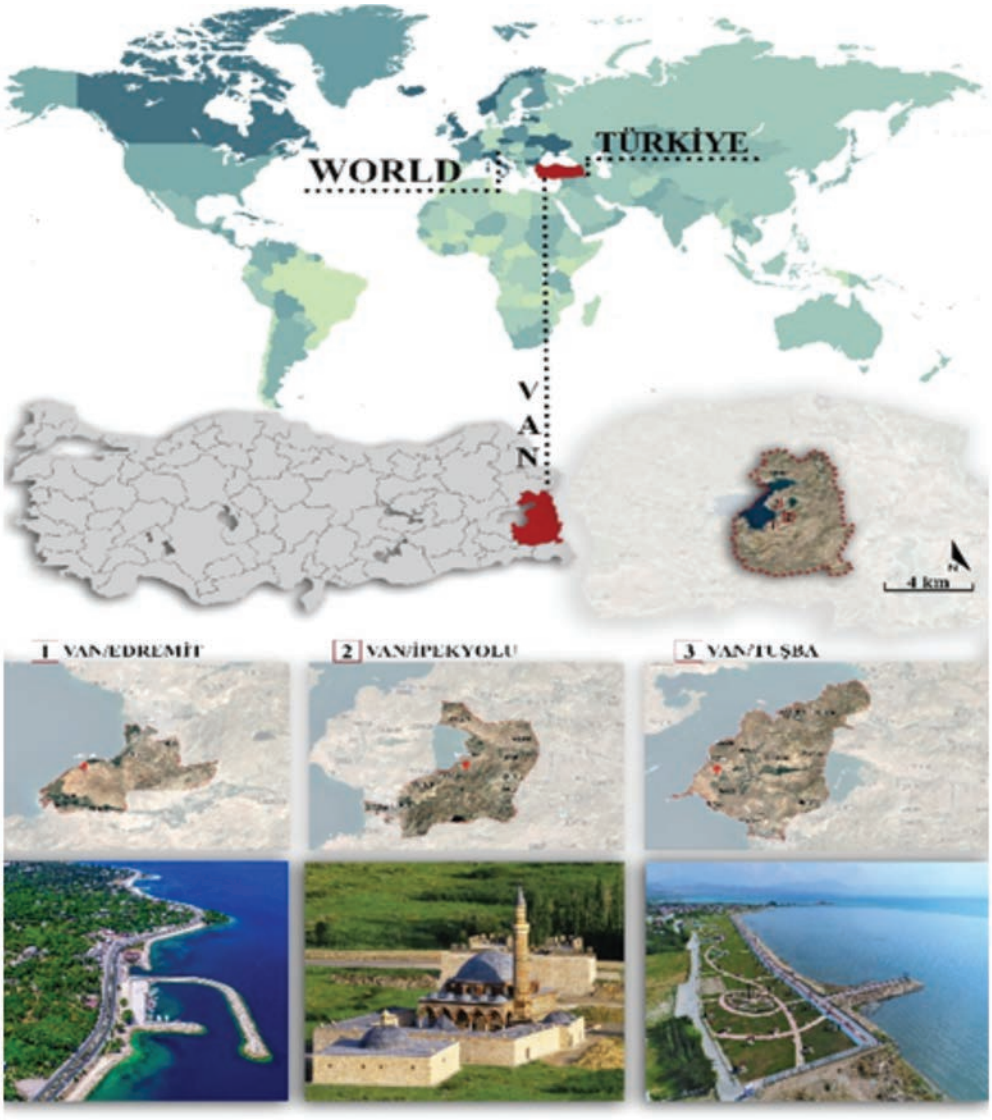

Figure 1. Location of the study area

The province of Van, which consists of 13 districts in total, has an area of approximately 1,938 km2 and is located in the Upper Murat-Van section of the Eastern Anatolia Region of Turkey. When the climatic characteristics are examined, the annual average highest temperature is 15°C, the lowest temperature is 3.7°C, the number of rainy days is 98.5, and the total precipitation is 396.3 mm (General Directorate of Meteorology 2022).

The region between Van province and Iran has a tectonic structure with a high earthquake potential. According to Ketin (1977), the Van Lake basin, located north of the Bitlis suture belt, is also between the Karlıova Joint and the Zagros Fault Zone, where the North Anatolian Fault intersects the East Anatolian Fault. These structures, which have been the source of significant seismic activity in the region, including the Van Lake Basin, are active. Due to this activity, it has been scientifically recorded that all the cities in the region were affected by severe earthquakes and destroyed throughout the historical process (Anonymous, 2012a). It is seen that the city of Van is predominantly built on the Van plain, which is younger and contains more filling material compared to its surroundings. Alluvial deposits, old lake, and fluvial deposits cover a large area in the mentioned area. The population of Van province was determined as 1.149.342 people as of the end of 2020. İpekyolu District is the most populous district of Van, with a population of 334.470 people, according to 2020 TUIK (Turkish Statistical Institute) data. In terms of the level of development, Van province ranks at the bottom of the country with its 6th Tier development class (Anonymous, 2012b).

2.2. Method

The study searched domestic and foreign literature on the subject and area, collected data, and set earthquake park standards. To analyze the site selection for the earthquake park according to the appropriate criteria, first of all, the assembly and evacuation areas determined by AFAD (Disaster and Emergency Management Presidency) in the city of Van were compiled. These areas were mapped according to three districts, and the assembly and evacuation areas overlapping with the park areas were determined among these areas. Using scientific literature, disaster management studies, reports of these studies, and expert opinions, the determining criteria for the site selection of earthquake parks have been put forward within the framework of the determined standards. The Analytical Hierarchy Process (AHP) was applied by taking the opinion of 18 experts consisting of three survey engineers, three geology engineers, two AFAD training specialists, one AFAD search and rescue technician, three architects, three landscape architects, and three city planners to determine the degree of importance of the determined criteria. A total of six areas, two from each district, were selected from the areas that were included in the list of areas determined by AFAD or were not included but were determined to be suitable for the purpose as a result of the evaluations. The ideal pilot area for the earthquake park was determined by applying the TOPSIS method by scoring the presence of weighted criteria in the selected areas. The data obtained as a result of the studies were evaluated and concluded. Six main criteria have been determined that should be considered in selecting earthquake parks. These are; transportation and accessibility, area size, secondary disaster risk, geological structure, infrastructure, and topographic slope.

Within the scope of the study, the integrated study of the MCDM Methodologies AHP and TOPSIS methods was used to select the site for the earthquake park in the city of Van. Within the scope of the study, the integrated study of the MCDM Methodologies AHP and TOPSIS methods was used to select the site for the earthquake park in the city of Van. In the first stage of this model, AHP was used to determine the importance levels of the criteria that an earthquake park should have. In the second stage, the TOPSIS method was applied to select the ideal area by scoring the alternative areas according to the criteria. The first step of this method, AHP, is a gradual process, and these stages can be summarized as follows;

Stage 1: First, the problem is defined, and the criteria for the solution to this problem are determined; alternatives are presented, and a hierarchical tree diagram is drawn.

Stage 2: After the hierarchical structure is established, pairwise comparison matrices are created to determine

the importance of criteria and sub-criteria relative to each other. In the A matrix created to determine the importance of i criterion according to the j criterion for n criteria to be evaluated, “Eq. 2.1” decision maker compares the criteria with each other and scores according to the Saaty scale (Table 1). Since the components on the diagonal of the matrix will be i=j, it takes the value 1. On the Saaty scale, scoring is done from 1-9 (Kaya Samut, 2014). After scoring the aij value, there is no need to score the aji value because aji=1/ takes the aij value.

(2.1)

$$A = \begin{bmatrix} 1 & a_{21} & a_{31} & \cdots & a_{n1} \\ 1/a_{21} & 1 & a_{32} & \cdots & a_{n2} \\ 1/a_{31} & 1/a_{32} & 1 & \cdots & a_{n3} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1/a_{n1} & 1/a_{n2} & 1/a_{n3} & \cdots & 1 \end{bmatrix}_{n\times n}$$

Importance level	*Definition*
1	Equally important
3	Moderately important
5	Strongly important
7	Very strongly important
9	Absolutely important

Table 1. Saaty scale severity levels and definitions

Stage 3: It is the step where the criterion weights are calculated. After the pairwise comparison matrix is created, the column elements in this matrix are summed. By making use of “Eq. 2.2”, B matrix “Eq. 2.3” (normalized pairwise comparison matrix) is obtained. In this step, aij; The ith row j th column element of the comparison matrix represents the i th row j th column element of the bij normalized matrix (Gökgöz et al., 2020). The normalization expression means the ratio of each criterion score to the column totals. The criterion weights are obtained by the mean of the rows of the normalized score values (Eleren, 2010).

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (2.2)$$

$$B = \begin{bmatrix} 1 & b_{21} & b_{31} & \cdots & b_{n1} \\ b_{12} & 1 & b_{32} & \cdots & b_{n2} \\ b_{13} & b_{23} & 1 & \cdots & b_{n3} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ b_{1n} & b_{2n} & b_{3n} & \cdots & 1 \end{bmatrix}_{n\times n} \quad (2.3)$$

Stage 4: This step aims to measure the consistency of the comparisons made by the decision-maker. The consistency ratio (CR) is calculated by dividing the consistency indicator from the randomness index table by the value corresponding to the number of criteria of the problem. The comparison is consistent if the consistency ratio (CR) is less than 10%. Values up to 20% are tolerable, but higher values cannot be tolerated. In such a case, it is understood that there is an inconsistency in the comparison, and return to step 2 to determine this inconsistency (Gökgöz et al., 2020).

Stage 5: After implementing the first four steps for the entire hierarchical structure, the importance levels for each criterion are determined, and the criteria are ranked according to these importance levels.

TOPSIS, which constitutes the second stage of the method, is based on choosing the alternative with the shortest distance from the positive-ideal solution and the farthest distance from the negative-ideal solution (Supçiller and Çapraz, 2011).

1. FINDINGS

Within the scope of the study, the emergency assembly and shelter areas recommended by AFAD as of December 2020 in the city center of Van/Turkiye were examined. It has been tried to determine the areas that can be converted into earthquake parks, two parks in each district, based on the criteria for selecting the right place from the areas overlapping with the existing parks. The findings of examining the areas that can be transformed

into earthquake parks with the help of official information and site investigation, reinforcement of reinforcement elements suitable for use during and after the earthquake, and some revisions are given below. For the İpekyolu district, ten emergency assemblies and three evacuation areas were determined by AFAD. The district border and satellite images of the locations of these areas are given in Figure 2. The category it belongs to, its name, the name of the village/neighborhood, the block/parcel, and the area (m²) are presented in Table 2.

Figure 2. Satellite image of emergency assembly areas in İpekyolu district

Order	*Category*	*Name*	*Village/Neighborhood*	*Parcel*	*Area (m²)*
1	Disaster Assembly Area (Public)	Treasury Land	Bostanici	Parcel 3798 (No Block Because There Is No Zoning)	1.842.966.00
2	Disaster Assembly Area (Public)	Treasury Land	Kevenli	Parcel 4888 (No Block Because There Is No Zoning)	607.249,00
3	Disaster Assembly Area (Public)	Treasury Land (Pasture)	Karpuzalan	Parcel 378 (No Block Because There Is No Zoning)	427,965.00
4	Disaster Assembly Area (Public)	Treasury Land	Kevenli	Parcel 4889 (No Block Because There Is No Zoning)	170.779,00
5	Disaster Assembly Area (Public)	Woodland and rally area	Selimbey	398/1 Block 395/1 Block	80.000.00
6	Disaster Assembly / Evacuation Area (Public)	Next to the City Stadium Empty space	Halilaga	283/2	16,790,00
7	Disaster Assembly / Evacuation Area (Public)	M.Akif Ersoy High School Garden	Cevdetpasa	426/47	16,017,00
8	Disaster Assembly / Evacuation Area (Public)	Esenler Life Center Building Empty Parking Area	Bostanici	4010/1	14,064,00
9	Disaster Assembly Area(Public)	Park/Green Area	Şerefiye	541/243	11,553,00
10	Disaster Assembly Area(Public)	Urban Park Area	Hafızıye	298/133	8.167.00

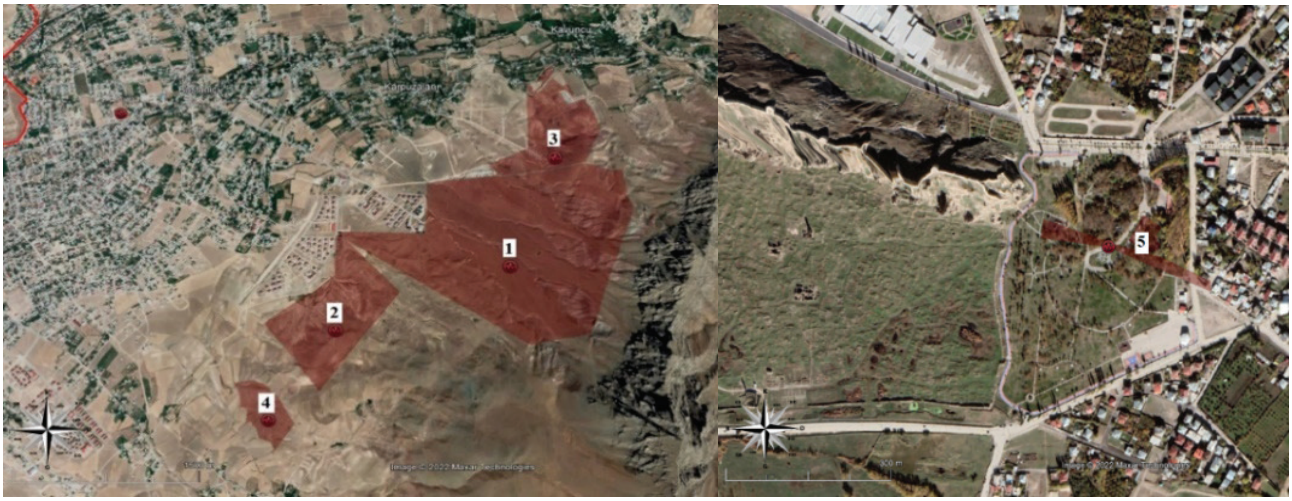

Figure 3. Satellite image of areas 1, 2, 3, 4, and 5 in Table 2

Shown with numbers 1, 2, 3, and 4 in Table 2; It has been observed that the areas numbered 3798 parcels in the Bostaniçi neighborhood, 378 parcels in the Karpuzalan neighborhood, 4888 and 4889 parcels in the Kevenli neighborhood are unqualified areas with huge surface areas, far from human density, and located at the foot of the mountains (Figure 3).

In İpekyolu District, three areas overlap with the existing parks from the emergency assembly and shelter areas recommended by AFAD. Apart from these areas, it has been observed that the areas numbered 398/1 and 395/1 Block/Parcel within Atatürk Park near Van Castle, whose information is given in line 5 in Table 2, do not comply with the collection area criteria.

The İpekyolu City park area, which is located in the Hafızıye neighborhood, the information given in the 10th line of Table 2, is included in the emergency assembly and shelter areas announced by AFAD and has the potential to become an earthquake park. Its proximity to area 6 in the table is also seen in Figure 4.

Figure 4 Satellite image of areas 6 and 10 in Table 2

Tusba District: 7 emergency assembly areas were determined by AFAD for the Tusba district, but data was not found for the Tusba district in the list of evacuation areas. The district border and satellite images of the locations of these areas are given in Figure 5. The category it belongs to, its name, the name of the village/ neighborhood it belongs to, the block/parcel, and its surface area (m²) are presented in Table 3.

Figure 5. Satellite image of emergency assembly areas of Tusba district.

In Tusba District, two areas overlap with the existing parks from the emergency assembly and shelter areas recommended by AFAD. The area that includes the 15th of July Martyrs Park on Iskele Street, whose information is given in line 2 in Table 3, has been declared as a gathering area (Fig. 6). It has been observed that the area numbered 501/2 Block/Parcel in the Altıntepe neighborhood, whose information is given in line 4 in Table 3, is full of residences (Figure 6).

Akköprü Park, located in the area numbered 7 in the Akköprü neighborhood, in the area numbered 355/1 Block/Parcel, has been identified as a park with the potential to be reorganized as an earthquake park (Figure 6). All parcels determined outside this area were examined; it was understood that they were empty and bare lands. There are many vacant lands of the exact nature around these areas, and in the event of a disaster, there is no feature that distinguishes these areas from other areas around them.

Order	*Category*	*Name*	*Village/Neighborhood*	*Parcel*	*Area (m²)*
1	Disaster Assembly Area (Public)	Auto Industry Sports Facilities Campus	Seyrantepe	507/6-508/1-507/11-507/7-507/10	40.000.00
2	Disaster Assembly Area (Public)	Tusba Municipality 15 July Martyrs Park and 2nd Recreation Area	İskele	648/4-648/6-643/1-642/25-642/28-642/1-642/2-642/27-676/12-676/13-676/14-676/15-690/ 16-676/20-676/18-676/19-676/17-676/1-677/1	185,000,00
3	Disaster Assembly Area (Public)	Tusba Municipality Spor Toto Sports Facility And Its Surroundings	İskele	711/25-711/26-711/27-711/28-711/29-711/30	65,000,00
4	Disaster Assembly Area (Public)	Private Site	Altintepe	501/2	20.000.00
5	Disaster Assembly Area (Public)	Tusba Municipality Site	Abdurrahmangazi	1042/22-14/1	31,000,00
6	Disaster Assembly Area (Public)	Tcdd Field	Seyrantepe - Akköprü	0/111-0/112-0/114-0/113-0/510-0/1084	47,000,00
7	Disaster Assembly Area (Public)	Tusba Municipality Park Area	Akköprü	355/1	8.000.00

Table 3. List of emergency assembly areas in Tusba district (AFAD archive, 2022).

Fiure 6. Satellite image of areas 2, 4, and 7 in Table 3.

Edremit District; 18 emergency assembly and evacuation areas were determined by AFAD for the Edremit district. The district border and satellite images of these areas are given in Figure 7. The category it is in, its name, the name of the village/neighborhood, the block/parcel, and its area (m²) are presented in Table 4.

Figure 7. Satellite image of Edremit district emergency assembly areas

	Category	Name	Village/Neighborhood	Parcel	Area (m^2)
1	Disaster Assembly / Evacuation Area (Public)	DSI 17th Regional Directorate	Eminpasa	107/68	50831
2	Disaster Assembly / Evacuation Area (Public)	Next to Eminpasa Secondary School	Eminpasa	559/22	2144.28
3	Disaster Assembly / Evacuation Area (Public)	Opposite Şabaniye Cemetery	Şabaniye	251/5	9900
4	Disaster Assembly / Evacuation Area (Public)	Opposite Şabaniye Cemetery	Şabaniye	375/2	4460
5	Disaster Assembly / Evacuation Area (Public)	Opposite Van Fruit and Vegetable Market	Selahattin Eyyubi Neighborhood	908/22	19628
6	Disaster Assembly / Evacuation Area (Public)	Kinyas Kartal Secondary School	Selahattin Eyyubi Neighborhood	1072/9	24964.70
7	Disaster Assembly / Evacuation Area (Public)	Van Training and Research Hospital Parking Lot	Suphan	1026/489	73935.27
8	Disaster Assembly / Evacuation Area (Public)	Garden of Work	Suphan	84/453	29401.76
9	Disaster Assembly / Evacuation Area (Public)	Opposite Hilmi Iraq Secondary School	Yenikoy	150/10	9921.99
10	Disaster Assembly / Evacuation Area (Public)	İpekyolu Boulevard, Garden of the Former Specialized Hospital	Yenikoy	206/6	11296.98
11	Disaster Assembly / Evacuation Area (Public)	Nur Tatar Sports Hall Garden	Yenicami	152/7	68676,61
12	Disaster Assembly / Evacuation Area (Public)	Opposite Edremit Anatolian High School	Yenicami	149/18	154872.45
13	Disaster Assembly / Evacuation Area (Public)	Behind the Provincial Directorate of Environment and Urbanization	Eskicami	261/1	38103.89
14	Disaster Assembly / Evacuation Area (Public)	Opposite the New TOKİ 3rd Stage	Eskicami	243/1	34977.71
15	Disaster Assembly / Evacuation Area (Public)	Erdemkent Mosque	Erdemkent	136/1	3856.58
16	Disaster Assembly / Evacuation Area (Public)	Erdemkent Health Center	Erdemkent	129/1	2578.02
17	Disaster Assembly / Evacuation Area (Public)	Gumusdere Opposite Primary School	Yenicami	321/1	40802.30
18	Disaster Assembly / Evacuation Area (Public)	Opposite Yunus Emre Secondary School	Yenicami	356/1	25263,90

Figure 8. Left; Satellite images of the assembly areas numbered 1 and 7 in Table 4, as well as the Eminpaşa shelter area (green area) and Süphan park (purple area) in its immediate vicinity. Right; Satellite images of areas 17 and 18 in Table 4 and the adjacent.

Within the borders of the Edremit district, two areas overlap with the existing parks from the emergency assembly and shelter areas recommended by AFAD. In the area where Van Ferit Melen Airport and Van Regional Training and Research Hospital are located, there are two assembly and evacuation areas in Eminpaşa neighborhood, in areas 107/68 Block/Parcel, Süphan neighborhood, 1026/489 Block/Parcel. These fields' information is given in lines 1 and 7 of Table 4. The area declared in this region has been the Süphan Park area (Purple parcel in the left image in Figure 8), to be evaluated together with the area numbered 1026/489 Block/Parcel (Parcel 7 in Figure 8) in the Süphan neighborhood.

The other place used by AFAD as an emergency assembly and shelter area and park for Edremit is Kardeslik Park. Kardeslik Park area information is given in the 17th and 18th lines of Table 4 as two parcels, Yenicami neighborhood assembly area, 356/1 and 321/1 Block/Parcel (Figure 8).

3. RESULTS

3.1. Parks That Can Turn into Earthquake Parks

As a result, of the information and examinations obtained, six park areas, two each with the criteria to be transformed into earthquake parks, were determined in İpekyolu, Tusba, and Edremit districts. The entire Atatürk park in İpekyolu District has been determined as one of the areas that can be transformed into an earthquake park due to its proximity to residences, large surface area, easy accessibility, and proximity to health centers (Figure 9). In addition, this area coincides with the emergency assembly and shelter areas recommended by AFAD.

The total surface area currently used in Atatürk Park is 133 thousand square meters. The road passing through the north of the area is shown as 24 m wide in the zoning plan, the road passing through the east is 30 m, and the road passing through the south is 15 m wide. However, it has been determined that the road on the park's east side is currently 15 m wide. These roads are generally suitable for transportation. There is a high density of residential buildings around the area, and there is no proximity to buildings that may pose a secondary disaster risk for the area. The geological structure of the ground also does not carry any risk factor for the earthquake park. Atatürk Park has an adequate infrastructure system due to its suitability for recreational use. In case of an earthquake park arrangement, its infrastructure is open to development. When the area is examined in East-West and North-South directions, it has been determined to have an average of 2.5%-3% slope.

Figure 9. Atatürk Park zoning plan and current situation satellite images (Left: Van Metropolitan Municipality).

İpekyolu City Park has been seen as one of the ideal alternatives due to its location in an area with a high population density, its proximity to residences and workplaces, its convenient accessibility, the condition of existing urban equipment, and its potential to be transformed into an earthquake park. It is seen that revisions have been made to the current situation of the İpekyolu City Park area. However, these revisions have not yet been reflected in the zoning plans, and the block/parcel numbers of the area have not been updated. After the revision of the park in the area specified in the zoning plan, a large part of the area shown as a health facility in the south of the parking area has been included in the park. The difference between the zoning plan and the current situation can be seen in Figure 10. The area has an area of 18 thousand m² in its current state. The road passing through the north of the area is 24 m wide, the road passing through the east is 15 m, and the road passing through the west is 20 m wide. All of these roads are asphalt and in good condition. The ground structure of the area is suitable for an earthquake park. Since the area is in the city center, infrastructure facilities are in a strong position. The slope in the area is in the range of 0% - 2%.

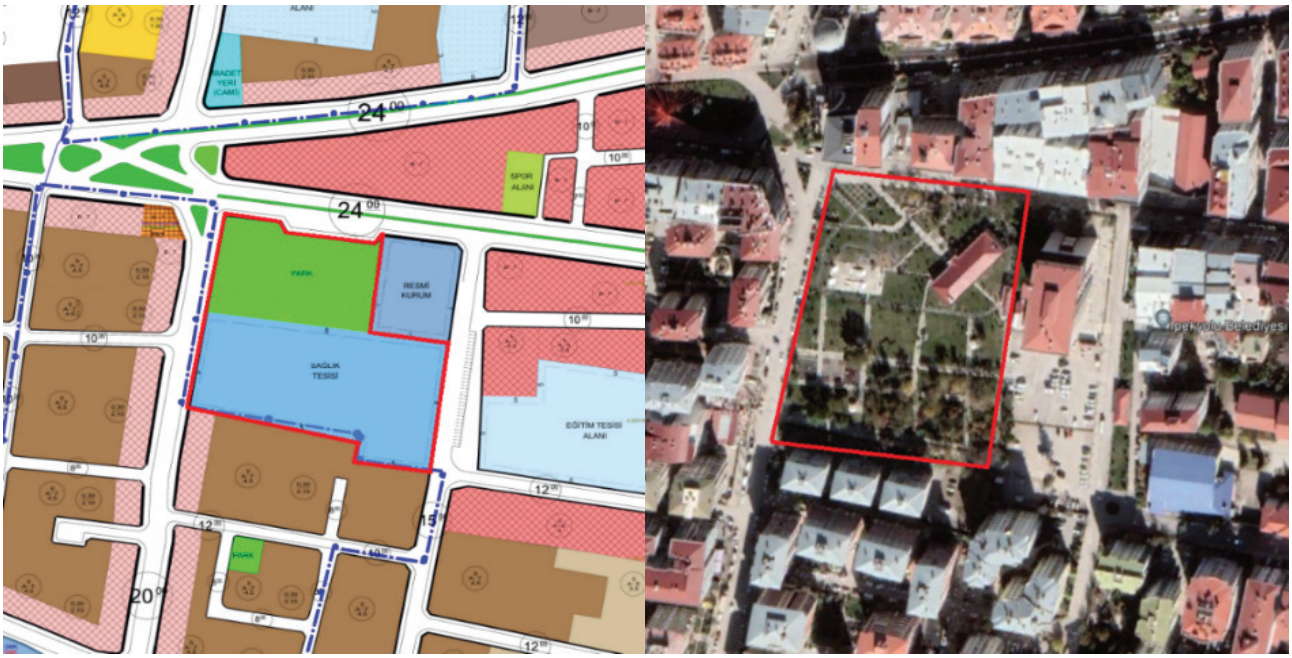

Figure 10. Ipekyolu City Park zoning plan and current situation satellite images (Left: Van Metropolitan Municipality)

In Tusba District, two areas overlap with the existing parks from the emergency assembly and shelter areas recommended by AFAD. Among them, July 15 Martyrs Park is not an area that can be converted into an earthquake park, as it is on the shore-side line of Lake Van, and because it is at risk of tsunami and the ground structure needs to be fixed. In addition, in the study of Alaeddinoğlu et al. (2016), this park is shown as an area of flooding and groundwater rise.

Another park designated in the Tuşba district is Akköprü Neighborhood 355/1 Block/Parcel number (Figure 11). This park lies in a particular area of the Akköprü Stream and is easily accessible and landscaped in the city center. Its total surface area is 11 thousand m². The territory is split in half by a road that runs through it from north to south and is 13 meters wide; the road to the west of the area is 12 meters wide. In an emergency, an aircraft can land 200 meters from the 6th Border Regiment. The site is in an area surrounded by residential buildings. It is not exposed to any secondary disaster risk. The ground structure is suitable for an earthquake park. Infrastructure is available and available for development. The slope of the land is between 0% - 2%.

Figure 11. Tusba/ Akköprü Park zoning plan and current situation satellite images (Left: Van Metropolitan Municipality).

The garden of Dursun Odabaş Medical Center, located on the Van Yüzüncü Yıl University campus, has the potential to be transformed into an earthquake park. Although it was not declared as an emergency shelter and assembly area by AFAD in the town of Tusba, it was determined that it complied with the necessary criteria determined and recommended (Figure 12). Green areas and hard floors are planned within the area, and a wide hard floor can also be used as a helipad in the middle of the area. The surface area of the area is over 55 thousand m². The ground structure of the area, which is in a sheltered position against secondary disaster risks, is also ideal for an earthquake park. The slope in the area is in the range of 0% - 2%.

Figure 12. Current status satellite image of the designated area in the Van YYU Dursun Odabaş medical center garden.

Kardeslik Park, one of the two areas that overlap with the existing parks among the emergency assembly and shelter areas recommended by AFAD within the borders of the Edremit district, is in a position where the density of people is high but far from the city center (Figure 13). It is located in TOKİ. An earthquake park located in this area will be able to respond to the needs of the disaster victims in the immediate vicinity in the time it takes for aid to arrive in the event of a disaster. The park area is 5 thousand m2. Each area designated as an assembly and evacuation area in its immediate vicinity has an area of 25 thousand m2. It has been seen that Kardeslik Park will turn into an ideal earthquake park area when designed together with these areas. The four sides of the designated areas are surrounded by roads with a width of 12-15 m. It is not located in a dangerous area against secondary disaster risks. The average slope in the fields is 6%.

Figure 13. Kardeslik Park zoning plan and current situation satellite images (Van Metropolitan Municipality)

The other park chosen in the Edremit district is Süphan Park. The assembly area with block number 1026/489, which is adjacent to the area, corresponds to the parking lot of the Van Regional Training and Research Hospital. This area can be used as a shelter in case of disaster. The area surrounded by a purple line in Figure. 14 shows the Eminpaşa accommodation area. In contrast, the area with a red frame to the north shows another assembly area included in the AFAD list. However, this area appears to be spread over a larger parcel in the zoning plan. The surface area of Süphan Park alone is 39 thousand m². Ipekyolu Street, 50 m wide, passes from the northwest of the area, and another 20 m wide road passes from the south. Another factor that increases the accessibility of the area is the fact that there is an airport opposite. The average slope in the area, which is in a protected position against secondary disaster risks, is in the range of 0% - 2%.

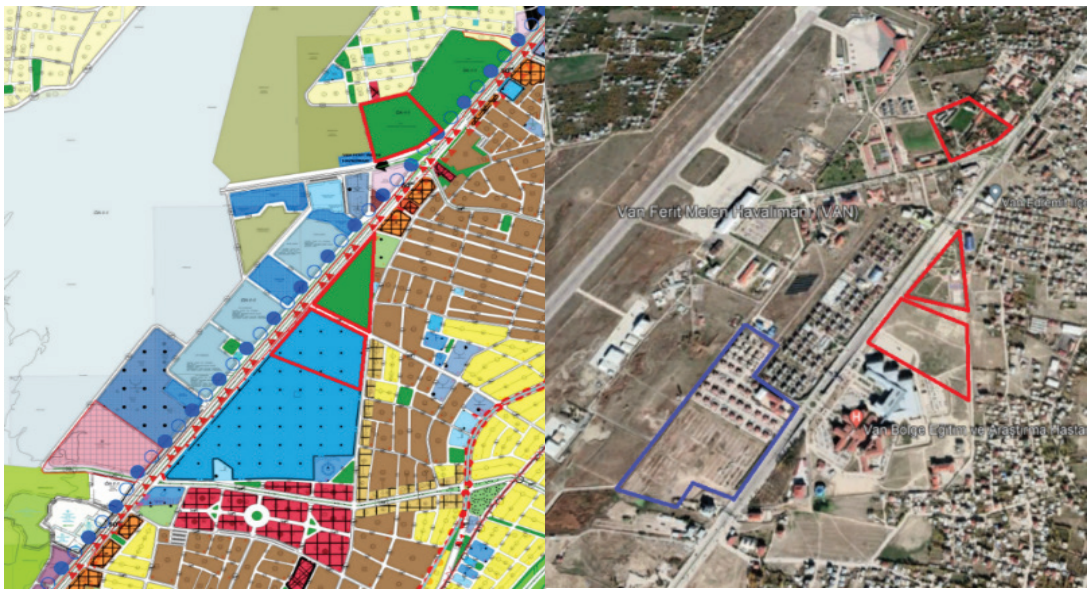

Figure 14. Süphan Park zoning plan and current situation satellite images (Left: Van Metropolitan Municipality).

3.2. AHP and TOPSIS Applications to Selected Areas

Predetermined in selecting the ideal area; an AHP study was applied to determine the importance levels of transportation and accessibility, field size, secondary disaster risk, infrastructure, geological structure, and topographic slope criteria. For this purpose, opinions were received from a group of 18 experts, including three architects, three landscape architects, three city planners, three survey engineers, three geological engineers, and three AFAD personnel (two training specialists and one search and rescue technician). In line with these opinions, the importance levels of the criteria were determined through the MCDM program. The graphical distribution of the criterion weights is given in Figure 15.

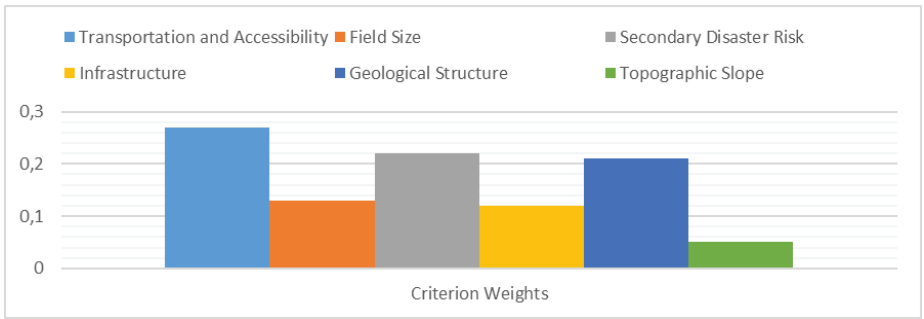

Figure 15. Graphical distribution of criterion weights.

	Transportation and Accessibility	*Field Size*	*Secondary Disaster Risk*	*Infrastructure*	*Geological Structure*	*Slope*
Ataturk Park	9	10	2	9	8	1
İpekyolu City Park	8	7	3	8	8	1
YYU Hospital Garden	7	9	1	6	8	3
Akkopru Park	3	5	6	5	8	3
Suphan Park	10	6	2	3	8	2
Kardeşlik Park	4	3	2	3	10	2

Table 5. TOPSIS decision matrix

For the criteria whose priority levels are determined, it is required that the criteria of transportation and accessibility, area size, infrastructure, and geological structure should be at maximum values, and secondary disaster risk and topographic slope criteria should be at minimum values. In order to create the decision matrix, Atatürk Park, İpekyolu City Park, YYU Hospital Garden, Akköprü Park, Süphan Park, and Kardeslik Park, which are six alternative areas in three districts, were scored in the range of 1-10 points in line with the criteria (Table 5).

Decision Radar TOPSIS Calculator (Balaei, 2022) was used to find the appropriate alternative by integrating the AHP results into TOPSIS. As a result of the procedures, closeness to ideal and negative ideal distance scores were made, and the results are presented in Figure 16. It is seen that the ideal choice among the parks proposed in the three districts is Atatürk Park in the district of İpekyolu. On the other hand, according to the results of AHP and TOPSIS applications, Akköprü Park in the Tuşba district emerges as the least suitable park.

4. Discussion and Conclusion

It is seen that people fleeing their living spaces with the desire to get away from the areas immediately after the earthquakes have difficulty finding open spaces to take shelter as a result of unplanned construction and unplanned urbanization. The necessity of meeting people's physical, social, and psychological needs with a sudden decrease in their living standards emerges after they gather in areas they think are safe and come together with their families and relatives.

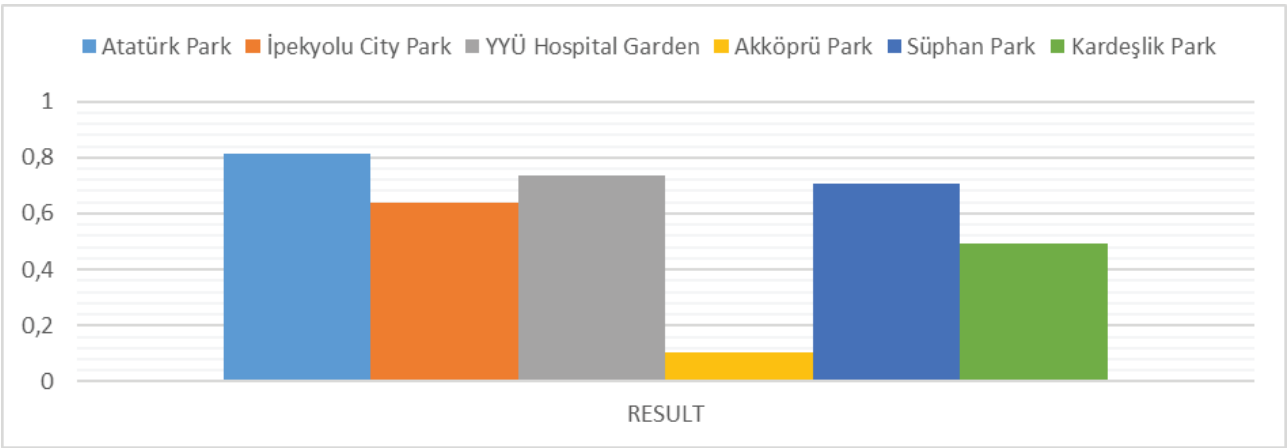

Figure 16. Graphical distribution of close to ideal values of AHP and TOPSIS results

It is noteworthy that earthquake parks are the most practical solutions in the studies carried out to create living conditions for earthquake victims at a humane level and meet their individual needs. Earthquake parks are safe areas where people can navigate and where disaster victims can meet their basic needs, such as eating, drinking, cleaning, and sheltering, when they are built with the correct planning. Thanks to the planning of these organizations with the coordination of central and local governments, relevant professional groups, and responsible persons, task distribution and responsibilities will be determined, and aids and necessary health interventions will be delivered to those in need as soon as possible.

In the troubled period that followed immediately after the earthquakes, several studies were carried out on temporary shelters for people. However, they differ from this study, which was carried out in the context of the method used in line with the site selections and the necessary criteria. For example, In the study conducted by Sürün (2019), the design of the earthquake park for the Burhaniye district of Balıkesir province was emphasized. Studies on the design criteria of disaster and earthquake parks were carried out by Marangoz (2021) and Komar (2021). Since a standard has not been established on the criteria that should be met in earthquake parks by both central administrations and responsible institutions and individuals, the critique of the criteria continues to be emphasized in the studies carried out in this process. Aman (2019) also focused on this issue and determined some criteria; spatial size and capacity, risk of building collapse, having closed areas, distance to dangerous structures, property, infrastructure, tsunami hazard, flood hazard, geological structure, liquefaction hazard, groundwater level, slope, landslide hazard, accessibility and proximity to health facilities. In their study, Zengin Çelik et al. (2018) evaluated the assembly areas in Bayraklı District, one of the central districts of İzmir, where intensive construction activities occur together with the new city center, in terms of security. In the study, which developed recommendations regarding the safety criteria to be considered within the scope of “disaster risks” for assembly areas, the Multi-Layer Weighted Overlay Method was applied in the ArcMap environment, taking into account the criteria determined according to the characteristics of the buildings. In their study, Dayanır et al. (2022) compiled, grouped, defined, and rated the criteria for location selection, planning, and design of temporary shelter areas using the Delphi method. According to the criteria list formed as a result of the three-stage panel made with the Delphi method, it has been determined that a limited number of areas in İzmir can meet the requirements.

Six criteria have been determined to be sought in the selection and organization of earthquake parks, which are problem-solving components at the scale of the city of Van, according to appropriate criteria. Of these determined criteria, It is desired that the transportation and accessibility and the size of the area are high, the secondary disaster risk is low or even zero, the infrastructure and geological structure are at a good level, and the topographic slope in the area is between 0% and 10%. It has been seen that these criteria are in common with the criteria of Aman (2019), but are separated as more general headings.

In the province of Van, there are areas recommended by the responsible persons, especially AFAD, for emergency assembly, evacuation, and temporary shelter. When the areas determined for İpekyolu, Tusba, and Edremit districts are examined, it has been determined that the selection of these areas is not based on the standard area selection criteria. It has been revealed that the areas are mostly unqualified areas that do not have purpose-oriented functionality. Among the block and parcels in the list, the areas overlapping with the parks have been determined, and the ones that can be converted into earthquake parks have been proposed. Six areas were identified, including two parks for each district, within or outside the list. The compliance of these areas with the criteria determined within the scope of the study was evaluated with the integration of AHP-TOPSIS.

In the literature review, it is seen that AHP and TOPSIS from MCDM methodology are used in many different studies. Gümüş et al. (2017), for the selection of suppliers in Alanya hotel businesses, Eleren (2010), for the selection of establishment location in the leather industry,

Gökgöz et al. (2020) applied to AHP for the evaluation of emergency assembly areas. Supçiller and Çapraz (2011) for supplier selection, Taş et al. (2018) For an outpatient clinic evaluation in Ankara, Kaya Samut (2014) used AHP-TOPSIS integration in his study to evaluate educational performances at an international level.

The criteria weights determined as a result of the AHP are listed, and the ranking made from the most important criterion to the least important criterion; transportation and accessibility (27%), secondary disaster risk (22%), geological structure (20%), area size (13%), infrastructure (12%) and topographic slope (5%). Based on these criteria, as areas that have the characteristics of transforming into earthquake parks in terms of site selection, Atatürk Park and İpekyolu City Park were suggested for İpekyolu District, Van YYU Hospital Garden and Akköprü Park for Tusba District, and Süphan Park and Kardeşlik Park areas for Edremit District. In order to evaluate the current situation of the determined areas and to determine the ideal area, the strength of the criteria, whose priorities were determined by AHP, in the areas was scored between 1-10. Criterion importance degrees and scores were evaluated in TOPSIS, another MCDM methodology, and it was determined that the ideal area was Atatürk Park in İpekyolu District. Atatürk Park is one of the favorite recreation areas of the city of Van, which is used intensively by the public regularly. It is in the best alternative position that can be turned into an earthquake park. It is the most suitable area in terms of the criteria required for the earthquake park, with its transportation, accessibility, and area size being high, the secondary disaster risk being low or even zero, the infrastructure and geological structure at a good level, and the topographic slope in the area is between 2.5% and 3%. At the same time, it has an infrastructure system that will allow the arrangement of earthquake parks. In this study, it is thought that the compilation of the important functions of open green areas during and after disasters can guide local governments in choosing the location for the creation of earthquake parks throughout the cities. At the same time, it will be a source for future studies on earthquake-oriented urban planning.

Conflict of Interests

State any potential conflicts of interest here or add the sentence “The authors declare no conflict of interests”.

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