Disaster Risk Analysis Using Geographical Information Systems: A Case Study of Ferhat Pasha Mosque in Çatalca

Handenur ÖZDEMİR and İlke CİRİTCİ, Türkiye

Key words: GIS, disaster management, weighted overlay, cultural heritage, vulnerability

SUMMARY

Cultural heritage comprises both abstract elements, such as language, traditions, dance, music, and rituals, and tangible elements, including historic cities and fabrics, cultural landscapes, monumental structures, and archaeological sites. These elements are associated with a society's identity, culture, and history, reflecting the shared past of its members. Cultural and natural assets of global significance may be vulnerable to destruction due to various internal and external factors, including disasters, wars, misuse, repairs, and ground characteristics. The present study aims to identify existing disaster risks that jeopardize cultural assets, assess the impact of these risks on historical structures, and provide information for neighborhood-scale studies during the planning phase of disaster-resistant construction of heritage assets, both in the present and in the future. The study focuses on the assessment of disaster risk at the neighborhood scale for the geographical area of the Ferhat Paşa Mosque, a work of Mimar Sinan (1490-1588), located in the Ferhatpaşa Neighborhood of Çatalca District, Istanbul Province, Turkey. In this context, the Weighted Overlay method was employed with Geographic Information Systems (GIS) tools in conducting disaster risk analyses. During the analysis process, eight key factors were considered as natural and built environment factors, and spatial analyses were performed. A sample model was created with the assistance of GIS within the scope of the disaster risk analysis of the study area, and eight parameters were defined as variables on this model.

Disaster Risk Analysis Using Geographical Information Systems: A Case Study of Ferhat Pasha Mosque in Çatalca

Handenur ÖZDEMİR and İlke CİRİTCİ, Türkiye

1. INTRODUCTION

The term "cultural heritage" refers to the totality of both abstract and tangible heritage values that express a society's identity, culture, and history. Abstract cultural heritage elements include language, traditions, dance, music, and rituals. Tangible cultural heritage elements include historic cities and fabrics, cultural landscapes, monumental structures, and archaeological sites. The potential loss of cultural and natural assets, which are esteemed by all of humanity, due to internal and external factors such as armed conflict, natural disasters, misuse, and restoration (Feilden, 2003; Ahunbay, 2019; Sanpaolesi, 1972) has prompted the international community to initiate measures for their protection. A wide array of influential and competent stakeholders is involved in the protection of cultural heritage. This group includes UNESCO, ICOMOS, ICCROM, IUCN, ICOM, ICOMOS-CIIC, central government agencies, local governments, non-governmental organizations, the private sector, and universities. According to the World Heritage Committee's "Operational Guidelines for the Implementation of the World Heritage Convention" (2011), cultural property faces numerous threats, categorized into five distinct classifications. The following factors must be considered: natural disasters and preparedness (earthquakes, floods, landslides), development pressure (changes in the physical context of properties, mining, agriculture), environmental pressure (industrial pollution, climate change, deforestation), visitor/tourism pressure, and population size. Disasters represent a significant threat to cultural assets, with the potential to inflict substantial material damage.

Disasters are typically classified into two categories: natural disasters and man-made disasters (AFAD, "Types of Disasters," n.d.). Natural disasters are further categorised into two distinct classifications: slow-onset natural disasters (including severe cold, drought and famine) and sudden-onset natural disasters (encompassing earthquakes, floods, flash floods, landslides, rockfalls, avalanches, storms, tornadoes, volcanoes, fires, etc.). Human-induced disasters can be categorised into five distinct classifications: nuclear, biological, chemical accidents, transportation accidents, and industrial accidents. Additionally, accidents caused by overcrowding, migrants, and displaced persons are also included in this categorisation. The types of disasters observed around the world have been examined under the headings of geological, climatic, biological, social, and technological disasters.

Bernstein (2006) posits that the concept of risk derives from the old Italian word "to dare," thus suggesting that risk is a matter of choice rather than fate. This notion is further reinforced by the scientist who developed Saturn 5, the inaugural spacecraft to go to the moon as part of the Apollo mission. This scientist elucidates the concept of risk management by way of the example of a valve (in memory of Arthur Rudolph, The New York Times, January 3, 1996). Bernstein posits that the optimum scenario would be the implementation of a leak-proof valve. However, in the practical context, one frequently encounters a leaky valve, necessitating the assessment of the permissible degree of leakage. According to the AFAD Explanatory Dictionary of Disaster Terms (AFAD, "Risk," n.d.), risk is defined as "the probability of loss of life, property, economic, and environmental values that an event may cause under certain conditions and environments." According to the United Nations International Strategy for Disaster Management (UNISDR) (2009), risk management is conceptualized as a systematic approach and a practiced based on the principle of managing uncertainty with the objective of minimizing potential harm. It follows, therefore, that the efficacy of disaster risk management is contingent upon the effectiveness of the risk analysis. Risk formulation is conceptualised by UNDRR (2024) as follows, Risk = (Hazard x Exposure x Vulnerability) / Capacity.

The Hazard Definition and Classification Review, 2025 Update of the Technical Report, published by UNDRR and ISC (2025), presents a revised classification containing 281 hazards grouped under eight hazard types. The following categories comprise the spectrum of potential hazards: meteorological and hydrological phenomena, extraterrestrial (space-related) occurrences, geological instabilities, environmental degradation, chemical substances, biological agents, technological malfunctions, and societal disruptions. Natural hazards, such as earthquakes, floods, or fires, in conjunction with the sensitivity level of the element exposed to said hazard -that is to say, its vulnerability- as well as exposure, referring to the heritage assets, structures, collections, communities, and cultural practices located within the hazard zone, constitute the numerator of the fraction. The denominator, on the other hand, is constituted by capacity, or, in other words, manageability.

Despite the employment of varying formulations in the calculation of risks across diverse disciplines, the standard risk formula posited by Nirupama (2013) -Risk = Hazard x Vulnerability- is the preponderantly utilised and acknowledged formula within the domain of disaster risk, as delineated in the methods section. Nirupama (n.d.) posited that risk is commensurate with the product of the values of the concepts of hazard -defined as the probability or possibility of a hazard occurring- and vulnerability, which is characterized as loss, impact, or consequences. As asserted by Pedersoli, Antomarchi, and Michalski (2016), the evaluation of the concept of risk necessitates the joint consideration of the probability of risk occurrence and the impact it will create if it occurs. Within the scope of this study, risk analyses were performed based on the Nirupama formula, and the findings obtained were evaluated in a

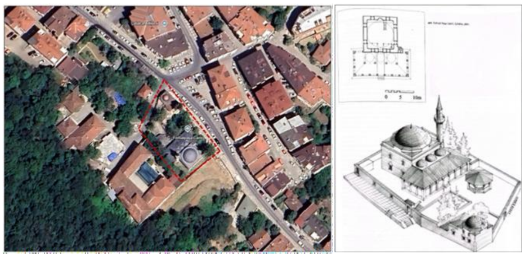
systematic manner. According to the UNISDR (2009) Terminology Related to Disaster Risk Reduction, disaster risk formation is defined as the magnitude and likelihood of losses that occur or may occur in people's lives, health, livelihoods, income, and services. Despite the inability to predict the magnitude of the risk with certainty, the current threat can be concretized through a thorough analysis of pertinent factors, including population distribution and socioeconomic development. Ünal (2019) posited that, while the prevention of disasters is frequently unfeasible, their impact can be mitigated. To safeguard cultural values from the threat of disasters, a comprehensive disaster risk management strategy must be implemented, encompassing a cycle of pre-disaster risk identification, preparation and mitigation, intervention during the disaster, and post-disaster recovery and renewed preparation.

Figure 1. Cycle diagram developed by Zeynep Gül Ünal
(Guideline for the Management of Earthquake Risks for Historic Structures, 2017, p. 212).

The identification of disaster risks and elucidation of their impact on historical structures facilitates more effective risk analysis and assessment through a multidisciplinary approach that integrates architectural and engineering disciplines. Analyses employing Geographic Information System (GIS) tools facilitate the methodical evaluation of risk components in areas where historical structures are present. These analyses unveil the intricate relationships between the current state of the structures and various environmental and structural risk factors. Stovel (1988, 25) underscored the significance of incorporating risk mapping into preparedness measures, emphasizing its role in mitigating the impact of disasters. Such analyses constitute a vital instrument in the arsenal of tools employed to provide scientifically data-driven contributions to the domains of planning, protection, and management of both extant and future heritage structures that exhibit resilience in the face of disasters. In accordance with Feilden (1987), the delineation of risk areas becomes imperative, a task to be carried out with consideration for the distinct characteristics inherent to various categories of historic edifices. The speaker underscores the inaccuracy of employing standard practices when addressing historic buildings, emphasizing that each structure possesses distinct characteristics and specific problems necessitating meticulous examination for effective resolution. The Sendai Framework for Disaster Risk Reduction (2015-2030) recognizes the primary role of the state in reducing disaster risk; however, it also emphasizes that this responsibility must be shared with other stakeholders, including local governments, the private sector, and other interested parties (UNDRR, 2015).

According to KUDEB (2020), the mosque sustained significant damage during the Balkan Wars, after which the structure was subsequently repaired. Following the 1990s, the penwork underwent restoration. Eyice (1995) observed that the areas encompassing the mihrab and windows, the base of the dome, and the surfaces of the pendentives were adorned with penwork embroidery. It is evident that the penwork embroidery once proudly displayed on the dome skirt, surrounding the windows and adorning the pendentives, is now no longer visible. According to KUDEB (2020), the mosque sustained significant damage during the Balkan Wars and was subsequently restored. Following the 1990s, the penwork underwent restoration. Eyice (1995) observed that the areas surrounding the mihrab and windows, the base of the dome, and the surfaces of the pendentives are adorned with intricate painted decorations embroidery. Despite the initial prominence of the penwork embroidery on the pendentives, it is no longer visible today. According to Özdemir's (2025) field observations conducted in 2024, recent painting works had been carried out on the dome and the load-bearing walls of the school; therefore, no painted decorations were observable on the dome. Since the architectural features of the mosque were presented in detail in the thesis prepared in 2024 (Özdemir, 2024), they are not addressed in this paper, as it focuses on technical analyses.

Figure 2. Ferhat Pasha Mosque and Sıbyan School (Özdemir Archive, 2024)



Figre 3. Aerial view of the Ferhat Paşa Mosque (Google Earth Web Application, n.d.), plan and axonometric perspective (Necipoğlu, 2017).

2. METHODOLOGY

The term Geographic Information Systems (GIS) can be defined as an information system that performs the functions of collecting, storing, analyzing, and presenting graphical and non- graphical data obtained through location-based operations within an integrated structure. Geographic Information Systems (GIS) offer a suite of functionalities encompassing the entry, storage, manipulation, analysis, and display of geographic, cultural, political, environmental, and statistical data within a unified spatial framework. A detailed assessment of the available data reveals that the information is of a spatial nature, represented by points, lines, and areas, with associated attributes denoting the characteristics of the features represented by these elements (EPA, 1992). Geographical Information Systems (GIS) function to convert data obtained from analyses in a variety of disciplines into a usable form, subsequently transforming it into a product. In other disciplines, GIS serves to transfer geographic information in a systematic and usable manner. ArcGIS software and its components are powerful GIS and remote sensing software, enabling distributions to be made using different interpolation techniques. The geostatistical component of the software enables the statistical modeling of data and the subsequent mapping of the results.

Additionally, various add-ons have been developed, permitting the reading and writing of numerous data formats.

In the analysis of the location of a historical structure in terms of disaster risk at the neighborhood scale, the Weighted Overlay method was utilized with Geographic Information Systems (GIS) tools, as described in the following methods section. A comprehensive review of the literature revealed seven studies on disaster risk, eight on flood/flooding risk, two each on earthquake, avalanche, and landslide risk, and one each on fire and seismic risk. A review of the literature revealed that the majority of studies addressing flood, inundation, and avalanche risk were conducted at the basin scale, while research on landslide, earthquake, and general disaster risk was predominantly carried out at the provincial or district scale. In this regard, the present study, which was undertaken at the neighborhood scale, addresses a significant gap in the literature by offering a novel contribution. This study employs a multifaceted approach to analyze disaster risk, leveraging factor maps obtained from diverse scales and sources. These maps provided a wealth of data, encompassing slope, aspect, elevation, precipitation amount, distance to hydrogeological structures, distance to fault lines, soil capacity, and land use characteristics. Geographic Information System tools were utilized to process and analyze this data, facilitating a comprehensive understanding of the study area's characteristics and potential hazards. The disaster risk assessment was conducted by collecting spatial and non-spatial data, processing them in GIS through digitization, classification, and expert-based weighting, and integrating all layers using the Weighted Overlay method to evaluate potential hazards.

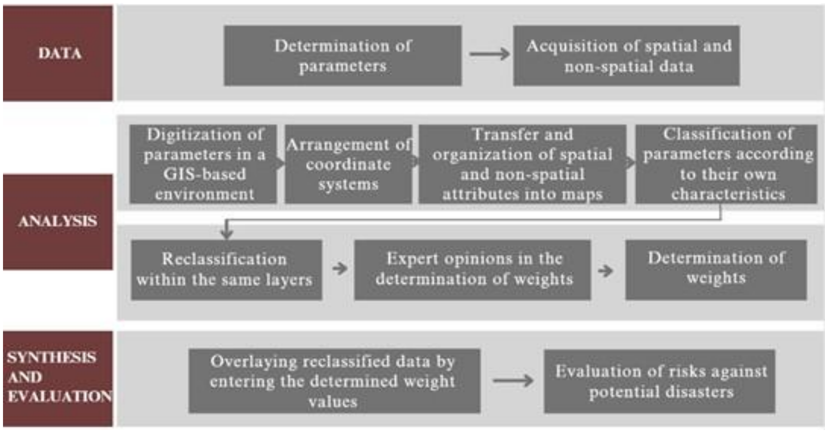


Figure 4. Stages of the Methodology.

3. FINDINGS

İstanbul Büyükşehir Belediyesi Deprem Risk Yönetimi ve Kentsel İyileştirme Daire Başkanlığı'na bağlı Deprem ve Zemin İnceleme Müdürlüğü'nün 2020 yılında yayımladığı "İstanbul İli Çatalca İlçesi Olası Deprem Kayıp Tahminleri" raporuna göre, Ferhatpaşa Mahallesi, Çatalca ilçesinde deprem açısından en yüksek riskli alanlardan biridir. Çatalca'da yer alan ve resmi toplanma alanları dışında bulunmasına rağmen halk tarafından buluşma noktası olarak tercih edilen camilerin, çevresiyle birlikte bütüncül bir yaklaşımla risk analizinin yapılması hem kültürel mirasın korunması için hem de yerel halk için önemli bir ihtiyaçtır. Çalışma kapsamında Ferhatpaşa Mahallesi ölçeğinde afet riskinin ortaya konulması hedeflenmiş ve afet riski oluşturan parametreler genel olarak iki sınıfta değerlendirilmiştir. Doğal çevre (topografik yapı unsurları olarak eğim, yükselti ve bakı, meteorolojik yapı unsurları olarak yağış miktarı, toprak kabiliyeti, fay hatlarına ve hidrolojik yapılara mesafe) ve yapılı çevreye (arazi kullanım) ilişkin belirlenen toplam sekiz parametre, mekânsal analiz sürecinde dikkate alınmıştır.

The slope factor is measured in six increments: 0-5, 5-10, 10-15, 15-20, 20-25, and 25 and above. The aspect factor is measured in three increments: east-west, south, and north. The south increment includes the sub-directions south, southeast, and southwest. The north increment includes the sub-directions north, northeast, and northwest. The elevation factor was categorized into five distinct segments: 0-50 meters, 50-100 meters, 100-150 meters, 150-200 meters, and 200 meters and above. Similarly, the precipitation amount factor was grouped into four categories: 897.8-930 millimeters, 930-960 millimeters, 960-990 millimeters, and 990-1, Measurements indicate that the dimensions are 120 mm and 1,120-1,127 mm, with the distance to fault lines measuring between 25,000 and 27,000. The distances of 000 meters, 27,000-

29,000 meters, and 29,000-31,000 meters were measured, as well as the distances of 10 meters, 50 meters, 90 meters, 130 meters, and 170 meters to the hydrogeological structure. The factors considered in this study include soil capability factor (soil types such as alluvial soils, brown forest soils, calcareous brown forest soils, calcareous brown soils, vertisols, and settlement area) and land use factor (dry farming (non-fallow), pasture, and settlement area). The classification system employed in the study was developed through a systematic review of national and international academic literature addressing analogous topics. Upon examination of the slope parameter, it was ascertained that 88.59% of the Ferhatpaşa Neighborhood exhibits a slope value within the range of 0–10%, while 9.17% falls within the 10–20% range. It is a commonly held tenet in the field that an increase in the slope ratio engenders a concomitant increase in the risk of a plethora of disasters, including but not limited to erosion, flooding, overflow, avalanches, and fires, due to the increased volume of water flowing.

The slope analysis yielded the following findings: 34.86% of the study area faces north, northeast, and northwest, while 27.25% faces south, southeast, and southwest. Notably, slopes facing north are considered to have a high risk of flooding and landslides. The range of elevation values extends from 37 to 321 meters. A significant proportion, amounting to 63.27%, of the area falls within the 37–75 meter range. Additionally, 26.8% of the area falls within the 75–150 meter range, and 9.93% falls within the 150–321 meter range. Areas exhibiting higher elevation values are considered to be at elevated risk of avalanches, erosion, floods, and flash floods. Upon examination of the slope parameter, it was ascertained that 88.59% of Ferhatpaşa Neighborhood possesses a slope value within the 0–10% range, while 9.17% exhibits a slope value within the 10–20% range. It is an established fact that an increase in the slope ratio engenders an elevated risk of disasters, including but not limited to erosion, flooding, and overflow resulting from increased water flow, as well as avalanches and fires. In the remote analysis of tectonic ruptures, it has been ascertained that the designated work area is situated between 25,000 and 31,000 meters from active fault lines. As the proximity to these fault lines diminishes, the susceptibility to seismic events, landslides, and avalanches is regarded as being elevated. The analysis of rainfall amounts revealed that 64.47% of the neighborhood area falls within the 897.8-925 mm rainfall range, 23.39% within the 925-975 mm range, and 12.14% within the 975-1,027 mm range. As precipitation levels increase, the likelihood of disasters such as floods, flash floods, and erosion in these regions is acknowledged to be elevated. A analysis of soil capability data reveals that 56.44% of the area is comprised of alluvial soils, calcareous brown soils, and settlement areas. In regions characterized by the presence of these soil types, the risks of erosion, flooding, and flash floods are deemed to be elevated in comparison to areas with different soil compositions.

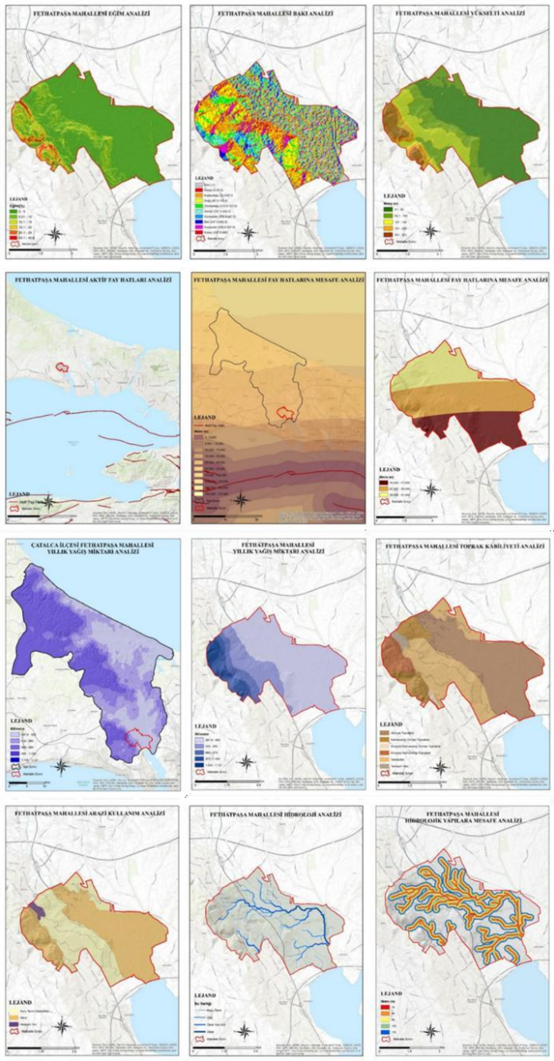


Figure 5. Analysis maps of the Ferhatpaşa neighbourhood.

A analysis of soil capability data reveals that 56.44% of the area is comprised of alluvial soils, calcareous brown soils, and settlement areas. In regions characterized by the presence of these soil types, the risks of erosion, flooding, and flash floods are deemed to be elevated in comparison to areas with different soil compositions. As established in the land use analysis, the percentage of land allocated to dry farming (non-irrigated) areas amounts to 37.61%, while 60.99% of the total area is designated for pasture. With regard to settlement areas, it is a commonly accepted premise that such areas are prone to an elevated risk of disasters in comparison to other land use categories. According to the buffer zones established in the distance assessment of hydrological structures, despite the absence of large-scale water bodies (e.g., rivers) in the region, observations have revealed the existence of numerous water resources. It is acknowledged that as proximity to water resources increases in these areas, the risk of floods and flash floods is elevated.

Table 1. Disaster Risk Parameters and Classification

Parameter	Values	Disaster Risk Classification	Impact Level
Slope (%)	0–10	Low risk	1
	10–20	Medium risk	2
	20 and above	High risk	3
Elevation (meter)	0–75	Low risk	1
	75–150	Medium risk	2
	150–321	High risk	3
Aspect	East–West	Low risk	1
	South (South, Southeast, Southwest)	Medium risk	2
	North (North, Northeast, Northwest)	High risk	3
Soil Capability	Vertisols	Low risk	1
	Brown forest soils	Low risk	1
	Non-calcareous brown forest soils	Medium risk	2
	Non-calcareous brown soils	High risk	3
	Alluvial soils	High risk	3
	Settlement area	High risk	3
Land Use	Pasture	Low risk	1
	Dry farming (non-fallow)	Medium risk	2
	Settlement area	High risk	3
Distance to Fault Lines (meter)	29,000–31,000	Low risk	1
	27,000–29,000	Medium risk	2
	25,000–27,000	High risk	3
Distance to Hydrological Structure (meter)	170	Low risk	1
	130	Low risk	1
	90	Medium risk	2
	50	High risk	3
	10	High risk	3
Precipitation Amount (mm)	897.8–925	Low risk	1
	925–975	Medium risk	2
	975–1,027	High risk	3

It is imperative to ascertain the weight effect for each parameter within the Weighted Overlay method post-reclassification stage. The study encompassed the calculation of the weight effects of the eight parameters utilized in the disaster risk analysis, informed by the discernments of experts in the field. In evaluating the disaster risk associated with the location of the historical structure, the aforementioned parameters were scored from 1 to 8 by experts in the field, with the parameter of utmost priority being assigned the highest score. The evaluation scores provided by five experts in the fields of Urban and Regional Planning, Civil Engineering, Surveying Engineering, Architecture, Geodesy and Photogrammetry Engineering were calculated in their total, and a priority ranking was established from highest to lowest. Accordingly, the parameters of distance to fault lines and rainfall amount were ranked first with 31 points each, while the aspect parameter was ranked eighth with 4 points. The remaining parameters were calculated as follows: hydrological structure and soil capacity, 25 points; slope, 24 points; land use, 23 points; and elevation, 14 points. The calculation of percentage values was determined by the total point values and distribution of the eight parameters evaluated in terms of disaster risk for the location of the historical structure on the terrain. Through the application of the weighted overlay method, these reclassified parameters were normalized with weight values, superimposed, and ultimately resulted in a disaster risk analysis.

Table 2. Weight Values of Parameters

Parameter	Weight Value (%)
Distance to Fault Lines (meter)	17,22
Precipitation Amount (mm)	17,22
Distance to Hydrological Structure (meter)	13,89
Soil Capability	13,89
Slope (%)	13,33
Land Use	12,78
Elevation (meter)	7,78
Aspect	3,89

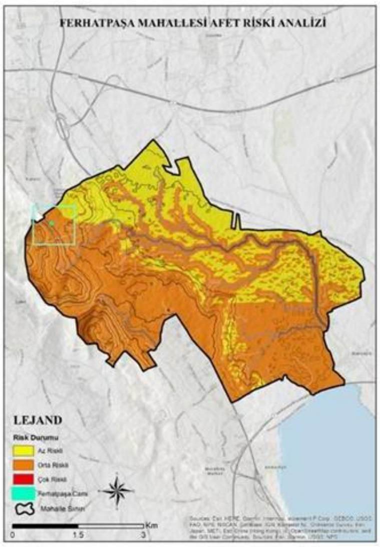


Figure 6. Disaster risk analysis of the Ferhatpaşa neighbourhood.

An analysis of disaster risks for the Ferhat Pasha Mosque, designed by Mimar Sinan, shows that 71.99% of the study area is at medium risk, 28% is at low risk, and 0.02% is at high risk. The mosque is located in the medium-risk area. As part of the disaster risk analysis of the study area, we created a sample model using Geographic Information Systems. We used eight parameters, which we defined as variables on the model. “Sample model” means that when examining another cultural heritage site within a neighborhood, you can use the parameters from this model and adjust them as needed. This makes the analysis faster.

4. RESULTS

This GIS-based disaster risk analysis in Ferhatpaşa Neighborhood shows that protecting cultural heritage structures requires consideration of more than just their physical characteristics. It also shows that environmental and spatial factors play a big role. The findings indicate that disaster risk increases significantly in areas close to water structures, with low elevation and dense surfaces that water can't penetrate. Additionally, slopes facing north and areas with soil made of material carried by flowing water are at a higher risk of flooding and erosion. Even though the buildings in the area are a considerable distance from fault lines, the strength of the buildings and the ground's characteristics show that care is needed when dealing with hazards caused by earthquakes.

When planning for areas related to water and wetlands, we should figure out the maximum water level for each season. We also need to consider the risk of fires, landslides, and avalanches in these areas. And we should implement buffer zone applications in the relevant areas. If people are allowed to build in the areas around rivers and streams, it's important to take steps to reduce the risk of flooding. This could include building flood walls and levees, fixing damaged riverbeds, and checking regularly to make sure nothing is blocking the flow of water.

In the Ferhatpaşa neighborhood, although there are no large-scale rivers, there are streams and their respective tributaries. A recent analysis has demonstrated that, in the event of the implementation of the buffer distances proposed in the aforementioned study, a substantial portion of the neighborhood will remain within these designated areas. Consequently, it is imperative that local governments adopt a sustainable and holistic planning approach that incorporates disaster risks in the determination of land use strategies and settlement decisions.

As demonstrated by the architectural example of Ferhat Paşa Mosque, situated in proximity to forest areas, the strategic planning of firebreak clearings is imperative in regions containing historical structures, with the objective of impeding the propagation of wildfires. Furthermore, augmenting the efficacy of fire suppression necessitates the judicious placement of fire hydrant systems, considering their designated areas of influence, thereby ensuring optimal accessibility for firefighting operations.

In consideration of these findings, the implementation of strategies aimed at regulating surface runoff, minimizing impervious surfaces, and enhancing secondary drainage systems must be given utmost priority. In regions characterized by steep slopes and geological hazards, the emphasis should be placed on non-structural measures, such as the organization of evacuation routes and the designation of assembly areas. In the course of restoration and maintenance processes, it is imperative that the integrity of the original materials and load-bearing systems be preserved, and techniques consistent with conservation principles must be applied. Furthermore, it is recommended that potential risk indicators, such as cracks, moisture, and vibrations in the structure, be subject to regular monitoring, and that an effective coordination mechanism be established between the General Directorate of Foundations, the Istanbul Metropolitan Municipality, KUDEB, and civil society organizations.

Cultural heritage sites, including historical buildings, towns, urban areas, archaeological sites, historical gardens, and cultural landscapes, necessitate distinct Disaster Risk Management definitions that are customized to address the unique characteristics inherent to each category of site. The primary objective of disaster management planning is to ensure the preservation of cultural heritage in the face of potential damage and loss resulting from disasters. To this end, comprehensive disaster management plans and emergency action plans must be meticulously formulated, encompassing all pertinent areas. During the planning process, it is imperative that protection policies and risk management strategies are integrated within the framework of the Protection-Oriented Zoning Plan. Moreover, necessary structural and non-structural interventions must be implemented, and the resilience of cultural heritage against disasters must be addressed with a holistic approach.

REFERENCES

AFAD, n.d. Glossary of disaster management terms. Ankara, Disaster and Emergency Management Authority. Available at: https://www.afad.gov.tr/aciklamali-afet-yonetimi-terimleri-sozlugu

AFAD, n.d. Types of disasters. In: Glossary of disaster management terms. Ankara, Disaster and Emergency Management Authority. Available at: https://www.afad.gov.tr/aciklamali-afet- yonetimi-terimleri-sozlugu

Ahunbay, Z., 2019. Tarihi çevre koruma ve restorasyon, 12th edition. Istanbul, Yem Publishing.

Akçıl Harmankaya, N. Ç., 2017. Symbolism in the mosques of Mimar Sinan. Doctoral dissertation. Ankara, Council of Higher Education Thesis Center.

Bernstein, P. L., 2006. Against the gods: The remarkable story of risk. Istanbul, Scala Publishing.

Çelebi, R., 1994. Ferhad Pasha Mosque. In: Encyclopedia of Istanbul from past to present, Vol. 3, pp. 291–292. Istanbul, Ministry of Culture and History Foundation.

EPA, 1992. Geographic information systems (GIS) guidelines document. Washington DC, Environmental Protection Agency. Available at: https://nepis.epa.gov/

Eyice, S., 1995. Ferhad Paşa Mosque. In: Encyclopaedia of Islam, Vol. 12, pp. 384–386. Istanbul.

Feilden, B., 1987. Between two earthquakes: Cultural property in seismic zones. Rome, ICCROM; Marina del Rey CA, Getty Conservation Institute.

Feilden, B. M., 2003. Conservation of historic buildings, 3rd edition. London, Architectural Press.

Istanbul Metropolitan Municipality, 2020. Estimated earthquake losses for Çatalca District, Istanbul Province. Istanbul.

Kuran, A., 1975. Ferhad Pasha Mosque in Çatalca. Boğaziçi University Journal, 3, pp. 73–90.

Kuran, A., 1986. Mimar Sinan. Istanbul, Hürriyet Foundation Publications.

KUDEB, 2020. Cultural and natural heritage inventory of Çatalca District, Istanbul. Istanbul, Istanbul Metropolitan Municipality KUDEB Publications.

Nirupama, N., 2013. Disaster risk management. In: Encysclopaedia of Natural Hazards, pp. 164– 170.

Özdemir, H., 2025. GIS-based disaster risk analysis for the conservation of cultural heritage: The case of Ferhat Paşa Mosque in Çatalca. Master's thesis. Council of Higher Education Thesis Center, Türkiye. Available at: https://tez.yok.gov.tr/

Pedersoli Jr., J. L., Antomarchi, C. and Michalski, S., 2016. A guide to risk management of cultural heritage. Rome, ICCROM and Canadian Conservation Institute.

Stovel, H., 1998. Risk preparedness: A management manual for world cultural heritage. Rome, ICCROM.

UNDRR, 2015. Sendai framework for disaster risk reduction 2015–2030. Geneva, United Nations Office for Disaster Risk Reduction.

UNDRR, 2024. Handbook on the use of risk knowledge for multi-hazard early warning systems. Geneva, United Nations Office for Disaster Risk Reduction.

UNDRR and ISC, 2025. Hazard definition and classification review: 2025 update of the technical report. Geneva, United Nations.

UNESCO, 2011. Operational guidelines for the implementation of the World Heritage Convention. Paris, UNESCO. Available at: https://whc.unesco.org/archive/opguide11-en.pdf

UNISDR, 2009. Terminology on disaster risk reduction. Geneva, United Nations.

Ünal, Z. G., 2019. Emergency response phase in the management of integrated disaster risks for cultural heritage. In: Disaster risk management for cultural properties, pp. 14–24. Istanbul, Istanbul Historic Areas Directorate Publications.

Vakıflar General Directorate and Istanbul Governorship Project Coordination Unit, 2017. Guideline for the management of earthquake risks for historic structures. Ankara, General Directorate of Foundations Publications.

BIOGRAPHICAL NOTES

Handenur Özdemir holds a bachelor's degree in Surveying Engineering and is a doctoral student in the Architecture Doctoral Program (Surveying and Restoration) at Yıldız Technical University. Her work focuses on disaster risk analysis, cultural heritage preservation, and disaster-resilient planning of historical structures/environments using GIS and remote sensing techniques, employing an interdisciplinary approach that combines geomatics/surveying engineering with architecture.

CONTACTS

Name and family name: Handenur Özdemir
Organisation: Yıldız Technical University, Faculty of Architecture, PhD Program in Architecture (Architectural Survey and Restoration)
Email: handenur.ozdemir@std.yildiz.edu.tr