# FIRE VULNERABILITY ASSESSMENT FOR HERITAGE PLACES: A CASE OF THE CITY OF SAFRANBOLU WORLD HERITAGE SITE

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# ABSTRACT

## FIRE VULNERABILITY ASSESSMENT FOR HERITAGE PLACES: A CASE OF THE CITY OF SAFRANBOLU WORLD HERITAGE SITE

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Fire incidents threaten cultural heritage and lead to irreversible damages. Loss of life, destruction of buildings, and traditional urban tissues are possible consequences of a fire. Major causes of fires at cultural heritage buildings include deficiencies in electrical installations, electrical appliances used during restoration works, unmaintained chimneys, and fire safety negligence. Historic urban tissues in Turkey are highly vulnerable to fires because of using timber as a building material, lack of maintenance, state of condition of buildings, and difficulties accessing narrow streets in emergencies. Fires are often preventable if measures are undertaken in all decision-making processes. The existence and implementation of fire risk management policies based on international and national policies are critical to preventing fires through practical actions. However, studies on fire vulnerability assessment for heritage places on an urban scale are limited in numbers and have deficiencies concerning time requirements and financial aspects.

In this respect, this thesis aims to propose a preliminary fire vulnerability assessment method for heritage places on an urban scale. It has three potential contributions to related literature. It defines fire vulnerability assessment indicators, a simplified method, and policies. In addition, it aims to contribute to UNESCO World Heritage Site management processes by providing a fire vulnerability assessment approach, methodology, and procedures.

Fire vulnerability of heritage places is related to different factors at building and neighborhood scales. In this study, four categories of factors are classified: (i) The existence of ignition sources, (ii) The existence of flammable materials, (iii) the Fire Combat within the building scale, and (iv) the Fire Combat within the Neighborhood scale. In this sense, a fire vulnerability assessment for the City of Safranbolu World Heritage Site is conducted. Site surveys were done at different times, and interviews with diverse local stakeholders were conducted for data collection. Analysis using geographical information systems revealed that 59 % of traditional buildings have a medium, high, and very high level of fire vulnerability in the Çeşme Neighborhood.

This study suggested a policy framework for fire risk management of cultural heritage. Namely, fire risk management of cultural heritage should be considered in different planning scales such as regional, urban, and building. Participatory processes, including different actors, sufficient technical capacity, and a national fire incidents database are required. In conclusion, the new policy-making process for cultural heritage fire vulnerability assessment can be adapted for current Turkish decision-making mechanisms and other heritage places exposed to fire risk.

**Keywords:** Fire Vulnerability Assessment, the City of Safranbolu UNESCO World Heritage Site, Fire Risk Management Policies

# ÖZ

## MİRAS YERLERİ İÇİN YANGIN HASAR GÖREBİLİRLİK DEĞERLENDİRMESİ: SAFRANBOLU KENTİ DÜNYA MİRAS ALANI ÖRNEĞİ

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Haziran 2022, 291 sayfa

Yangın olayları kültürel mirası tehdit etmekte ve geri dönüşü olmayan zararlara sebep olmaktadır. Can kaybı, binaların ve geleneksel kentsel dokuların tahribatı yangının olası sonuçları arasında yer almaktadır. Kültürel miras yapılarındaki yangınların başlıca nedenleri elektrik tesisatlarındaki eksiklikler, restorasyon çalışmaları sırasında kullanılan elektrikli aletler, bakımsız bacalar ve yangın güvenliği ihmali sayılabilir. Bu faktörlerin yanı sıra, yapı malzemesi olarak ahşabın kullanılması, bakımsızlık, yapıların durumu ve acil durumlarda dar sokaklara ulaşım zorluğu nedeniyle Türkiye'deki tarihi kent dokuları yangınlara karşı oldukça hassastırlar. Tüm karar alma süreçlerinde önlemler alındığı takdirde yangınlar genellikle önlenebilir olaylardır. Uluslararası ve ulusal politikalara dayalı yangın risk yönetimi politikalarının varlığı ve uygulanması, kolaylaştırılmış yöntemlerin geliştirilmesi yangınların önlenebilmesi için kritik öneme sahiptir. Ancak, kentsel ölçekteki kültürel miras alanları için yangın hasar görebilirlik değerlendirmesi çalışmaları sayıca sınırlıdır. Mevcut yöntemlerin zaman gereksinimleri ve mali açıdan uygulanabilmeleri zordur.

Bu kapsamda, bu tez kentsel ölçekteki kültürel miras alanları için kullanılan mevcut ilkeler, metodlar ve araçlara dayalı bir ön değerlendirme yöntemi önermeyi amaçlamaktadır. Çalışma literature üç temel konuda katkı sağlamaktadır. Kültürel miras için yangın hasar görebilirlik değerlendirme parametrelerini, kolaylaştırılmış bir yöntem ve politikalarını tanımlamaktadır. Yangın hasar görebilirlik değerlendirme yaklaşımı, yöntemi ve sürecini tanımlayarak UNESCO Dünya Mirası Alanı yönetimine de katkıda bulunmayı amaçlamaktadır.

Kültürel miras alanlarının yangına karşı hasar görebilirliği, yapı ve mahalle ölçeğindeki farklı faktörlerle ilişkilidir. Bu çalışmada, kültürel miras yangın hasar görebilirliğine dair faktörler dört kategori altında sınıflandırılmıştır: (i) Tutuşturma kaynaklarının varlığı, (ii) Yanıcı maddelerin varlığı, (iii) Yapı ölçeğinde Yangınla Mücadele ve (iv) Mahalle ölçeğinde Yangınla Mücadele. Bu kapsamda, Safranbolu Kenti Dünya Miras Alanı için yangın hasar görebilirlik değerlendirmesi yapılmıştır. Veri toplama için farklı zamanlarda saha çalışması ve çeşitli yerel paydaşlarla görüşmeler gerçekleştirilmiştir. Yangın hasar görebilirlik değerlendirmesi için Coğrafi Bilgi Sistemi'nde yapılan analizler sonucunda Çeşme Mahallesinde yer alan yapıların % 59'unun orta, yüksek ve çok yüksek yangın hasar görebilirlik seviyesinde olduğu ortaya çıkmıştır.

Bu çalışma, kültürel mirasın yangın risk yönetimi için bir politika çerçevesi de önermektedir. Buna göre kültürel miras yangın risk yönetimi bölgesel, kentsel ve yapı gibi farklı ölçeklerde ele alınmalıdır. Farklı aktörleri ve yeterli teknik kapasiteyi içeren katılımcı süreçler ve geçmiş yangın olaylarına dair ulusal bir veri tabanı gerekli politikalar arasında yer almaktadır. Sonuç olarak, kültürel miras yangın hasar görebilirlik değerlendirmesine yönelik politika oluşturma süreci, Türkiye'deki mevcut karar alma mekanizmalarına ve yangın riskine maruz kalan diğer miras alanlarına uygulanabilir.

**Anahtar Kelimeler:** Yangın Hasar Görebelirlik Değerlendirmesi, Yangın Risk Yönetimi politikaları, Safranbolu Kenti UNESCO Dünya Miras Alanı

To my dear mother Cevahir Uluç and my father Beşir Uluç,

with love, respect, and gratitude

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Everyone has stories that shape their lives. My story starts with visiting different archaeological and urban sites in my childhood. I did not know the legal explanation of these terms and responsibilities of different bodies then, but I knew those sites were unique and significant to be sustained. My story continued with completing my bachelor's in city and regional planning and my master's in the conservation of cultural heritage. I have learned spatial stories of various cities and regions in different aspects. In every study I make, I have tried to choose current problems of heritage places to contribute to their sustainability. My Ph.D. thesis is formed from this point of view.

Many people kindly helped me in various respects and contributed to finalizing my Ph.D. thesis. First, I would like to thank my advisor, Assoc. Prof. Dr. Meltem Şenol Balaban and my co-advisor Assist. Prof. Dr. Sibel Yıldırım Esen. Their guidance and valuable feedback shaped and developed my study. I always feel free to share any difficulties I face. Their enthusiasm often affected my studies.

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## ABBREVIATIONS

AFAD: Disaster and Emergency Management Authority

BYKHY: Regulation on Fire Protection of Buildings *(Binaların Yangından Korunması Hakkında Yönetmelik)*

CH: Cultural Heritage

DRM: Disaster Risk Management

DRR: Disaster Risk Reduction

DSİ: The General Directorate of State Hydraulic Works

IRAP: Provincial Disaster Risk Mitigation Plan *(İl Afet Riski Azaltma Planı)*

FVA: Fire Vulnerability Assessment

FRA: Fire Risk Assessment

FRM: Fire Risk Management

SWHS: Safranbolu World Heritage Site

MTA: Mineral Research and Exploration General Directorate

OUV: Outstanding Universal Value

WHS: World Heritage Site

WCH: World Cultural Heritage

# CHAPTER 1

# INTRODUCTION

Fire has been one of the most devastating hazards that historic buildings and environments encountered throughout history. There are many cascading fires globally, and many historic buildings and settlements have been affected by fires negatively for centuries. They were partially or lost. Two of the most critical and known urban fire events were the 1666 London fire and the 1871 Chicago fire (Figure 1), which resulted in the collapse of both cities and the loss of life (Ferreira et al., 2016).

Notre Dame Cathedral, a World Heritage Site, faced a destructive fire on 15 April 2019 (Figure 2). Two-thirds of the roof was affected, and the bell tower collapsed [URL 1]. Due to the National Museum of Brasil fire in 2018, about 20 million items were destroyed [URL 2]. When bush fires in Australia started in June 2019 and continued until March 2020, roads and pathways to heritage places were blocked. Archaeologists and Aboriginal land managers could not assess fire damage in those places [URL 3].

In addition, Namdamun Gate/South Korea (2008) (Figure 3), Krasna Horka Castle/Slovakia (2012) (Marrion, 2020), Wangduephodrang Dzong Monastery/Bhutan (2012) (H @ R, 2014, p.9) Hampton Court Palace/England (1986) (Harris, 2021), Battersea Art Center/England (2015) (BBC, 2015) was damaged as a result of fires. The loss or deterioration of cultural properties negatively affects national and local communities concerning their cultural, social, economic, and spiritual values (UNESCO, 2009). Their role in attractiveness and economic growth for countries makes them internationally significant (Julià and Ferreira, 2021).


Figure 1 Chicago after Fire in 1871 [URL 4]

Figure 2 Notre Dame Fire in 2019 [URL 5]

Figure 3 The Namdaemun gate in Seoul, South Korea, after a fire in 2008 [URL 6]

Fire incidents happen when a fuel that can be a flammable material is reached its ignition temperature by a heat source such as flame in the oxygen presence (Kidd, 1995) (Figure 4). The existence of three elements: fuel, heat, and oxygen, are necessary for a fire occurrence. If any of those elements are removed, fires can be prevented or extinguished (CFPA-E, 2013).

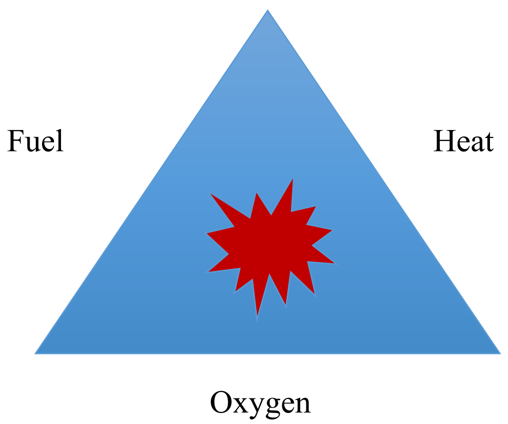


Figure 4 The Fire Triangle

Fire incidents are a critical hazard for traditional settlements in Anatolia, built with wooden materials or systems. They sometimes cause irreparable damage. Fires can spread to the environment quickly due to the adjacent or close proximity of the buildings and narrow streets in traditional patterns (Atılgan, 2013). Gazi Osman Paşa Primary School (2002) (Figure 5), Haydarpaşa Station Building (2010), Kılıç Ali Pasha Mosque (2011), Beyazıt Mosque Hünkar Pavilion (2011), Grand Bazaar (2012), Provincial Directorate of National Education (2012) (Figure 6), Galatasaray University (2013) (Figure 7) fires in İstanbul are some examples of fires encountered by traditional buildings in Turkey (Atılgan, 2013).

Figure 5 Gazi Osman Paşa Primary School Fire on 13 July 2002 (Atılgan, 2013)

Figure 6 Provincial Directorate of National Education Fire on 24 December 2012 (Atılgan, 2013)

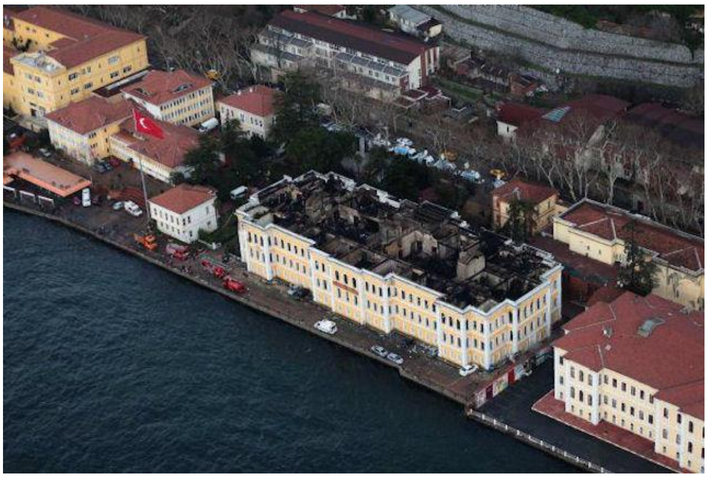

Figure 7 Galatasaray University Fire on 22 January 2003 (Atılgan, 2013)

In addition to fires in traditional buildings, fires happen in traditional environments. For example, between 2013 and 2017, 17 fires occurred in Historic Safranbolu [URL 7]. Some traditional buildings burnt due to fires in Safranbolu can be seen in Figure 8. When considering the significance of cultural heritage, this number is critical. The occurrence of many fires in such areas where the traditional urban pattern is dominant poses a severe risk to the sustainability of cultural heritage sites. Since a fire that will occur in the historical tissue can spread rapidly to the nearby environment due to being constructed very close to each other in a street pattern, including narrow and dead-end streets, the fires in these areas may cause more destructive consequences.

Many factors related to traditional buildings and environments increase their vulnerability to fire incidents. For example, being old, including combustible materials, the high density of buildings in narrow streets, and adapting buildings for inappropriate non-residential uses increase the vulnerability of heritage places to fires (Granda and Ferreira, 2019a; Ferreira et al., 2016). Moreover, traditional construction techniques, undivided roof spaces, hidden voids, historic furnishings, high fire loads, and changes can increase the vulnerability of historic buildings to fires (Mitchell, 2010).

Concerning different fire incidents in historic buildings and environments in Turkey and other countries and factors increasing fire vulnerability of traditional buildings and environments have shown the severity of fire risk. They revealed the urgent need for fire risk mitigation policies and measures in historic buildings and environments.

Salleh (2012) defines fire safety in heritage as life safety, protection of contents, and fabric (Figure 9). The primary fire safety goals include life safety such as occupants, emergency responders, protection of spirit of the place and traditions, contents and historic fabric, building, monument, site, business continuity, and environment protection (Marrion, 2016, p. 748). Due to various values, only paying attention to life protection is insufficient for conserving cultural heritage (Torero, 2019).

Figure 8 Some samples of burnt traditional buildings that were investigated during the site survey conducted in October 2020

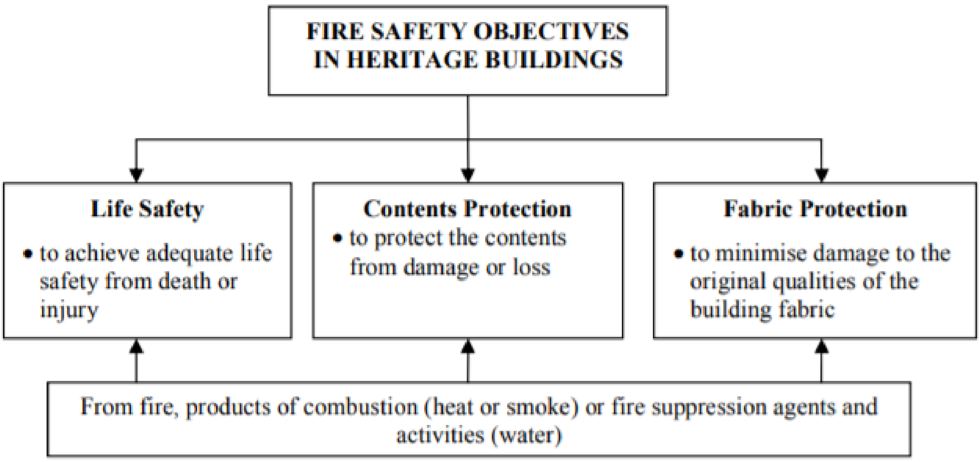


Figure 9 Fire Safety Objectives in Heritage Buildings (Salleh, 2012)

Assessing fire vulnerability is one step in the fire risk assessment of cultural heritage. Due to limited knowledge and resources on pre-disaster plans and preventive actions, technical, institutional, and financial sources are usually based on post-disaster activities (Granda and Ferreira, 2019a, p.106). However, fires can be prevented when necessary policies, principles, and actions are applied. In order to mitigate the fire risk of cultural heritage, the fire vulnerability of traditional buildings and environments should be assessed, and required interventions should be applied on time. Due to the applicability of methods on larger scales of cultural heritage, preliminary fire vulnerability assessment methods with fewer input data are needed.

In this sense, it is necessary to develop simplified fire vulnerability assessment methodologies for historic buildings and environments. This thesis proposes a simplified fire vulnerability assessment method that can be applied to heritage places on a larger scale. The study aims to evaluate fire vulnerability on an urban scale since the research is conducted with the perspective of the city and regional planning discipline combined with the notion of cultural heritage conservation in a broader approach. Results of the research provide preliminary fire vulnerability assessments of traditional buildings in Safranbolu WHS that need further detailed analysis.

## 1.1.Problem Definition

From ancient times to today, fires have been one of the critical hazards affecting heritage places. Fires can appear as primary hazards due to human-induced or natural causes such as temperature increases and secondary threats following earthquakes, landslides, and volcanic eruptions.

Fires in historical buildings can occur for many reasons. The most frequent one is caused by electricity issues such as malfunctions in electrical installations and improper use of electrical types of equipment (Karlsen, 2001; Kılıç, 2011). In addition, arson, improper stove use and open fire, lightning, explosions, self-ignition, the spread of fire flames, and the transport of sparks, construction works, welding, and cutting can cause fires in historic buildings (Karlsen, 2001). Unique characteristics of historic buildings and environments can also trigger fire ignition and propagation (Neto and Fereira, 2020). Beilicke (1991, p.58) explains the causes of fires in historic buildings as changes in heating systems, electric installations, technical equipment, repair works, small distances between buildings, insufficient fire-resistant structures, deteriorations, and water supply problems, adaptation to modern life, and accessibility.

In addition, ignition sources and flammable materials used during restoration are among the reasons for fires encountered by historical buildings (Marrion, 2016, p. 747; Marrion, 2020; Kılıç, 2011, p.36). For example, it was thought that restoration and construction works were the reasons for the Notre Dame Cathedral fire in 2019 (Ferreira, 2019). According to Fire Protection Association in Scotland, about 20 % of fires in listed heritage buildings happened due to construction or maintenance works (Kidd 2010b, p.7). Heat-producing works such as welding, cutting, grinding, tar boiling, and paint stripping are thought to be lost millions of pounds in fire damage in Scotland annually (Kidd, 2010b).

Fires affect heritage places in various aspects. Taboroff (2000, p. 72) identifies the main effects of fires as damage to buildings and their contents, damage from heat smoke and combustion by-products to structures, and interior elements, the impacts of water on a building during firefighting, and impacts on infrastructure systems. In addition, damage to structures and objects located within archaeological sites and cultural landscapes, impacts on natural habitats, and secondary damage from floods and mudslides are caused by fires (Taboroff, 2000). The effects of fires on historic buildings and environments are irreversible; if a traditional building is lost in a fire, it is lost forever. Furthermore, fires in historic settlements where people live and work can create a higher fire risk since the loss of life and economic disruption occurs.

The fire risk may increase due to the absence of explanatory principles in the restoration, maintenance, or any repair projects regarding the measures that should be taken during these applications or the difficulties experienced during monitoring. Moreover, the aging of the buildings built with timber-frame construction systems can be considered another factor that increases the vulnerability to fire. The street pattern of the traditional urban fabric formed by narrow and organic network systems (Ferreira et al. 2016, p.739) is also one factor that increases vulnerability by causing difficulties in an intervention during fires.

Furthermore, the abandonment of the buildings due to the poor structural condition and the problems experienced in adapting these structures to modern living conditions also make these structures very vulnerable to fires. Being vacant also means problems in fire risk mitigation on the building scale. As seen in the Safranbolu case, 41 out of 233 vacant buildings were investigated during the site survey in the Çeşme Neighborhood.

Historical urban areas generally show mixed-use in terms of small commercial and service areas on the ground floors and residential uses on the upper floors. This situation is an essential risk factor (Granda and Ferreira, 2019, p.126). Özgünler (2007 cited in Özgünler, 2018, p.15) emphasized that in many historical buildings, the budget required to protect historic structures and the valuable features of its are provided by using the building. Although various activities, rental, and tourism revenues may be sufficient for fire safety investments in large-scale buildings, finding resources in smaller buildings that are inappropriate for such activities is difficult. Therefore, in some cases, changing original functions and organizing activities to create financial resources also damage historic buildings. They make an additional fire risk to the historic buildings (Özgünler, 2018, p.15). In other words, due to not being constructed according to new function requirements, uncontrolled and inappropriate installations required by adapted use result in a higher fire risk to cultural heritage.

Proper policies and principles mitigate the fire risk of cultural heritage. Unlike natural disasters such as earthquakes and landslides, it is possible to prevent fires despite all these reasons (Jennings, 2013). Therefore, fire prediction and risk reduction are evaluated as easy tasks (Kelley, 2020, p.195; Sarıkaya, 2003, p.36).

In this sense, legal and administrative regulations play an essential role in reducing fire risk. It was emphasized that local planning authorities should develop technical documents, administrative rules, and installation instructions to provide legal authority on fire safety and protect the characteristics of different building types (Huang et al., 2009). Therefore, implementing the laws is essential (Tomar et al., 2017, p.135-136). Still, legal and administrative regulations should have policies that will take the necessary measures against the fire risk of historic buildings and environments.

In addition, as emphasized in the Sendai Framework for Disaster Risk Reduction (2015-2030), disaster risk reduction and management can be achieved with the participation of public and private sector actors, including national and local government agencies, businesses, and academia [URL 8]. Parallel to this, there is a need for a multi-actor active participation process in fire risk management. In addition, as discussed in the Sendai Framework, the recording and evaluation of disaster losses will reveal the issues that need to be addressed for potential disasters [URL 8]. As Huang et al. (2009) emphasized, databases on past fire incidents are necessary to protect historic buildings and environments from fire, as data on the fire-related performance and propagation characteristics of traditional materials are difficult to access. These databases should include a primary database containing basic information and details for historical buildings and a database containing fire-related properties of traditional materials and material diffusion characteristics of historical buildings (Huang et al., 2009, p.75). It is vital to establish a national database to evaluate past fires and losses caused by them systematically. In addition, the technical capacity should be developed and increased by increasing the awareness of the technical personnel who will respond to the fire (Tomar et al., 2017; Stovel, 1998: 47) due to the differentiation of historic buildings and environments from the existing cities.

Fires are also secondary hazards following earthquakes, volcanic eruptions, and landslides. Juliá, Ferreira, and Rodrigues (2021) analyzed post-earthquake fires in historical city centers, which means the probability of urban fire triggered by a seismic event. Historical records revealed that fires following earthquakes caused destructive urban fires (Juliá, Ferreira, and Rodrigues, 2021). For example, the fires after the 1906 San Francisco Earthquake (Kelley 2020, p.195) and the 1995 Kobe Earthquake caused more destruction than the earthquake in both cities. After the Kobe Earthquake, fires broke out in 148 different places, and 6,513 buildings were damaged due to the fires (NFPA, 2015). Following the Great Hanshin earthquake in Japan, the fire caused devastating impacts on traditional buildings (Okubo, Nakayabu, and Kim, 2020). Okubo, Nakayabu, and Kim (2020) stated that in an earthquake in cultural heritage sites with high-density wooden structures, it is challenging to control largescale fire following an earthquake since an earthquake can cause building collapse and prevents fire brigade access.

Because of being located on different critical active fault lines, such as the North, East, and West Anatolian Fault Line, many earthquakes happened between 1900 and 2018. As seen in the Earthquake Hazard Zoning Map of Turkey in Figure 10[1], some of Turkey's UNESCO World Heritage Sites are located close to 1st-degree fault lines (pga>0.4 G), which shows the degree of profound effects of earthquake hazards on cultural heritage sites. Therefore, due to being located on or close to active fault lines, fires following earthquakes in heritage places in Turkey become a significant secondary hazard to consider.

[1] At this şpoint, it is important to emphasize that as a focus point of the research project, only UNESCO WHS were shown in Figure 10; however, many other cultural heritage sites are not on the World Heritage List in Turkey. Further analysis should be conducted to investigate cultural heritage, which is exposed to fire as a secondary hazard.

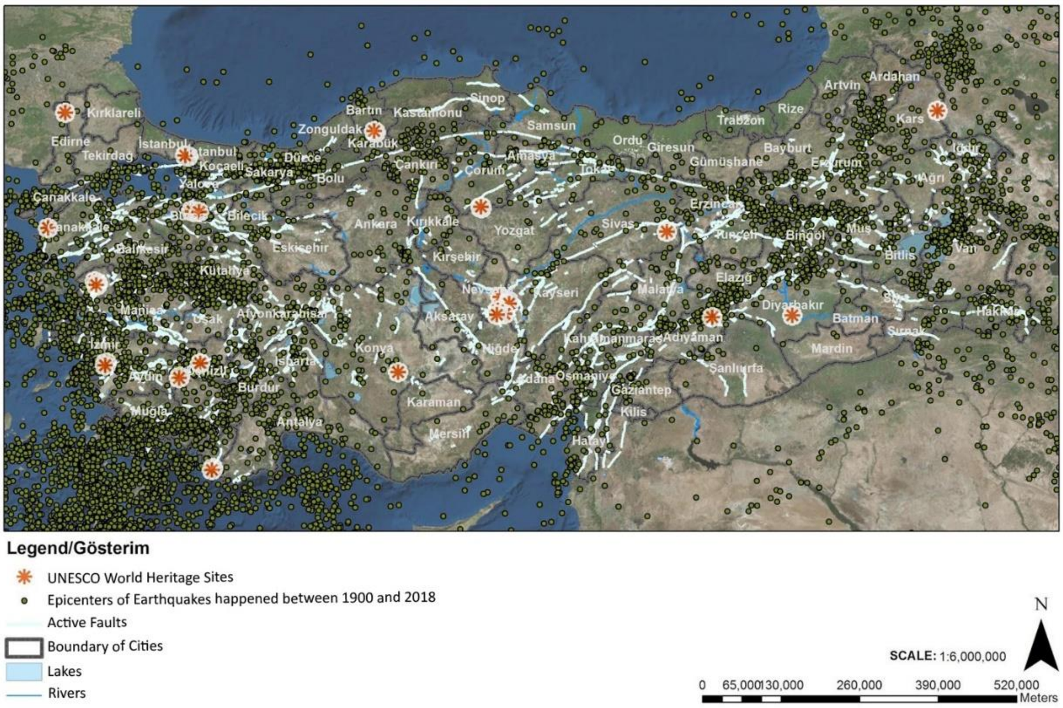


Figure 10 Earthquakes occurred in Turkey between 1900 and 2018, Active Faults and UNESCO World Heritage Sites (prepared by Şenol Balaban and Uluç in 2018 based on data taken from Disaster and Emergency Management Authority (AFAD))

Although many studies consider fire risk on a building scale (Watt and Kaplan, 2001; İbrahim et al., 2011), wooden Churches in Sweden (Arvidson, 2006; Arvidson, 2008), building scale methods can be incompatible with urban scale (Julià and Ferreira, 2021). Therefore, it is not easy to apply them to historic environments on a larger scale. As Pehlivan Eraybat (2017, p.160) reported, a fire risk assessment should also be conducted for site scales. Site-scale or urban scale evaluations will create opportunities for determining sub-regions with top priority in terms of fires. In addition, historical environments have been examined by considering the scale of the area, urban development, and building scale (Granda and Ferreira, 2019, p.111). Fire and its spread have been handled as an urbanization problem (Sarıkaya, 2003, p.36), so it is emphasized that fire risk reduction is a part of urban planning (Tomar et al., 2017). Fire risk mitigation policies and measures can be the subject of different scale planning studies (Tomar et al., 2017, p. 135-136). Just as the fire risk can be reduced by measures taken at urban and building scales (Sarıkaya, 2003), regional planning policies will also reduce fire risk.

Considering all these policies and challenges, studies assessing fire vulnerability on an urban scale are necessary. Although different methods are applied to assess fire risk and vulnerability, their application to heritage places is problematic. It is not easy to use existing methodologies of fire risk and vulnerability assessment of cultural heritage due to not considering heritage buildings' material, construction, and structural characteristics (Julià and Ferreira, 2021).

For this research, the fire vulnerability assessment is conducted for Safranbolu WHS, cultural heritage on an *urban scale* due to the current critical fire risk in the site. FVA is related to building scale, urban environment, and social environment characteristics. Although some studies focus on specific hazards for risk assessment index for heritage places, limited studies deal with identifying fire vulnerability indicators and simplified fire vulnerability assessment methods and fire risk mitigation policies for heritage places on an urban scale. Approaches that explain fire vulnerability assessment indicators, methods, and policies can help local institutions, central institutions of conserving heritage places, and site managers of UNESCO WHS.

## 1.2.Historical and Conceptual Background

### 1.2.1. The Evolution of the Concept of Risk in the Cultural Heritage Conservation: Conferences, International Documents, and Agreements[2]

Different attempts have been conducted on disaster risk management for the conservation of heritage places on the international agenda. Because of cultural heritage's increasing risks, international non-governmental and intergovernmental organizations such as ICOMOS, ICCROM, IUCN, and UNESCO have organized seminars, workshops, and conferences. These organizations published various

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[2] See Appendix A. Briefly, from past to present with focusing on important publications regarding concept of risk, the evolution, the context of how it changed.

manuals contributing to risk assessment, management, and mitigation to conserve cultural heritage sites.

In the 19th century, suggestions on handling war's impacts on heritage places were discussed. *The Hague Conventions of 1899* and *1907* are essential since they are the first international documents dealing with conserving cultural heritage during armed conflicts and determining the general rules of war (Çokişler, 2019). After World War II, the preservation of cultural heritage in armed conflict was emphasized. *The 1954 Hague Convention* for the Protection of Cultural Property in the Event of Armed Conflict also clarified the scope of cultural properties to be protected in case of war, and the risks caused by armed conflict on the cultural property were emphasized. It was stated that armed conflict destroyed cultural properties (UNESCO, 1954). Then, suggestions on coping with natural and artificial hazards that heritage is subject to are argued on different platforms in time.

In addition, *after the flood in Florence in 1966*, ICCROM managed the international aid for the conservation of cultural properties. This catastrophic consequence makes disaster management one of ICCROM's[3] core topics (Tandon, 2013, p. 5). It brought global attention to the challenges faced by cultural heritage due to disasters (Chmutina, Jigyasu, and Okubo, 2019, p. 2). Therefore, *disaster preparedness* has become one of the critical issues for preventive conservation.

In 1972, with *World Heritage Convention (WHC),* the different threats to heritage places were described as disasters, fires, earthquakes, ground slides, volcanic eruptions, changes in water level, floods, tidal waves, large projects, rapid urbanization, tourism development projects, changes in land and property use, armed conflicts (UNESCO, 1972). This document emphasized that natural and cultural heritage in the world was threatened by changing social and economic conditions and

[3] Since Indian Ocean Tsunami in 2004, ICCROM has continued to reduce risks to cultural heritage. Its studies are based on an innovative methodology for assessing risks, identifying priorities, and informing conservation decisions (Tandon, 2013).

decay (UNESCO, 1972)[4]. It can be evaluated as the first international document related to the risk and conservation of cultural heritage.

In 1975, *the integrated conservation concept*, supported by the initiations, started by the European Commission and ended with the Amsterdam Declaration. In this period, new settlement areas around historical patterns were evaluated as hazards; however, there was no emphasis on today's risks (Jokilehto, 2010, cited in Dinçer, 2012).

In *ICOMOS Charter on Historic Towns* (1987), also called the Washington Charter, the protection of historic towns against natural disasters and pollution and vibration problems for conserving the heritage and residents' security and well-being was emphasized. In addition, it was stated that preventive and repair measures that consider the unique character of properties in case of disasters must be applied (ICOMOS, 1987).

*In the Hyogo Framework for Action (2005-2015)* published by UNISDR (2005), the role of cultural heritage is emphasized in Priorities for Action[5]. This event was evaluated as a *landmark* (Jigyasu, 2013). In this document, the gaps and challenges, which are also valid in risk assessment for the conservation of cultural heritage, are identified as:

> (a) Governance: organizational, legal, and policy frameworks;
> (b) Risk identification, assessment, monitoring, and early warning;
> (c) Knowledge management and education;
> (d) Reducing underlying risk factors;
> (e) Preparedness for effective response and recovery.
>
> (Hyogo Framework for Action, 2005, p.2)

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[4] The reason why UNESCO prepared this convention is the transfer of Abu Simbel Temple because of the construction of a dam on Nil Valley and the water level rise in Venice. During this period, the attempts by ICOMOS and ICUN in terms of finding international funds for reducing and preventing risks were evaluated as essential steps in this subject (Dinçer, 2012).

[5] The role of cultural heritage is emhasized as below:

(a)…The information should incorporate relevant traditional and indigenous knowledge and culture heritage and be tailored to different target audiences, considering cultural and social factors.

(b) Implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction, including structural and non-structural measures, such as integrated flood management and appropriate management of fragile ecosystems.

*The 2030 Agenda for Sustainable Development* aims to achieve a better and more sustainable future. There are 17 goals announced. In Goal 11, *"make cities inclusive, safe, resilient and sustainable"* was emphasized. In Target 4 of Goal 11, heritage was highlighted as *"strengthen efforts to protect and safeguard the world's cultural and natural heritage"* (United Nations, 2015). Global attention to the role of heritage in risk management is a significant attempt.

*In Sendai Framework 2015-2030* that UNISDR published, there are five main priorities: understanding disaster risk, strengthening disaster risk governance and managing disaster risk, investing in disaster risk reduction for resilience, enhancing disaster preparedness for effective response, and "Build Back Better" in recovery, rehabilitation, and reconstruction. In addition, culture was accepted as a dimension of Disaster Risk Reduction (Sabbioni et al., 2016). It is vital to emphasize the role of culture and cultural heritage in DRR.

Briefly, after World War II, the focus was on protecting cultural heritage in armed conflict. In 1972, the different threats that heritage places face were identified at World Heritage Convention. Furthermore, in the 1980s, the concept of *risk preparedness* started to be discussed in the field of cultural heritage protection (Yıldırım Esen, 2014, p.40). Conservation policies for the cultural heritage sites remaining in seismic areas have been obtained in these years. Between Two Earthquakes, published by Bernard Feilden in 1987 with the ICCROM and the Getty Preservation Institute, provides information on preserving historic buildings, monuments, and archaeological sites in seismic regions (Feilden, 1987). Although various international conferences and conferences have been organized for cultural heritage sites remaining in the seismic areas in the 1990s, they have focused on *prevention* (Yıldırım Esen, 2014; Stovel, 1998). In the 2000s, *disaster risk management* was discussed to protect cultural heritage (Jigyasu, 2015; Jigyasu, 2016), emphasizing mitigation and reducing disaster effects instead of avoiding natural hazards (Tandon, 2013). While, in 1987, the focus was on earthquakes, in 1998, a comprehensive document regarding risk reduction in the conservation era was published. In 2010, a manual for managing disaster risks for World Heritage was published. Although those kinds of frameworks contribute to developing general policies, assessing the fire vulnerability of heritage places on an urban scale needs to be studied in detail.

**Factors affecting UNESCO WHS:** Cultural heritage sites, which constitute tangible and intangible values, are irreplaceable. UNESCO has designated properties as World Heritage Sites, including 869 cultural, 213 natural, and 39 mixed ones by 2019 (UNESCO World Heritage List, 2019). However, those sites are exposed to various threats. The hazards to cultural heritage include meteorological, hydrological, geological/geomorphological, biological, astrophysical, human-induced, and climate change (UNESCO, 2010) (Table 1).

Table 1 Hazard Typology (UNESCO, 2010, p. 59-60)

| **1. Meteorological** | **2. Hydrological** | **3. Geological/geomorphological** | **4. Biological** |
|---|---|---|---|
| a. storm<br>b. fire<br>c. drought<br>d. heatwave<br>e. high sea-surface temperature | a. flood<br>b. tsunami | a. volcanic<br>b. seismic<br>c. mass movement (land and sea)<br>d. erosion (river bank / coastline / reef) | a. epidemics (human, animal, or plant and human-animal transferable diseases)<br>b. pest infestations<br>c. algal blooms<br>d. rapidly spreading weeds or nuisance plants<br>e. coral bleaching event |
| **5. Astrophysical** | **6. Human-induced** | **7. Climate change** | |
| a. space weather<br>b. meteorite impact | a. fire (land clearance, arson, accident, drainage of peat soils)<br>b. pollution (health, e.g., food poisoning, disease)<br>c. Violence- and conflict-induced human and wildlife mortality and ecosystem destruction<br>d. Gas flaring<br>f. Mining-induced | a. sea-level rise<br>b. melting permafrost<br>c. rainfall pattern change<br>d. increased storm severity or frequency<br>e. desertification | |

According to research[6] conducted by ICOMOS in 2005, management deficiencies and development are the most dominant threats seen in Arab States, Europe, Asia/Pacific, Latin America, and Africa between 1994 and 2004. Namely, 95 % of sites in Africa, 88 % in Asia/Pacific; 77 % in Latin America; 77 % in the Arab States, and 41 % in Europe were exposed to management deficiencies. Development threat rates for those regions were as follows: 67 % in the Arab States, 49 % in Europe and North America, 47 % in Latin America, 40% in the Asia Pacific, and 42 % in Africa. After management issues and development, natural disasters were the significant threats. The affected sites were Latin America at 67 %, 26% in Europe & North America, and 21 % in Africa (ICOMOS, 2005).

After the revision of the Periodic Reporting Exercise (Section 2) in 2008, the World Heritage Committee adopted a standard list of factors/threats that affect the outstanding universal value of World Heritage properties. Fourteen factors/threats are affecting them. To address different factors that those sites face, UNESCO has identified the list of those factors. Fourteen major factors also have related subfactors (Appendix B). Those 14 major factors are classified as:

- Buildings and Development
- Transportation Infrastructure
- Utilities or Service Infrastructure
- Pollution
- Biological Resource Use/modification
- Physical Resource Extraction
- Local conditions affecting the physical fabric
- Social/Cultural uses of heritage
- Other human activities
- Climate change and severe weather events
- Sudden ecological or geological events
- Invasive/alien or hyper-abundant species
- Management and Institutional Factors
- Others

[6] This analysis dealt with 614 sites including 617 cultural and 24 mixed, which constituted 29 % of the total of all cultural and mixed sites. In this analysis the sites were classified by five regions as Arab States, Europe/North America, Asia/Pacific, Latin America and Africa. Sources of information were State of conservation reports from WH Bureau and WH Committee and rapporteur, ICOMOS evaluations, ICOMOS mission reports, Extraordinary Session reports of WH Bureau (ICOMOS, 2005).

Those are also used in the State of Conservation System of UNESCO, which provides a wide variety of data related to World Heritage properties. However, it should be stated that those factors do not include fires that happened in historic buildings and environments. While fires are assessed in human-induced hazards derived from land clearance, arson, accident, and drainage of peat soils in UNESCO (2010), fire incidents of World Heritage are just limited to wildfires in the State of Conservation System of UNESCO. The recent fire in Notre Dame Cathedral, a part of the Paris Banks of the Seine, and fires in the City of Safranbolu WHS show the destructive impacts of fires on WHS and the required policies, principles, and interventions.

UNESCO World Heritage properties are classified in the list of World Heritage in danger. The List of World Heritage in danger informs the international community about the conditions that threaten the unique character for which a property is designated as a World heritage and enhances the necessary action (UNESCO, 2018). This situation was decided with Article 11 (4)[7] of the Convention concerning the World Cultural and Natural Heritage Protection. Cultural heritages are included in the List of World Heritage in Danger by the Committee if the cultural property is exposed to at least one of the criteria as follows (UNESCO, 2018): ascertained danger in terms of specific problems related to materials, structure, coherence, authenticity, the significance of the heritage. Potential hazards include changes in heritage's legal status, negatively affecting conserving it, insufficient conservation policy, negative impacts of planning projects, armed conflict, climatic, geological, or other environmental factors. As stated in the List in Danger (2019) on the UNESCO website, 53 properties,

[7] The Committee shall establish, keep up to date and publish, whenever circumstances shall so require, under the title of "List of World Heritage in Danger", a list of the property appearing in the World Heritage List for the conservation of which major operations are necessary and for which assistance has been requested under this Convention. This list shall contain an estimate of the cost of such operations. The list may include only such property forming part of the cultural and natural heritage as is threatened by serious and specific dangers, such as the threat of disappearance caused by accelerated deterioration, large- scale public or private projects or rapid urban or tourist development projects; destruction caused by changes in the use or ownership of the land; major alterations due to unknown causes; abandonment for any reason whatsoever; the outbreak or the threat of an armed conflict; calamities and cataclysms; serious fires, earthquakes, landslides; volcanic eruptions; changes in water level, floods and tidal waves. The Committee may at any time, in case of urgent need, make a new entry in the List of World Heritage in Danger and publicize such entry immediately.

including 36 cultural and 17 natural properties, are on the List of World Heritage in Danger[8] (UNESCO, 2019).

### 1.2.2. Disaster Risk Management Process for Conservation of Cultural Heritage

The impacts of natural hazards on cultural heritage have been studied across many countries and scientists, with an emphasis on *floods* (Lanza, 2003; Wang, 2015; Holický and Sýkora, 2010; Nedvědová and Pergl, 2013; Vojinovic et al., 2016), *climate change* (UNESCO/WHC, 2007; Sabbioni et al., 2008; Forino et al., 2016; Chmutina et al., 2016; Howard, 2013; Carroll and Aarrevaara, 2018; Maus, 2014; UNESCO, 2007; UNESCO World Heritage Centre, 2007a; UNESCO World Heritage Centre, 2007b; UNESCO World Heritage Centre, 2008; Markham et al., 2016), *earthquake (seismic risk)* (Parsizadeh et al., 2015; Romão, Paupério, and Pereira, 2016), *fire* (Marrion, 2016; İbrahim et al., 2011; Watt, 2001).

In addition to the effects of disasters on the physical environment of heritage places, disasters may create risks to visitors' lives, WHS management staff, and local communities adjacent to WHS (Kaddory Al-Zubaidy, 2014). Ravankhah et al. (2017) emphasized the absence of integrated and systematic risk identification and analysis process, which assesses disasters in a multi-hazard context for World Heritage Sites. In addition, they claimed that World Cultural Heritage needs an integrated and systematic risk identification and analysis process assessing disasters in a multi-hazard context and the distinctive character of WCH, such as the OUV and authenticity and integrity of the sites as well (Ravankhah et al., 2017, p.273). They focused on earthquake-based threats and classified risks as direct risks, including loss of fabric

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[8] In some sense, being deciphered in terms of risks that WHS are subject to are not welcomed by states. For example, in May 2016, Australian government forced UNESCO to extract important Australian cultural heritage sites remarks in the final version of 'World Heritage and Tourism in a Changing Climate' report prepared by UNESCO. This showed that climate change related risks on cultural heritage seen as a politically sensitive topic (Forino et al, 2016, p.236).

and collections, value, and documents. In addition, fires and explosions, flooding and rising groundwater, and climate-related threats were identified as secondary risks following an earthquake.

Spennemann and Graham (2007) stated that disaster planning is still taken separately from site management. They also claim that the integration of cultural heritage into the disaster recovery phase of disaster management plans enables the realization of the historical and cultural environment significance (Spennemann and Graham, 2007, p.997-998). Therefore, integrating cultural heritage into disaster risk mitigation and management approaches has become an important issue. A study conducted by ICOMOS in 1997 showed that 14 countries, most industrialized countries, generally do not have an integrated approach to risk assessment and cultural heritage management plans (Taboroff, 2003). Integrating conservation principles into related phases of disaster planning and mitigation is assessed as one of the elements of effective conservation (Taboroff, 2000, p.75). Vileikis et al. (2012, p.147) claim that integrating risk methodology into a site management plan contributes to the preservation of integrity and authenticity of a property.

Disaster risk management processes for heritage places have been discussed in different documents (Feilden, 1987; Stovel, 1998; UNESCO et al., 2010). The current one is Managing Disaster Risks for World Heritage, published by UNESCO et al. in 2010. In this document, the importance of Disaster Risk Management (DRM), components of DRM, the process of identification and assessment of disaster risks, prevention and mitigation of risks, preparation and response to emergencies, recovery, and rehabilitation of property after a disaster, implementation, and reassessment of DRM were discussed. This manual provided a general framework for DRM in heritage places.

The main questions answered in the manual are as follows (UNESCO et al., 2010):

- What is Disaster Risk Management, and why is it important?
- What does a DRM plan consist of?
- How do you get started?
- How do you identify and assess disaster risks?
- How can you prevent disaster risks or mitigate their impact?
- How do you prepare for and respond to emergencies?
- How do you recover and rehabilitate your property after a disaster?

- How to implement, reassess and reappraise the DRM plan?

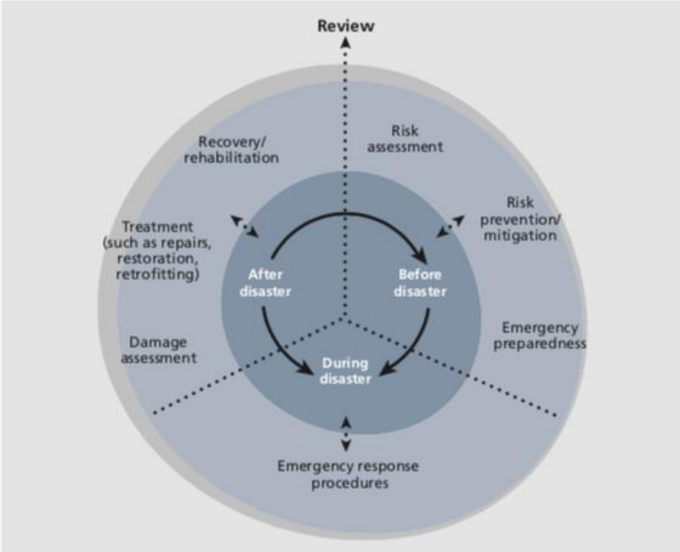


Figure 11 Disaster Risk Management Cycle (UNESCO et al., 2010, p.13)

The disaster risk management process is derived from the DRM cycle. Accordingly, there are three main stages defined for the disaster risk management process: before, during, and after disasters. As seen in Figure 11, *before the disaster* includes risk assessment, risk prevention/mitigation, and emergency preparedness. In addition, this step includes creating an emergency team, an evacuation plan and procedures, warning systems, drills, and temporary storage. *During disaster* consists of emergency response procedures. *After disaster* includes recovery/rehabilitation, treatment, and damage assessment (UNESCO et al., 2010), there are some questions identified for these stages in the manual (UNESCO et al., 2010, p.16):

- **Identification and assessment:** how do you identify and assess disaster risk?
- **Prevention and mitigation:** how do you prevent or mitigate disaster risk?
- **Emergency preparedness and response:** how do you prepare for and respond to emergencies?
- **Implementation and monitoring:** how do you make your plan work?

The coordination between site management systems for heritage places and organizational setup, policies, and procedures for disaster management is emphasized in the city or region where heritage is located (UNESCO et al., 2010, p.18) (Figure 12). When considering fire risk management of cultural heritage, it can be said that, as discussed before, FRM of CH should be regarded in different planning scales such as regional, urban, and building scales. The relation between those plans and management plans or conservation development plans should be enhanced.


Figure 12 Relationship between a DRM plan and other management plans (UNESCO et al., 2010, p.18)

The factors that cause disasters are essential to be analyzed. In Figure 13, the steps of analyzing factors can be seen. It starts with listing natural and human-induced hazards that heritage places face. Then, the factors that increase the site's vulnerability to the defined threats are identified.

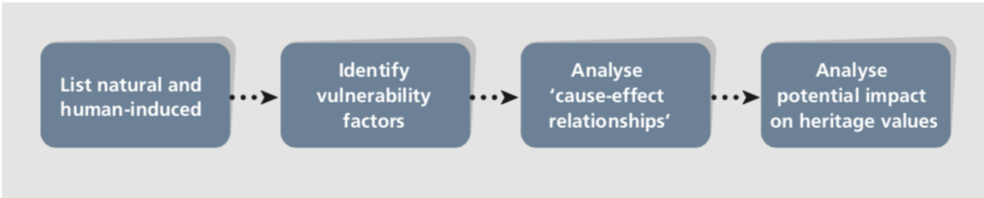


Figure 13 Risk Analysis Process (UNESCO et al., 2010, p.26)

After, the cause-effect relationship between primary hazards and risk factors is analyzed. In this way, the factors that increase the vulnerability of the sites and expose it to disaster are identified. Then, the potential impact on heritage values could be analyzed. This research identifies cultural heritage fire vulnerability factors within this perspective. These factors also show mitigation policies and interventions for cultural heritage to fire risk.

In addition, the vulnerability of the heritage places to primary hazards may be increased by secondary threats (UNESCO et al., 2010, p.26) (Figure 14). Fires are secondary hazards following earthquakes, landslides, and volcanic eruptions.

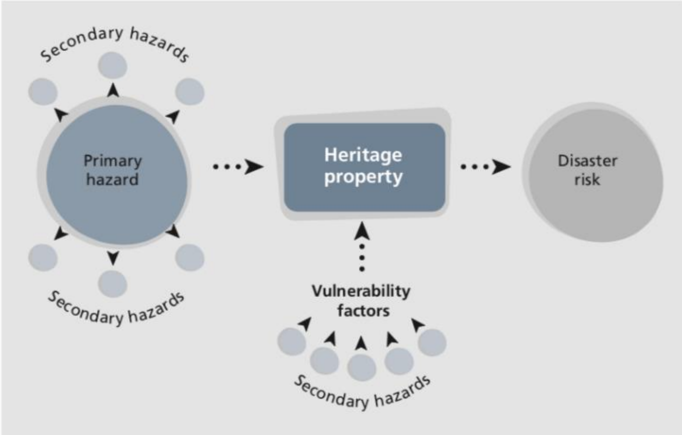


Figure 14 Relationship between hazard, vulnerability, and disasters (UNESCO et al., 2010, p.26)

Although it is a vital document presenting the general route of DRM for heritage places, the methods of assessing and mitigating different natural and human-induced risks should be evaluated in detail on different planning scales. In addition, it should be noted that it is for cultural and natural heritage places, and a general perspective was discussed. However, heritage places with distinctive characters need to be analyzed on a different scale, and the method of assessing vulnerabilities and risks derived from various factors should be figured out. In addition, each risk requires a specific disaster risk management process. Accordingly, this research evaluates cultural heritage fire risk management within this framework. This approach contributes to fire risk management of WHS and other urban cultural heritage.

Different methods exist for disaster risk assessment and management of cultural heritage in the literature. Some of those methods are proposed by heritage conservation organizations, such as The ABC method (ICRROM and CCI, 2016b) and Impact Assessment Method (ICOMOS, 2011). There are also national and international projects dealing with different threats and risks of the heritage sites[9].

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[9] They focused on specific hazards such as geological hazards, climate change, and earthquakes. On the other hand, two international projects related to fire risk assessment of heritage places were investigated: FireTech (Fire Risk Evaluation to European Cultural Heritage) and FireSkill Projects. They were also analyzed within the thesis regarding their methods and results. For detailed information on projects, see Table in the Appendix C.

Tandon (2013) identifies some challenges for cultural heritage disaster risk management. Those are classified as global challenges, including lack of awareness, global climate change, armed conflicts, an economic downturn, and institutional challenges as incorporating risk management in the day-to-day functioning of a cultural heritage resource and integrating cultural heritage with the general disaster risk management field, terminology, different methodologies for risk assessments, coordination and collaboration and legislation. In addition, it was emphasized that lack of documentation, expansion in heritage typologies, capacity for disaster risk management, recovery, protection of heritage from armed conflict, and working with local communities are necessities that should be considered (Tandon, 2013).

DRM process should be designed as part of conservation management practices. As discussed above, the manual prepared for managing risks for WHSs only provided a general framework for DRM in heritage places. Although it is an essential document about DRM of WHS, it is an insufficient document regarding the integration of the DRM process into the conservation and management process of cultural heritage and the possible methods that will be applied for different heritage places on different scales and characters. In this sense, the integration of DRM into the conservation and management process of cultural heritage is a significant issue to be handled.

In addition, in Turkey, the integration of the DRM process, as stated in the manual, has some obstacles since there are different responsible institutions related to DRM and the conservation of heritage places. Therefore, this study also aimed to discuss integrating DRM into the management plan process, including those different central and local institutions, focusing on fire hazard.

Fires are the most devastating hazard for Safranbolu WHS's authenticity and integrity. Karabük Provincial AFAD Directorate staff stated that two or three traditional buildings are lost yearly because of fire (Personal Interview, 2019). In addition to affecting heritage and its various values, fire also negatively affects people's lives. Therefore, one of this research aims to define the DRM process as a part of conservation management, define natural hazards that Safranbolu WHS is subject to, and discuss fire risk mitigation policies for the City of Safranbolu WHS.

## 1.3.Aim of the Study and Research Questions

Many disastrous fire events that cultural heritage faced and the existence of limited studies dealing with fire vulnerability assessment on an urban scale affected the aim and scope of this research. In this context, this study proposes a methodological framework that assesses the fire vulnerability of a historic environment with various tangible and intangible values.

Safranbolu World Heritage Site is one of the important cultural heritage sites reflecting the Ottoman Period lifestyles and urban characteristics in Turkey. The City of Safranbolu WHS, which was listed in UNESCO World Heritage List with respect to criteria (ii), (iv), (v) with Çarşı, Bağlar and Kıranköy areas in 1994, is today the center of Safranbolu. The relation between nature and the built-up environment could be observed and felt in different parts of the city. Traditional Anatolian houses, narrow and dead-end streets, and significant monuments constitute the traditional urban pattern of the city. Traditional buildings were mainly constructed with timber-frame construction systems and stone masonry.

In addition, some of the buildings in Safranbolu, especially in the North and South of the Çarşı Region, are in poor condition. The traditional street pattern has narrow and dead-end streets, which increases these buildings' vulnerability to fire hazard. The existence of traditional houses with timber-frame construction systems and lack of maintenance are the factors that increase the site's vulnerability to fires. For example, since the material of wood was used in Safranbolu houses and they were adjacent to each other, the fires in Safranbolu sprawled to large areas in the past (Turhan Sarıköse, 2020). The population density is high in the center of the city, where the houses are adjacent. The fires in the historic part have primarily occurred in the outer peripheries of the city center, where the density of houses and population is relatively low (Anonymous, 2018). However, during the site survey conducted in 2020, there were burnt traditional buildings across all parts of the Çeşme Neighborhood.

There are various urban uses for traditional buildings not being constructed according to their needs. Adapting these new uses brings an additional fire risk to historic buildings (Özgünler, 2018, p.15). For example, according to Safranbolu Fire Brigade

Archive, between 2015 and 2020, 9 building fires occurred in the Çeşme Neighborhood, where the commercial city center is located, and many accommodation facilities exist.

In addition, the City of SWHS is located in the 1st-degree Earthquake zone. This situation makes fires a secondary threat following earthquakes. Furthermore, no disaster risk management plan deals with the site's natural and human-induced hazards of the City of SWHS. Hence a possible fire may cause irreversible damage to these structures or cause them to disappear.

Briefly, why the City of Safranbolu WHS was chosen as a case for FVA is as follows:

- It is a critical cultural heritage site on an urban scale with various values.
- Every year 2 or 3 traditional houses are lost due to fires (Personal Interview, 2019). In addition, between 2013 and 2017, 17 fires happened in Historic Safranbolu (FireSkills Project Report).
- It is located in the 1st-degree earthquake zone and close to the fault line. This situation makes fires a secondary hazard following earthquakes.
- It is a WHS that many foreign and local tourists visit, and accordingly, it contributes to the economy of the city and province.
- It is a continuous settlement area, and the existence of inhabitants still living there may increase the fire risk.

In this regard, this study aims to assess the fire vulnerability of the City of SWHS. Accordingly, based upon literature reviews and site surveys, this study will focus on:

- Identifying the indicators of FVA for CH on an urban scale
- Developing a simplified qualitative FVA method for CH on an urban scale
- Presenting and discussing FRM policies for CH
- Applying this simplified method and policies to the City of SWHS

Major research questions are described for this research to fulfill these aims. Data needed and how to gather and analyze data are shown in Table 2. Major research questions and sub-questions (SR) below that are answered within this study are:

**R1.** What are the Fire Vulnerability Assessment (FVA) indicators for heritage places on an urban scale?

**R2.** How could a simplified method assess the fire vulnerability of a heritage place on an urban scale?

**SR2.1.** How could the fire vulnerability of Safranbolu WHS be assessed?

**SR2.2.** To what degree is the City of Safranbolu WHS exposed to fire threat? What past fire incidents show for existing fire threat?

**R3.** What kind of policies could be developed to mitigate the fire risk of cultural heritage?

**SR3.1.** What are the current international and national policies regarding Fire Risk Assessment?

**SR3.2.** What is the current legal and administrative framework regarding Risk Assessment, Management, and Mitigation for the Conservation of Cultural Heritage in Turkey? What are the system's deficits and needs?

**SR3.3.** What are the current policies regarding cultural heritage fire risk mitigation in England?

**SR3.4.** What are the current policies regarding cultural heritage fire risk mitigation in Turkey?

**SR3.5.** What kind of policies could be developed to mitigate the fire risk of Safranbolu UNESCO World Heritage Site by considering its integrity, authenticity, and various values?

**R4.** What natural threats is the City of Safranbolu WHS subject to that increase its vulnerability to fire risk?

Research questions are answered by identifying indicators and methods for fire vulnerability assessment and policies of fire risk mitigation of heritage places on different scales by considering various actors[10]. The proposed method is evaluated in the City of SWHS in Turkey, which is exposed to a disastrous fire risk. Through this, fire vulnerability assessment for the City of SWHS is conducted using GIS, enabling integration, management, and visualization of different spatial data. It also helps to store and revise spatial data when needed.

Furthermore, the new policy-making process regarding fire vulnerability assessment and risk management can be integrated into the Turkish decision-making mechanism for conserving cultural heritage. Moreover, the method and policies developed can be used for other UNESCO World Heritage Sites and urban cultural heritage sites. In this regard, World Heritage site managers, local institutions responsible for conserving cultural heritage, and disaster risk management, World Heritage Center can benefit from those policies and simplified fire vulnerability assessment method.

[10] See Table 42 Contributions of the research regarding parameters, method of FVA of CH, and policy of FRR for CH. This table also shows the brief summary of this research.

Table 2 Research Questions of the Study (prepared by the author)

| Research Question | Data Needed | How to gather data | How to analyze data |
|---|---|---|---|
| **R1. What are the vulnerability indicators of heritage places to fire incidents on an urban scale?** | **Vulnerability Indicators for FVA of CH** | **Literature Review** | Interpretation |
| **R2. How could the fire vulnerability of Safranbolu WHS be assessed?** | **Physical Vulnerability for FVA**<br>Construction technique<br>Structural Condition<br>Use<br>Accessibility to Buildings<br>Existence of Fire Hydrant<br>Level of Preparedness | -Site Surveys<br>-Interviews with staff at Provincial AFAD Directorate and Fire Brigade Directorate<br>-Conservation Plan Analysis (2010)<br>-Fire Brigade Directorate Archive<br>-Results of the FireSkill Project<br>-Archival Research<br>-Literature Review | -Interpretation and Spatial Analysis on GIS via Qualitative FVA Method in GIS (based on indexing and algorithmic methods) |
| **R3. What kind of policies could be developed to mitigate the fire risk of cultural heritage?** | **Current policies** | Literature Review<br>Case Study | Interpretation |
| **R4. What kind of natural threats is Safranbolu subject to?** | **Past Events**<br>Earthquake<br>Flood<br>Landslide<br>Rock Fall | **Literature Review**<br>**Visited Central Institutions**<br>AFAD Presidency<br>DSİ<br>The Ministry of Culture and Tourism<br>**Visited Local Institutions**<br>Safranbolu Municipality<br>Fire Brigade Directorate<br>Regional Conservation Council<br>Provincial AFAD Directorate | Past Events Map in GIS<br>Past Earthquakes<br>Landslide Susceptibility |

### 1.4.Significance of the Study and Contribution to Science

The number of and context of studies dealing with fire vulnerability assessment for conservation of cultural heritage are limited. The studies carried out globally and in Turkey on cultural heritage disaster risk management are still developing[11]. Parallel to this, national and international policies for cultural heritage fire risk management are also limited, as was discussed in Chapter 2-Evaluation of Fire Risk Management Policies for Conservation of Cultural Heritage.

This research has three significant contributions (Figure 15). Firstly, it identifies fire vulnerability indicators for heritage places on an urban scale. Secondly, this study presents a simplified fire vulnerability assessment method that can be applied to an urban heritage place. This method provides a preliminary assessment of cultural heritage on an urban scale that requires further analysis. Thirdly, this study also provides policy implications to mitigate the fire risk of cultural heritage.

Furthermore, this study tests and discusses the proposed method for the City of SWHS. It presents policies of fire risk mitigation for the City of Safranbolu WHS by considering different responsible actors. These inputs of the research also contribute to the WHS management process.

In this sense, the research would contribute:

- To define fire vulnerability assessment parameters/indicators for cultural heritage on an urban scale,
- To conduct a preliminary fire vulnerability assessment for CH on an urban scale by a simplified method,
- To develop policy implications for fire risk mitigation that can be followed both on national and international levels,
- To WHS management process concerning how to assess fire vulnerability and how to mitigate fire risk of cultural heritage,

[11] See Appendix C. International Projects dealing with Disaster Risk Management of Cultural Heritage

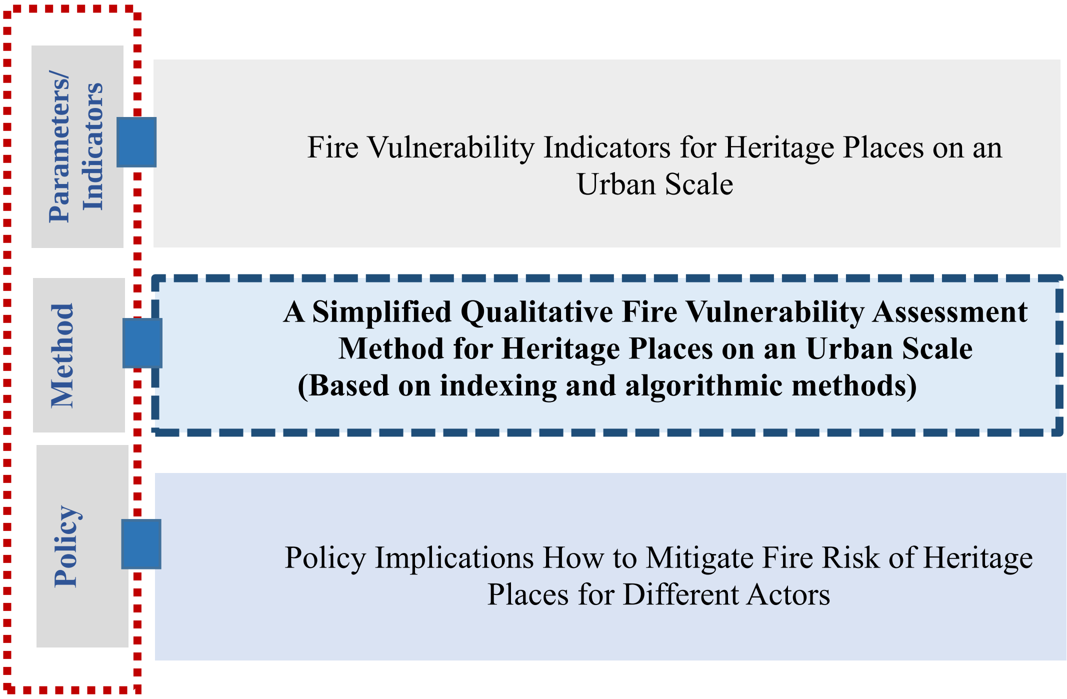


Figure 15 Contributions of the research regarding parameters, method, and policy of FVA for CH (prepared by the author)

Briefly, the research contributes parameters, methods, and policies of fire vulnerability assessment of cultural heritage on an urban scale. Firstly, physical and social indicators of fire vulnerability assessment are identified. Secondly, a simplified method of fire vulnerability assessment is proposed. Lastly, policy implications on reducing the fire risk of cultural heritage are figured out for different actors enrolled in fire risk management.

## 1.5.Methodology

The research methodology means the overall strategy to fulfill the aims and objectives of the research (Sutrisna, 2009). In this regard, different research tools are used in this Ph.D. thesis. Since this study focused on a simplified fire vulnerability assessment method, the research method and tools were selected accordingly.

This study is based on a fire vulnerability assessment of cultural heritage on an urban scale. There are different steps for conducting a fire vulnerability assessment. Various data are needed during this process, as shown in Table 1. Research Questions.

In risk analysis, probabilistic calculation of threat, vulnerability, and resilience. Probabilistic estimates require sufficient and reliable data and good analytical processes (Romão, Paupério, and Pereira, 2016, p.697). On the other hand, when considering characteristics of cultural heritage, these can be difficult. Qualitative methods can be an alternative to those challenges. Accordingly, this study adopted the qualitative research approach as a method. The main reason for choosing this approach is that the research focuses on understanding the fire vulnerability of cultural heritage by a simplified method with selected indicators emphasized in the literature.

In this context, data are gathered through the literature review, archival search for the historical background of recorded disasters, and spatial data from Safranbolu Municipality, The Ministry of Culture and Tourism, and AFAD. Those data are gathered from State of Conservation Reports, literature reviews, and related central institutions inventories, including AFAD, The Ministry of Culture and Tourism, DSİ, and local institutions such as Safranbolu Municipality, Regional Conservation Council, Karabük Provincial AFAD Directorate, Fire Brigade Directorate.

In addition, Turkey's legal and administrative framework for conserving cultural heritage sites within the scope of disaster risk management and fire risk management is analyzed. The dissertation examines national and international charters, laws in use, manuals, declarations, recommendations, and guidelines published by non-governmental and intergovernmental organizations.

It should be noted that the scale of the study and the aim to conduct it define the research's general process. This research aims to present how to assess the fire vulnerability of cultural heritage on an urban scale. In this research, the fire vulnerability assessment of the City of Safranbolu WHS, an urban site, is assessed by comparing neighborhoods of the Çarşı Region. Following this, detailed investigations are conducted at the most vulnerable part because of time and cost limitations. As stated by Paupério, Romão, and Costa (2012), assessing the vulnerability of heritage buildings necessitates human resources, time, and budget. Therefore, this study is limited to Çeşme Neighborhood in the Çarşı Region of Safranbolu WHS. The selection approach was explained in detail in 1.5.1. Selection Process of the Case and the Neighborhood in the Case.

As an approach to qualitative research, the City of SWHS in Turkey was determined as a case study research technique[12]. The City of Safranbolu UNESCO WHS is exposed to different risks. In Chapter 4.3.Understanding Threats to the City of Safranbolu WHS, different hazards that the City of SWHS faces are explained. However, the main focus of the research depends on the fire vulnerability of the City of SWHS. Detail analyses are conducted to assess the fire vulnerability of the site.

### 1.5.1. Selection Process of the Case and the Neighborhood in the Case

As part of national and community pride and social cohesion, UNESCO World Heritage properties are significant for districts and states. States Parties must preserve those properties for future generations within the World Heritage Convention. Site managers have to conserve those properties with their outstanding universal value (UNESCO, 2010, p.8). Their national and international significance brings extra attention to risk management studies.

Accordingly, in the first part, of the ‘Research Project: Spatialization of Different Natural and Man-made threats 17 UNESCO World Heritage Sites in Turkey face’, different natural and human-induced threats that those sites are exposed to have been identified. Differentferent hazard maps have been developed using the Geographical Information System (GIS). This project provided important data and results for this dissertation.

[12] Zainal (2007) explains case study as exploration and understanding of complex issues and examining data in specific context.

The case study selection was based on this Scientific Project's preliminary results. There were 17[13] World Heritage Sites in Turkey. 15 out of 17 are cultural, and 2 out of 17 are mixed. 8 out of 15 are archaeological sites, 5 out of 15 are urban sites, and 2 out of 15 are monuments. Mixed ones are excluded since they include an exceptional natural environment. Since this thesis is conducted in the City and Regional Planning Department, urban heritage places are selected to be analyzed. The selection process of the case area can be seen in Table 3.

Correspondingly, in the second part, five urban sites of UNESCO World Heritage in Turkey were analyzed. In this sense, some parameters were defined to decide the case study for the thesis. Those parameters include the significance of the study, characteristics of the sites, and current threats to heritage places. Diyarbakır was excluded since it was in another process. Since 2015, there have been conflicts in the historic part of the city. İstanbul Historic Areas WHS was excluded since there are different thesis and scientific studies about risk management for the conservation of cultural heritage. Bursa and Cumalıkızık: The Birth of Ottoman Empire WHS was excluded because there are different heritage places in UNESCO World Heritage boundaries, such as monuments and rural heritage in the designated WHS. Pergamon and its Multi-layered Cultural Landscape was not evaluated for the thesis since there have been scientific studies about this site related to risk assessment.

Then, analysis regarding this case study is conducted on GIS, enabling different spatial analyses. In this sense, a database including various hazards of this cultural heritage site is prepared first to investigate Safranbolu's general hazard situation. Namely, hazard maps of the area such as past incidents, past earthquakes, and landslide susceptibility maps are provided.

[13] 17 World Heritage Sites in Turkey have been analyzed in the first part of this research because while starting this thesis and project and making analysis, there were 17 UNESCO World Heritage Sites designated in Turkey. However, two UNESCO WHS in Turkey: Göbeklitepe in Şanlıurfa (2018) and Arslantepe Mound in Malatya (2021) are not included in this project.

Table 3 Selection of the case in City Scale (prepared by the author)

**Step 1:** Analyzing 17 WHSs and classifying them into categories

**Cultural: 15**

- Archaeological Sites: 8
- Urban Sites: 5
- Monuments: 2

**Mixed: 2**

**Research Project**: Spatialization of Different Natural and Man-made threats that UNESCO World Heritage Sites in Turkey face'

**Step 2:** Selecting and analyzing urban sites

- City of Safranbolu
- Pergamon and its Multilayered Cultural Landscape
- Diyarbakır Fortress and Hevsel Gardens
- Bursa and Cumalıkızık: The Birth of Ottoman Empire

**Step 3:** Determining the site and making detailed analysis

- The City of Safranbolu WHS

**Step 4:** Analyzing current threats that WHS are subject to

- The City of Safranbolu WHS
  - Kıranköy
  - Çukur/Çarşı Region
  - Bağlar

**Step 5:** Making analyses in a smaller scale for selected parts of Safranbolu WHS

- Çarşı Region

The City of Safranbolu WHS was selected to be studied in this thesis. As it was searched, there are no scientific studies such as thesis and articles about disaster risk management for the conservation of this site. In addition, being a continuous settlement area increases this study's significance because the existence of inhabitants still living there may increase the fire risk.

There are three cultural heritage places in the City of Safranbolu World Heritage Site: Kıranköy, Çukur (Çarşı), and Bağlar (Figure 16). Their main characteristics are explained below.

**Çarşı (Çukur) Region:** Çarşı has a distinctive character with authentic traditional buildings. The streets are narrow and organic, following the topographic characteristic of the city. This region took its Çukur name due to its location on the lower part of the Safranbolu. The marketplace was placed at the center of the Çarşı Region, where craftsmen's traditional houses and workshops, including saddlers, shoemakers, leatherworkers, and blacksmiths, settled around.

This region includes most part of İzzetpaşa, Çeşme, Hüseyin Çelebi, Hacı Halil, and Karaali Neighborhood and a part of Babasultan, Musalla, Akçasu, Camiikebir Neighborhoods. This region is the most preserved because of its topographic situation (SKAİPAR, 2010). The buildings have timber-frame construction systems and show traditional Ottoman cultural life and architectural characteristics. Today many accommodation facilities and touristic services have been located in this part of the historic city.

**Kıranköy:** Kıranköy is located between Bağlar and Çarşı Region. This region is now a new center due to urban growth in Çarşı Region. This region includes İnönü and Barış Neighborhoods. Since it was located in the new city center and its population changed with population exchange, this area is evaluated as the most deteriorated site (SKAİPAR, 2010).

Kıranköy was a non-Muslim district at first, and its socio-architectural pattern was assessed as similar to contemporary European towns. The houses in this region were constructed with stone masonry systems instead of the homes with timber-frame construction systems in Çukur (Canbulat, 2012). In this research, Bağlar was not taken into consideration due to its lower fire[14] risk when compared to Çarşı Region.

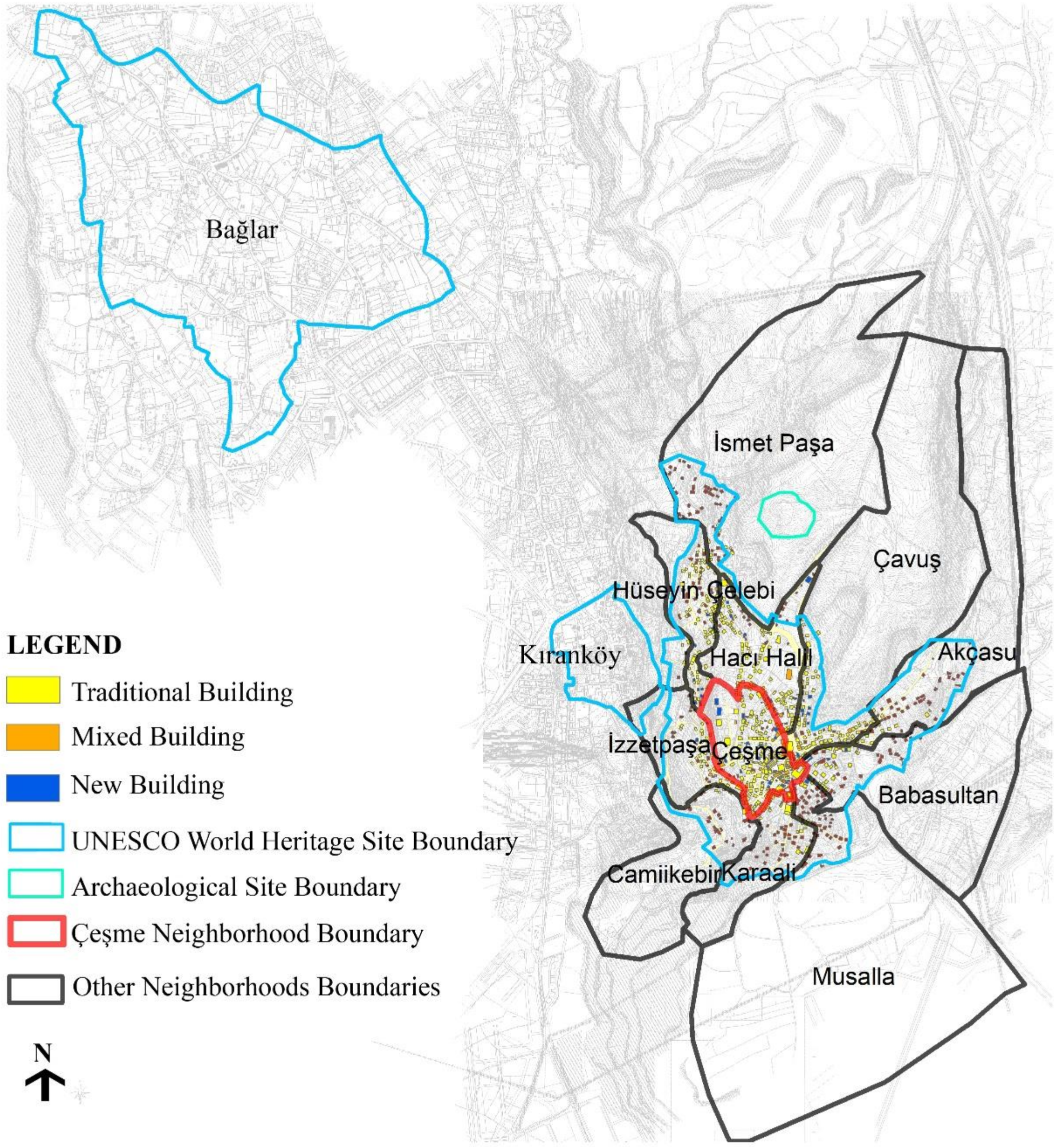


Figure 16 Safranbolu WHS, Neighborhoods in the Çarşı Region and the Çeşme Neighborhood (prepared by the author)

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[14] At this point, it should be emphasized that the level of risk is not quatified but since Çarşı Region has trditional buildings with mostly timber frame construcrion systems. The density of traditional buildings with timber frame construction systems make Çarşı Region more risky to fires.

**Bağlar:** Bağlar Region includes Bağlarbaşı and Cemal Caymaz Neighborhoods. It is located about 2.5 km away from Çarşı Region. The settlement pattern of the Bağlar region includes one house with extensive gardens (Canbulat, 2012). People choose to live there in summer in the past. The area between the new development area and the central settlement area lost its settlement characteristics partially because of residential pressure from the close Neighborhood (Plan Report, 2010). In this research, Bağlar was not considered due to its rural features[15].

### Selection of the Neighborhood to Study in the City of Safranbolu WHS

Due to the different characteristics of Çarşı, Bağlar, and Kıranköy and the time limitation of the research, Çarşı Region is selected to be studied in detail. Çarşı Region constitutes the historic center of Safranbolu. Accordingly, various land uses, from commercial to accommodation, and residential, are located in this area. Its mixed-use character was one of the selection criteria.

After selecting Çarşı Region to study for fire vulnerability assessment, a comparison was made between neighborhoods to determine where fire vulnerability assessment is conducted. The main selection parameter for the case area was based on including different uses such as commercial, residential, public, and socio-cultural facilities. There are 11 neighborhoods in Çarşı Region.

Çeşme, Hacı Halil, and Çavuş Neighborhoods constitute a significant part of the commercial city center with various urban uses. Mixed-use characteristics are mainly concentrated in the Çeşme Neighborhood, which is at the center of the Çarşı Region. Therefore, Çeşme Neighborhood can be evaluated more centrally than other neighborhoods due to constituting the major part of the historical city center. Accordingly, Çeşme Neighborhood was selected, and detailed analyses regarding fire

[15] It is assumed that having mixed land use character affects fire risk in the settlement areas and Çarşı Region has various land uses from residential to commercial, accommodation and public uses.

vulnerability assessment were conducted on Çeşme Neighborhood. The selection process can be seen in Figure 17.

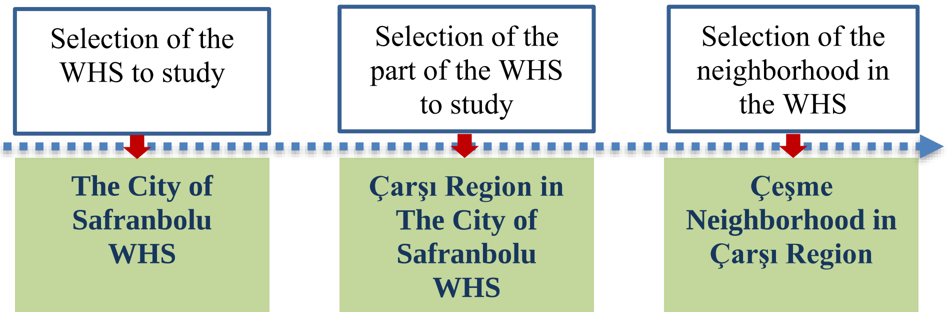



Figure 17 Site selection process (prepared by the author)

When past fire inventory between 2015 and 2020 was analyzed, Çeşme Neighborhood had residential and working area fires. In addition, when the fire archive between 2015 and 2020 was analyzed, the most considerable number of fire incidents in buildings happened in the Çeşme Neighborhood.

Table 4 Çeşme Neighborhood and General Characteristics (prepared by the author concerning different data and observations during site surveys)

| Çeşme Neighborhood | |
|---|---|
| **Land-use** | Mixed-use<br>It serves as a center of Historic Safranbolu. It also has residential uses. |
| **Population [URL 9]** | 183 |
| **Condition of Cultural Properties** | While near Cinci Han, cultural properties stay in good condition; in the South of the Neighborhood, some buildings remain in poor condition, and some are vacant. |
| **Slope** | South/West/South-west: %15-30 |
| **Accessibility** | There are streets whose width is less than four m. (Karaüzüm, Müftü Street) |
| **Total Fire (2015-2020)** | 10 |

Çeşme Neighborhood has a mixed-use character and is the major central part of Historic Safranbolu (Table 4). Many accommodation facilities, gift shops, mosques, and residential uses exist[16]. Its population is 183 [URL 9]. Also, thirty-seven people are 65+ and 16 people below 18 years old in Çeşme Neighborhood (Çeşme

[16] For current landuse of the Çeşme Neighborhood see Figure 64 Functions of Buildings.

Neighborhood Mukhtar, Personal Interview, 2020). When the structural condition of traditional buildings is assessed, while close to surrounding Cinci Han, traditional buildings and monumental buildings stay in good condition due to being restored; in the South of the Neighborhood, some buildings are in poor condition, and some are vacant.

### 1.5.2. Data Gathering Process

Various data were needed to assess different risks that cultural heritage faces. Each risk may require specific data for additional analyses to evaluate the level of risk. In this study, for each chapter, different resources are used (Table 8). According to UNESCO (2010, p.23-24), for the identification of risks, the information is needed to be identified as below:

- Particular tangible and intangible attributes for outstanding universal value and criteria for inscription
- Hazards affecting property
- Location of property, its boundaries, its buffer zone, immediate surrounding, access, topography
- Geological, hydrological and meteorological information on the nature of the climate, soil, fault lines (if any), water table, and surface water such as a river.
- Hazard vulnerability map
- History of different disasters affecting the property
- Inventories and the current status of existing management systems and disaster preparedness equipment and facilities in the property
- Hazard-specific equipment
- Existing relevant institutions and the community within and around the property
- The physical planning (land use, transport, infrastructure) of the property's area.
- The conditions of the roads for potential evacuation.
- Local and traditional knowledge systems relevant to disaster risk reduction.
- Directory of agencies that will take action.

Data gathering of this study consists of two parts related to each other. The data stated by UNESCO were gathered from different related institutions in Karabük, site surveys, literature reviews, and interviews with various stakeholders.

Furthermore, the scale of risk assessment and management is an important issue. The study's scale affects data collection and risk level evaluation (Yıldırım Esen, 2014) (Figure 18). Each scale necessitates different information-gathering processes. Within the context of this study, urban heritage places were chosen to be studied. A site was analyzed for fire vulnerability assessment. Site-specific data were collected through site surveys, literature and archival surveys, visiting institutions, and interviews with various stakeholders (Table 6).

| Scale / Process | National (assessment of territories, e.g. province,municipality) | Territorial/Provincial (assessment of aggregates of sites located in the same territory) | Site-level (assessment of a single heritage site) |
|---|---|---|---|
| **Data Collection for Risk Identification** | -secondary sources: literature, documents, etc.<br>-number of sites in a territory (e.g. municipality, province) | -secondary sources: literature, documents, hazard maps, master plans etc.<br>- cultural heritage inventory & maps, geographical location and coordinates of sites | - primary sources: technical studies, site observations, interviews, etc.<br>- secondary sources: literature, maps, reports, researches, etc. |

Figure 18 Primary and secondary sources that can be utilized for risk identification at national, territorial, and site-level risk assessment (Yıldırım Esen, 2014, p.152)

In the first part of the study, different analyses were carried out on the Safranbolu scale. Accordingly, as different hazards that the City of SWHS were identified, data related to earthquakes, landslides, and past events were gathered through a Scientific Project[17]. Different institutions[18] were visited for the thesis and Scientific Project, and these data were used for the first part of the thesis to assess Safranbolu's hazards. Furthermore, *interviews*[19] with experts from National Agencies such as the Disaster and Emergency Management Authority (AFAD) and the General Directorate of State Hydraulic Works (DSİ) were carried out to understand their awareness and ideas about possible actions to mitigate different risks of CH. Also, online surveys were sent to

[17][17]Accordingly, the data gathering process of the thesis continued simultaneously with Scientific Project: 'Spatialization of Different Natural and Man-made threats that UNESCO World Heritage Sites in Turkey face.' This process started by visiting various institutions. Accordingly, epicenters, magnitudes, and depths of past earthquakes between 1900 and 2018 were taken. Landslide susceptibility maps for those cities and past events that occurred (landslide, rockfall, avalanche, and flood) between 1950 and 2008 were taken from the Disaster and Emergency Management Authority (AFAD). In addition, from the General Directorate of Mineral Research and Exploration (MTA), the soil typology of areas where UNESCO World Heritage Sites are located was bought within this project. Those data were used to assess the state of the City of Safranbolu WHS through different hazards.

[18] Within Scientific Project related with hazards that 17 UNESCO WHS in Turkey face, different actors enrolled in disaster risk management and conservation of cultural heritage were visited. See Appendix D. In this context, AFAD (Disaster and Emergency Management Authority), The Ministry of Culture and Tourism, the General Directorate of State Hydraulic Works (DSİ) and the Mineral Research and Exploration General Directorate (MTA) were visited.

[19] These interviews were conducted within Scientific Project: 'Spatialization of Different Natural and Man-made threats that UNESCO World Heritage Sites in Turkey face''I have been involved.

experts working in Disaster and Emergency Management Authorities in cities where 17 UNESCO WHS are located. This online survey aimed to understand different natural, human-induced, and institutional risks defined by local institutions and assess those experts' awareness. Accordingly, a survey was sent to Karabük Provincial AFAD Directorate.

In the second part, analyses regarding the fire vulnerability assessment of Safranbolu are conducted. The data gathering process is shaped by considering fire risk assessment of cultural heritage on an urban scale. Namely, data needed are obtained through site surveys, literature, and archival surveys to carry out those analyses. 1/1000 base map was derived from Safranbolu Conservation and Development Plan. The plan was adapted to GIS, and layers were organized for analysis.

**Site Visits to the City of SWHS**

Four site surveys have been conducted, and different kinds of data are gathered during site visits to Karabük and Safranbolu, as seen in Table 5. Accordingly, Karabük Provincial AFAD Directorate, Safranbolu Municipality, Safranbolu Fire Brigade Directorate, and Karabük Regional Conservation Council were visited, interviews were conducted, and different data were gathered for the research. Safranbolu World Heritage Site has two main disaster risks: rock falls and fires, which should be considered first.

After interviewing local actors and site surveys, fire risk is decided to be evaluated for Safranbolu due to the severity of the fire hazard. Accordingly, the research focused on fire vulnerability assessment of the City of Safranbolu World Heritage Site.

Table 5 Visited Institutions, Interviews, and Data gathered (prepared by the author)

| Date | Institution Visited | Data Obtained |
|---|---|---|
| **6 August 2019** | Provincial AFAD Directorate | Interviews with AFAD staff<br>FireSkills Project report<br>Precautions taken for Rock Falls<br>Site visit |
| | Mayor of Safranbolu Municipality | A conversation about Safranbolu's general condition, problems, and potential |
| **25-27 September 2019** | International Science and Engineering Applications, Symposium on Hazards (ISESH2019) | *''Investigating the City of Safranbolu World Heritage Site with its Natural Threats''* Karabük, Proceeding Book (Editor: Dr. İnan Keskin) (p. 429-434)<br>Meeting with related new experts |
| **18 October 2019** | Safranbolu Fire Brigade Directorate | Past Fire Incidents |
| | Safranbolu Municipality | Past Conservation Plans<br>Current Conservation Plan and its report |
| | Karabük Regional Conservation Council | The analysis made in Conservation Plan in 2010 |
| **12-17 October 2020** | Site Survey | The data of FVA was gathered.<br>Systematic photographing was carried out.<br>Conversations with residents, mukhtar, and craftsmen were conducted. |
| | Safranbolu Fire Brigade Directorate | Fire Inventory between 2015 and (September) 2020<br>The location of fire hydrants<br>Electricity infrastructure<br>Gas Infrastructure |

In addition to the site survey, the International Science and Engineering Applications, Symposium on Hazards was conducted in Karabük in 2019. At this conference, *'Investigating the City of Safranbolu World Heritage Site with its Natural Threats'* research was presented. The fire threat of Safranbolu was also discussed at this conference.

Parameters of fire vulnerability assessment are classified into three categories building characteristics, urban and social environment[20] (Table 6). Data related to building characteristics and urban environment were gathered. Accordingly, data on *flammable*

[20] The role of social factors on fire risk mitigation of cultural heritage is crucial. However, due time limitation, data related to social environment could not be gathered. As ssen in Appendix G. Development Process of the Thesis and Feedback was given by the Thesis Committee, thesis scope was shaped through meetings. As the research is not started with fire vulnerability assessment, time was a limitation to gather all data needed.

*materials* are gathered through construction techniques and any combustible materials within the building or next plot. *Structural condition* data is gathered through site surveys. *Maintenance works* in which heat or flammable materials are used are also gathered through site surveys. *Vacant (being in use or not*) is another data gathered during site surveys.

Data related to the urban environment, including *building functions* and infrastructure use, are also obtained through site surveys. In the building function parameter, the existence of ignition sources and hazardous use are assessed. *Infrastructure* data comprises accessibility to the building, the existence of fire hydrants, distance to a fire station, and the existence of water supply nearby environment.

Table 6 Parameters used in the thesis and how data related to those parameters gathered (prepared by the author)

| Parameter | Sub-parameter | Name of the Indicator | Use of Ind. | Data derived from |
|---|---|---|---|---|
| **Building Characteristics** | **Exterior** | **flammable materials (construction technique/** building materials) | Yes | Site Survey<br>Conservation Plan |
| | | **conservation status/structural condition** | Yes | Site Survey |
| | | **vacant** | Yes | Site Survey |
| | | **Maintenance works that heat/flammable materials are used.** | Yes | Site survey |
| **Urban Environment** | **Use** | **Building function (hazardous use/ignition source)** | Yes | Site Survey |
| | | **adjacent building/ adjacent plot** | Yes | Site Survey |
| | **Infrastructure** | **accessibility to building** | Yes | Site Survey |
| | | **fire hydrant** | Yes | Site Survey<br>Fire Brigade |
| | | **fire station** | Yes | Site Survey |
| | | **natural water supply** | Yes | Site Survey |
| | | **fountain** | Yes | Site survey |

The main hazards and risks Safranbolu WHS faces are figured out concerning spatial data taken from public institutions. Related data that can be possibly used in risk analyses were obtained, and interviews were done with experts working in Provincial AFAD Directorate, Fire Brigade Directorate, Regional Conservation Council, and Safranbolu Municipality. Based on interviews made with different experts working in Provincial AFAD Directorate, the primary threat for Safranbolu was defined as fire. According to those interviews (2019), it was stated that every year two or three traditional houses were lost due to fires. The other factors, such as earthquakes, landslides, and floods, were not evaluated as a significant threat to the City of Safranbolu WHS.

Problems defined by Provincial AFAD Directorate Staffs in Karabük:

- The most dangerous threats for Safranbolu are fires, rockfalls, and excessive tourist visits (Interview, AFAD, 06.08.2019).
- Interventions have been taken partially for rockfall (Interview, AFAD, 06.08.2019)
- There is no extinguishing system for fires. (Interview, AFAD, 06.08.2019)
- Every year one or two traditional buildings are lost because of fires. (Interview, AFAD, 06.08.2019)
- Risks for Safranbolu are not identified, and there are no risk management studies for Safranbolu (Interview, AFAD, 06.08.2019).

Therefore, as there are limited policies on national and international agendas regarding fire risk management of cultural heritage and the main devastating hazard for the City of Safranbolu WHS was described as fire, the fire hazard is selected to be studied in this dissertation. The analysis made in the site survey and fire archive also confirmed the severity of fire hazard for the City of Safranbolu WHS.

**Events related to the thesis's topic attended**

In addition, in the thesis period, different national and international events were organized related to the aim and scope of this research. Those events provided information for different parts of the thesis. In other words, due to covering different aspects related to disaster risk management or conservation of cultural heritage, those events contributed to thesis improvement on various issues. Accordingly, the dates, the events' names, contents, and contributions to the thesis can be seen in Table 7.

Table 7 Attended events related to thesis context (prepared by the author)[21]

| | Date | Name | Content | Contribution to Thesis |
|---|---|---|---|---|
| 1 | 26 February 2021 | Disaster Risk Management of Turkey 23th Round Table Meeting, METU, TURKEY | Discussion of current topics about disaster risk management/ Presentation about BAP | Discussion of different DRM examples |
| 2 | 4 September 2020 | Heritage and Pandemics: My Museum on Fire ICCROM (Webinar) | Different examples of FRM for museums | Different FRM examples |
| 3 | 13 April 2020 | Protecting Our Cultural Icons from Fire:<br>Lessons learned from Notre Dame and beyond (Webinar) | Policies about how to handle fire risk for heritage buildings | Policies to mitigate FR for CH |
| 4 | 13-15 January 2020 | Evidence4policy Disaster Risk Management, Florence, İtaly. | knowledge regarding the integration of scientific evidence into policy-making | Scientific Network |
| 5 | 22 February 2019 | Disaster Risk Management of Turkey 21st Round Table Meeting, METU, TURKEY | Discussion of current topics about disaster risk management | Discussion of different DRM examples |
| 6 | 16 March 2018 | Disaster Risk Management of Turkey 20th Round Table Meeting, METU, TURKEY | Discussion of current topics about disaster risk management | Discussion of different DRM examples |
| 7 | 23 January 2018 | Safeguarding Cultural Heritage from Natural and Man-made Disasters, Danube University, Krems, Austria | Different projects about disaster risk management for the conservation of cultural heritage | Scientific Network/ Different methods of DRM for CH |
| 8 | 2017 Fall Semester | SA 506 Workshop in Settlement Archaeology: Cultural Heritage in Disaster Zones | Theoretical discussion about disaster risk management for heritage and preparing a paper about it | Learning the primary literature and factors WHSs face |

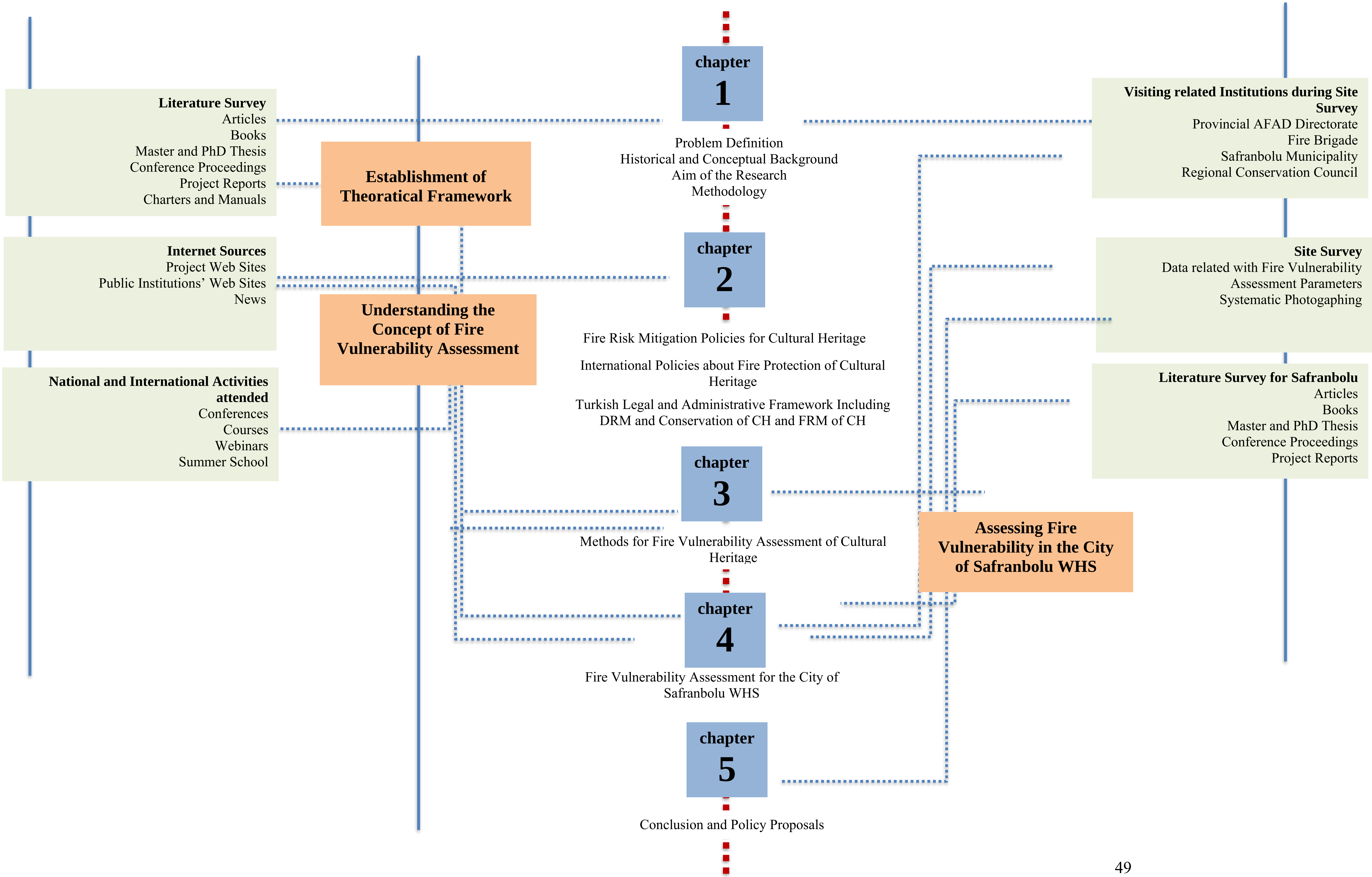
[21] For data typology See Appendix E. Data Obtained from Local Institutions.

This table also showed that DRM of CH is an important topic discussed by different organizations and those contributing to this research in various aspects. In addition, due to current well-known fire incidents, fire risk management of cultural heritage is also discussed in different organizations.

In addition, during the thesis process, different organizations contributed to the thesis's structure, content, and method[22]. Presentations, posters, and extended abstracts published in various national and international articles contributed to the thesis in terms of providing and analyzing. Those activities also became input and output for this study.

[22] Events and produced materials can be seen in Appendix F. Thesis Development Process and Different Inputs and Outputs contribute to the Thesis.

Table 8 Framework of the Thesis and Resources Used (prepared by the author)



### 1.5.3. Data Analysis Process

Different data related to the City of SWHS, such as urban characteristics, buildings, and infrastructure, were gathered and inserted into the GIS database for analysis. Data were analyzed concerning the existence of fire vulnerability indicators in four categories. Indicators are collected in four categories, including (i) The existence of ignition sources, (ii) The existence of flammable materials, (iii) the Fire Combat within the building, and (iv) the Fire Combat within the Neighborhood. In each of those categories, data related to different indicators were gathered. The existence of indicators classifies the fire vulnerability degree of traditional buildings.

Since this study aims to assess the fire vulnerability of heritage places on an urban scale via a simplified method, checking the existence or absence of indicators in four categories confirms this aim. Accordingly, the method developed in this study is based on:

- Assessing Fire Vulnerability Assessment of the City of Safranbolu WHS through the proposed FVA approach by using GIS, which enables integration, management, and visualize different spatial data
- Testing proposed methodology on selected Çeşme Neighborhood in Çarşı Region that has various urban functions and many recent fires in buildings in Çarşı Region happened there.

Within this context, data were assessed to fulfill these two significant aims. Since the method is based on a qualitative approach, the method needs to be validated. Some factors validate the research. The results can be generalized to other urban cultural heritage sites exposed to fire risk in Turkey and other countries. The proposed method can also be adapted to urban heritage places in Turkey and the world. In addition, parameters can be added to each category of fire vulnerability assessment of cultural heritage on an urban scale if needed.

## 1.6.Structure of the Thesis

This thesis comprises six chapters related to each other[23] (Table 9). The first chapter is the introduction, and the last chapter includes a conclusion and proposals that summarize the significant issues and discuss further studies related to this research.

In the first chapter, the concept of risk management for conserving cultural heritage was evaluated in addition to the introduction. Accordingly, the evolution of the concept was discussed by analyzing conferences, international documents, and agreements. Then, the concepts in the risk management process were explored. The disaster risk management process for the conservation of cultural heritage was evaluated.

In the second chapter, policies regarding fire risk mitigation of cultural heritage were discussed. Accordingly, past fire phenomena from ancient times to today on the urban scale are discussed. In addition, international policies about the fire safety of cultural heritage, including standards provided by the National Fire Protection Association (NFPA) and guidelines provided by the European Confederation of Fire Protection Associations (CFPA-E), were analyzed. This section also analyzed England to evaluate its policies related to FRA and FRM for CH. Then Turkish legal and administrative framework, including RM and Conservation of CH and FRM of CH, were discussed. Following this, a comparison between NFPA, CFPA-E, England, and Turkey regarding fire risk management for the conservation of cultural heritage were conducted. How to deal with the fire safety of heritage places is elaborated, and a policy framework for FRM of CH is proposed.

The third chapter introduced a simplified method to assess the fire vulnerability of heritage places on an urban scale. First, the concept of vulnerability was discussed. Then, methods for fire vulnerability assessment of cultural heritage on an urban scale and building scale are assessed. Algorithmic models and indexing methods are discussed. Following this, existing methods for fire vulnerability of cultural heritage

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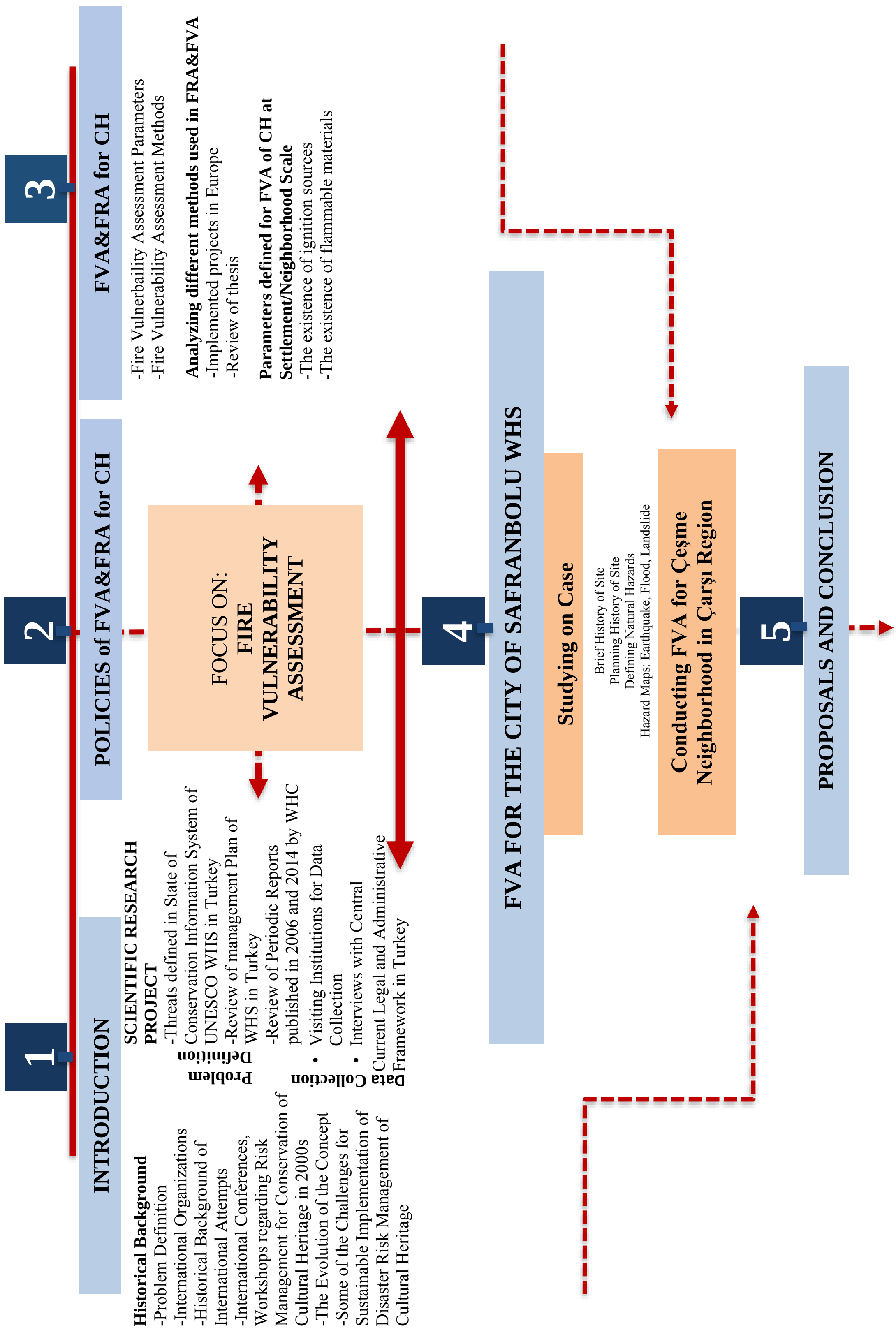
[23] Thesis process shaped structure of the thesis. In each Thesis Committee, the research has developed accordingly. For further information see Appendix G.

were evaluated, and a new novel model and approach were proposed to assess fire vulnerability for heritage places on the urban scale.

In the fourth chapter, the fire vulnerability of the City of Safranbolu WHS was discussed. First, the context, brief history, and planning and conservation activities of Safranbolu were introduced. Then heritage components of Safranbolu were introduced. Following this, hazards that the City of Safranbolu WHS were subject to was presented and discussed. In the next section, the fire hazard of Safranbolu WHS was evaluated. Past fire incidents in the City of Safranbolu WHS were discussed through different aspects, and initiatives for fire risk mitigation conducted by local actors were introduced. Then, a proposed method is applied to Çeşme Neighborhood to assess its fire vulnerability.

In the fifth chapter, different policies for fire risk mitigation of cultural heritage at the national and international levels were discussed. In addition, policies for fire risk mitigation in the City of SWHS were presented.

Table 9 Thesis Structure (prepared by the author)



# CHAPTER 2

# EVALUATION OF FIRE RISK MANAGEMENT POLICIES FOR CONSERVATION OF CULTURAL HERITAGE

## 2.1.Devastating Fire Incidents on an Urban Scale from Ancient Times to Today

Throughout history, many devastating fires have destroyed a considerable number of cities. For example, a fire in Ancient Rome on 18 July 64 CE that continued for nine days affected almost the whole city. Hundreds of homes, thousands of apartments, and many monuments were affected (Figure 19). After this great fire, broader and straighter major streets for firebreaks, fire resistance construction materials, and limiting height were emphasized by Imperator and others following Nero (Aldrete, 2018). This devastating fire incident affected new regulations concerning fire risk mitigation.

Figure 19 The Fire of Rome Painting by Hubert Robert, 1771 [URL 10]

The volcanic eruption in Mount Vesuvius near Pompeii resulted in one of human history's most tragic natural disasters. This disaster is named *'the sudden interruption of life by this great natural catastrophe'* (Sigurdsonn, 1999, p. 1326, cited in Zissos, 2016, p.526).

Figure 20 Last Day of Pompeii Painting by Karl Bryullov, 1833 [URL 11]

This fire event following the Vesuvius Mount volcanic eruption caused the loss of the whole city with its citizens (Figure 20). An archaeologist found the city in the 17th century. Since then, archaeological research has been continuing.

The Great London Fire happened in 1666. Streets were narrow and blocked by open markets (Hanson, 1989). Most of the buildings were constructed with timber-frame construction systems. (Figure 21)


Figure 21 The 1666 London Fire [URL 12]

The 1988 Chiado Fire in Lisbon destroyed warehouses and commercial areas (Julià and Ferreira, 2021). These fire incidents were assumed to be the worst disaster after the earthquake and fire in 1775 [URL 13] (Figure 22). As a result of this fire, two people died, 18 commercial buildings, 40 businesses were destroyed, 300 people lost their homes, more than 2000 lost their jobs, and the fire resulted in $350 million in damage [URL 14]. The causes of the fire were unknown. The area's characteristics, not having fire detection and suppression systems, destroyed those buildings (Santana, 2007). After this disastrous event, new fire safety regulations were developed (Santana, 2007).

Figure 22 The 1988 Chiado Fire [URL 15]

İstanbul has been exposed to many fires in its history (Figure 23). These fires spread to large areas and caused significant loss of life and property. Fires happened frequently, they spread in a short time, and they had an impact on the environmental scale in İstanbul (Ceylan and Arpacıoğlu, 2017). Population increase and construction of buildings parallel to this, and not implementing passive fire protection solutions brought by the administration increased fires (Ceylan and Arpacıoğlu, 2017, p. 146).

Figure 23 İstanbul after the 1908 Fire [URL 16]

## 2.2.National and International Policies about Fire Risk Management of Cultural Heritage

In Turkey, which has rich and diverse cultural assets, fire is one of the significant dangers threatening historic buildings and the environment. It is impossible to make a nationwide assessment due to the lack of statistical information on historical buildings affected by fires in Turkey. However, the frequency of fire incidents and lost traditional buildings in the Safranbolu World Heritage Site, which has been examined in detail in this study, reveal the extent of the fire risk for historical environments of similar characteristics. However, there is a need for legal regulations and practices at different scales to prevent and reduce the fire risk in Turkey (Yıldırım Esen and Bilgin Altınöz 2020, 2021). This part of the research aims to evaluate the international policies dealing with the fire safety of historic buildings and environments and compare those policies with Turkey and England cases.

England has been selected for research due to its large and diverse cultural heritage and its experience in building safety regulations to reduce fire risk, which began in the 18th century and continues to the present day. Despite current regulations, fire is the most significant risk to cultural heritage in the UK (Harris 2021, Kincaid 2019b). In 2019, a fire broke out in ten historic buildings in Bradford alone [URL 17]. Despite the differences in the contexts of the studied examples and the understanding that the existing regulations or practices are still insufficient in preventing fires, it is essential to compare different samples and identify the differences and deficiencies.

A literature review on fire risk management policies of cultural heritage has been conducted. The sub-titles of the research are *(a) legal and administrative regulations, (b) addressing the issue of cultural heritage fire risk management in planning studies at different scales, (c) preparing the database for past fires,* and *d) increasing and developing technical capacity*. Within the scope of the planning studies on different scales, policies that can be applied for fire risk management on a regional scale, site scale, building scale, multi-actor participation process, and measures that can be applied during restoration applications are discussed. Within the framework of these titles, international policies and the examples of England and Turkey have been evaluated comparatively.

Various sources have been examined for data and information on the samples of Turkey and England and international policies. Interviews, internet resources, and fire archives were used for the data on the past fires to evaluate fire risk threatening the cultural heritage in the Safranbolu. In the case of England, statistical information was produced using the data available on the Consulting Company website. In addition to the literature review, the web pages of the relevant public institutions and non-governmental organizations and the news were used.

## 2.3. International Policies about Fire Risk Management of Cultural Heritage

Due to devastating fire incidents in historic buildings and environments, various studies focus on policies dealing with fire risk management of cultural heritage (Torero, 2019; Julià and Ferreira, 2021; Marrion, 2016; İbrahim et al., 2011b). As can be seen in Table 10, different scholars focused on various aspects of fire risk management to conserve cultural heritage.

Fires in traditional urban areas (Julià and Ferreira, 2021) and fires in historic buildings (Torero, 2019; Marrion, 2016; İbrahim et al., 2011b) are discussed. Julià and Ferreira (2021) emphasized the incompatibility of methods used for historic buildings in traditional urban areas. Furthermore, Torero (2019) stated principles for fire risk mitigation of historic buildings. Marrion (2016) stated fire risk mitigation principles to conserve cultural heritage. İbrahim et al. (2011b) figured out the primary roles of actors such as regulatory authority, restorer, and building stakeholders in fire risk assessment of cultural heritage.

Table 10 Literature about Principles of FRA and FVA for CH

| Authors | Article Title | Main Notes |
|---|---|---|
| **Torero (2019)** | Fire Safety of Historical Buildings: Principles and Methodological Approach | • Emphasizing performance-based analysis rather than a prescriptive approach |
| **Julià and Ferreira (2021)** | From single‐ to multi‐hazard vulnerability and risk in Historic Urban Areas: a literature review | • Reviewing fire vulnerability and risk assessment methodologies<br>• Most of the assessment methodologies are not easily and accurately applicable to evaluate historic urban areas and buildings<br>• The material, construction, and structural characteristics of historic buildings are not considered<br>• Incompatibility of methods with the scale of an urban area, always for individual buildings |
| **Marrion C. E. (2016)** | More effectively addressing fire/disaster challenges to protect our cultural heritage | • An approach to identifying prevention and mitigation measures to protect cultural heritage from fires<br>• Fire strategy including fire safety management plan, emergency evacuation plan, fire brigade pre-plan, construction/renovation/rehabilitation procedures |
| **İbrahim et al. (2011b)** | Fire Risk Assessment of Heritage Building- Perspectives of Regulatory Authority, Restorer, and Building Stakeholder | • The perceptions of Fire-Rescue Department Malaysia personnel, contractor/consultant, and building maintenance personnel differ.<br>• For Fire-Rescue Department Malaysia: the most critical element is fire management.<br>• For contractor-active protection system<br>• For maintenance personnel: active protection systems, passive protection systems, and fire management are critical criteria. |

On the other hand, fire risk management regulations can differ from country to country. Analyzing different countries' perspectives through fire risk management for heritage places can provide a broader approach to understanding the current situation.

Since fire is one of the threats that historic buildings and environments frequently encounter and causes severe damage, it is also addressed in various international documents. However, the absence of international standards for fire interventions and international guidance documents may be insufficient. Global regulations are needed to deal with fire risk (Pickard, 1994b, p.9).

In *Risk Preparedness: A Management for Cultural Heritage* which addresses the different dangers faced by cultural heritage, fire prevention strategies, fire risk reduction, fire response plan, preparation, response, and rescue processes are emphasized (Stovel, 1998). In the International Building Codes [URL 18], escape routes, exit signs, stair railings, and automatic fire extinguishing systems are discussed by defining the rules to be observed in the changes related to fire safety in historical buildings and different building uses. All of these measures are stated on a building scale.

In different countries, the duty to conserve cultural heritage from fires varies. Local, regional, and central governments share this responsibility in almost all countries. For example, in Scotland, Historic Scotland is responsible as the central government body for the fire safety of cultural heritage. In Switzerland, the fire authority is responsible; in Germany, the responsibility belongs to the local government, while in Italy, the central government is responsible (Twilt and Lostetter, 2005). In addition to local and central government responsibilities, owners of cultural heritage have a critical responsibility in cultural heritage fire safety.

While international documents are assessed, the information regarding fire risk assessment for heritage places is insufficient. There are only limited articles related to this critical topic. There are technical and prescriptive documents related to fire safety regulations for historic buildings (Huang et al., 2009). American codes and European guidance are technical documents.

According to the research conducted in 2005 within FIRE-TECH Project that includes 11 countries[24], it was shown that Italy, Switzerland, and Portugal have an explicit fire regulation for cultural heritage, while other countries' cultural heritage is considered rather than fire regulation. Nearly half of the cultural heritage regulation covers fire safety issues (Twilt and Lostetter, 2005, p.9).

Fire regulations for cultural heritage sites were formulated for various reasons in different countries. For example, in Austria, regulations were developed after II World War; in Italy, since II World War, there has been regulation, but more attention was given after several fires in the 1980s; in Portugal, regulation for fire safety was organized after the devastating Chiado fire in 1988. Also, in Germany, regulations regarding cultural heritage were enacted in the 1970s to make explicit regulations

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[24]Project partners include Belgium, The Netherlands, Portugal, England-Wales, Scotland, Austria, Germany, France, Greece, Hungary, Italy, and Sweden. On the other hand, questionnaires were also sent to other European countries but just Switzerland and Norway sent complete questionnaires.

(Twilt and Lostetter, 2005, p.9). As can be seen, the emergence of cultural heritage fire safety regulations is based on different aspects in different countries.

There are also prescriptive and performance-based codes for fire risk management of buildings. There is a transition from prescriptive to performance-based codes for more flexible and cost-effective designs. (Bukowski, 1996; Mehaffey, 1999; Magnusson, 1997, cited in Hadjisophocleous and Fu, 2004). These codes provide technical solutions to conserve historic buildings (Arborea, Mossa, and Cucurachi, 2012). However, the fire safety of the building is evaluated in compliance with the prescriptive rules identified. Prescriptive codes are easy to apply (Hadjisophocleous and Fu, 2004).

### 2.3.1. Standards provided by The National Fire Protection Association (NFPA)

NFPA is an organization offering various and comprehensive standards on fire safety. Many countries and organizations have adopted NFPA's standards, and Turkey is one of the members of this union, too. Two standard guidelines of NFPA contain the principles for protecting historical buildings against fires. Those are the NFPA 914 *Code for Fire Protection in Historic Structures* and the NFPA 909 Code for *the Protection of Cultural Resource Properties: Museums, Libraries, and Places of Worship*. NFPA 909 includes chapters related to protection plans within the context of protection plan emergency operations, fire safety management, security, new construction, addition, alteration, renovation, and modification projects, management of operational systems, fire prevention, inspection, testing, and maintenance of protection systems, special events, museums, libraries, and their collections and places of worship (NFPA 909, 2017).

NFPA 914 *Code for Fire Protection in Historic Structures* describes the principles and practices of protection and recovery for historic buildings and areas. It also determines the minimum requirements for preservation and recovery, considering the vulnerability of historic buildings while preserving the features that make historical buildings historically or architecturally important (NFPA 914, 2019). In addition, the fire safety process, prescriptive-based approach, performance-based approach, management operating systems, fire prevention, security, additions, modifications and rehabilitation, and fire precautions to be taken during construction, repair, inspection, testing, and maintenance are also included.

### 2.3.2. Guidelines provided by The European Confederation of Fire Protection Associations (CFPA-E)

CFPA-E prepares guidelines for a common approach and acceptable solutions, concepts, and models to fire hazard in European countries. These guidelines reflect the practices developed by the CFPA European countries, but national rules prevail in a conflict between the guidelines and national requirements [URL 19]. This situation also shows that the guidelines are not legally binding. CFPA-E has also published a guide entitled "Fire Safety Management in Historic Buildings." This guide is designed for property owners, administrators, and others responsible for historic buildings' safety. Cooperation between rescue services, consultants, and security companies is necessary to increase fire safety in historical buildings. They can provide information about basic, simple, and low-cost actions (Ditlev and Orrainen, 2013). This approach shows that fire risk reduction consists of a multi-actor process.

This guideline includes sections such as fire protection in historical buildings, basic measures to provide fire protection, personnel training, basic conditions to ensure effective firefighting, a checklist for fire protection actions in historical buildings, and regular inspections. The first section deals with fire protection in historic buildings and includes risk assessment, documentation, and precautions. The primary measures to provide fire protection include prevention of fire ignition, prevention of the spread of fire, evacuation, and recovery of items of historical value. Access to roads and water resources are mentioned in the basic conditions that will ensure the effective response of the fire brigade. The checklist for fire protection actions in historic buildings covers the principles of escape safety, fire compartments, fire spread between buildings, electricity and other installations, firefighting equipment, regulations regarding the accessibility of the rescue service to the building, water resources, maintenance elements, drawings and plans of the building. Regular inspections consist of control headings such as escape, partition boundary, fire extinguishing equipment, electrical installations, gas installations, and kitchen use that may cause fire, first aid, flammable materials, and arson (CFPA-E, 2013).

Briefly, this guideline includes the basic principles to be observed to protect historical buildings against fire. This example is important because it is a framework document on the fire risk of historical buildings on a European scale and sets out the basic policies. Such a framework guideline is essential for more detailed studies that need to be prepared to reduce the fire risk encountered by historical buildings.

### 2.3.3. Regulations on Conservation of Cultural Heritage and Fire Risk Management in England

The 1666 Great Britain fire is considered to initiate building-level fire safety regulations in England (Papaioannou, no date, p. 61). The Fire Prevention Law of 1774 emphasized that stairs should be built for multi-storey buildings to help evacuate people from burning houses. This quick and straightforward approach emerged in the 18th century (Bernardini, 2017, p.13-14). Fire safety has continued to develop in England from the past to the present. In England, more emphasis has been placed on life safety and prevention of fire spreading in buildings, and the protection of the building and its components has remained in the background (Pickard, 1994a, p.27).

Individuals, organizations, and the government has defined roles in managing fire risk to reduce the national expenditures caused by fires. Among the measures taken by the government for this purpose are fire safety regulations, legal measures, laws, and standards, ensuring fire safety by fire brigades, training, and promotional campaigns (Ramachandran, 1999, p.363). The central government publishes the 'National Framework for Fire and Rescue,' providing national standards and information on how services should respond to emergencies. The government also provides funding to 46 firefighters in the UK [URL 20]. The primary legislation governing the fire and rescue service is the Fire and Rescue Services Act of 2004 and the 2007 Fire and Rescue Service Instruction. Fire and Rescue Services specifies the principles to be followed in fire, road, traffic accidents, and other emergencies [URL 20]. With the death of 72 people due to the Grenfell Tower fire in 2017 [URL 21], attention was given to the professional groups responsible for the construction and the built environment. The Royal Town Planning Institute (RTPI) emphasized the role of planning in fire safety [URL 22].

In England, fire risk reduction measures are considered most at the building scale in planning. Most decisions are taken by local planning authorities, who are part of local governments. The planning system aims at sustainable development, addressing the workforce, environmental impacts, society's needs, and heritage (RTPI, 2017a). RTPI (2017b) argues that building control and planning are necessary for development. The two should support each other, emphasizing that building control and fire services should also be involved in high-risk development projects. It has been stated that the 2010 Building Regulation may be restrictive for historical buildings and that some provisions may be appropriate. It is reasonable to evaluate the hazard and risk according to the situation and the fire safety in this context [URL 23].

There are different institutions for the conservation of cultural heritage in England. In 2015, English Heritage was divided into Historic England and English Heritage Trust. As an independent organization, English Heritage is responsible for protecting the national heritage collection. The English Heritage Trust supports registration, planning, funding, suggestion, documentation, research, and public information (Jahed et al., 2020). Various regulations for managing the fire risk faced by the cultural heritage exist. Historic England has recommended several guidelines for the fire safety of historic buildings. These are "Fire Safety Guide for Thatched Buildings" [URL 24], "Preservation of Life and Heritage in the North West" to reduce the risk of deliberate fires, and "Fire Safety for Traditional Church Buildings" [URL 25]. In addition, "Fire Safety: Hot Work and Historical Buildings" [URL 26] for fires caused by heat processes and the damages that fireworks and bonfires may cause, and sky lanterns used in historical environments [URL 27] are highlighted. The Fire Service suggested the checklist [URL 28] for the issues to be considered. Historic England also made several recommendations on Fire Emergency Plans, highlighting the principles to be followed in preparing Emergency Plans [URL 29].

In addition, "Fire Safety Guide: Heritage and Special Buildings" was published by the London Fire Brigade [URL 30]. This document includes responsible actors, fire safety regulations, fire risk assessment, fire strategy, fire safety engineering, passive and active fire safety, rescue/damage control plan, work with fire and rescue services, and business continuity (London Fire Brigade, 2019). Actors responsible for fire risk management are also defined in this guideline. This guideline is vital in providing a basis for critical issues in fire risk reduction faced by the cultural heritage. Accordingly, if the building is being built or modified, it is subject to the approval of the Building Control Office in the local authorities or an approved inspector following the 2010 Building and Approved Inspectors Regulation.

In addition, there is statistical information prepared by the Heritage & Ecclesiastical Fire Protection regarding the fires that historical buildings have faced since 2017 in England. This organization performs fire risk assessments for registered Historic Buildings and Houses of Worship in Chester, North Wales, nationwide [URL 17]. The statistics include fire date, how many people intervened, building use or whether the renovation was carried out, building name, address, registration degree, the protection area, fire reason, damage percentage, and building construction date. A private consulting firm has prepared this database, but the need for a national database is also highlighted ([URL 31]; Harris 2021, p.21). Statistical information is problematic due to the lack of records of fires encountered by historical buildings. Still, when the data collected for England is evaluated, it is stated that more than 350 fires occurred in historical buildings in 2018 (Kincaid 2019a). When the data in the database prepared by the Consultancy Company were evaluated, 193 historical building fires occurred in the UK in 2020 [URL 17]. It can be said that the fire poses a severe hazard for England, considering these numbers. There are also some problems in terms of current technical capacity. Harris (2021, p.22) emphasized that Fire Services should have Integrated Risk Management Plans, and cultural heritage should be a part of it. However, research has shown that all Fire Services in the UK do not have enough information to identify which cultural heritage structures are in danger (Harris 2021).

### 2.3.4. Turkish Legal and Administrative Framework Including Risk Management and Conservation of Cultural Heritage

#### 2.3.4.1.Disaster Risk Management for Cultural Heritage in the Legal Documents

The existence of independent legal and managerial regulations on conserving cultural heritage and risk management in Turkey makes risk management difficult in cultural heritage areas. For example, the risk and risk management issue has not been addressed in *the Law on the Protection of Cultural and Natural Assets (Law No. 2863),* which entered into force in 1983. It is the fundamental law on conservation concepts and approaches. In addition, it was emphasized that measures against disaster risks should be taken in *the Law on the Renewal and Protection of Damaged Historical Properties No. 5366***,** which was enacted in 2005. Still, it has not been stated who should be the responsible actors. The Ministry of Culture and Tourism's Regulation on the Preparation of a Conservation Development Plan emphasized the strategies and practices against natural disasters such as earthquakes, floods, landslides, fires, and rockfalls that the cultural heritage might encounter. However, it seems that the process of risk management and the actors responsible for it are not yet defined (Uluç and Şenol Balaban, 2017b). In addition, the relation of the Conservation and Development Plan with existing regulations and laws stays undefined (Figure 24).

Following the 1999 Marmara Earthquake, to gather the authority and coordination for disaster management under one institution, the General Directorate of Civil Defense, the General Directorate of Disaster Affairs, and the Turkish Emergency Management Directorate were closed. Disaster and Emergency Management Authority (AFAD), established under the foundation law with *Law No 5902*, has taken responsibility for taking necessary precautions and ensuring the coordination between these institutions and organizations, policy production, and implementation. In addition, within the scope of this law, the Disaster and Emergency Management Center, Disaster and Emergency Higher Board, and Disaster and Emergency Coordination Board have been foreseen. However, there is no definition of duty to protect cultural heritage in this arrangement (Uluç and Şenol Balaban, 2017b).

*Law No. 5902,* on which the National Disaster Management Plan is based, does not provide an arrangement specifically related to cultural heritage structures. However, during the implementation, especially within the scope of the ''Safe Building Safe Settlement'' studies, many monuments, schools, hospitals, and dormitories registered as cultural heritage need to risk analysis and be strengthened for an earthquake. (Gündoğdu, 2010, p.181-182).

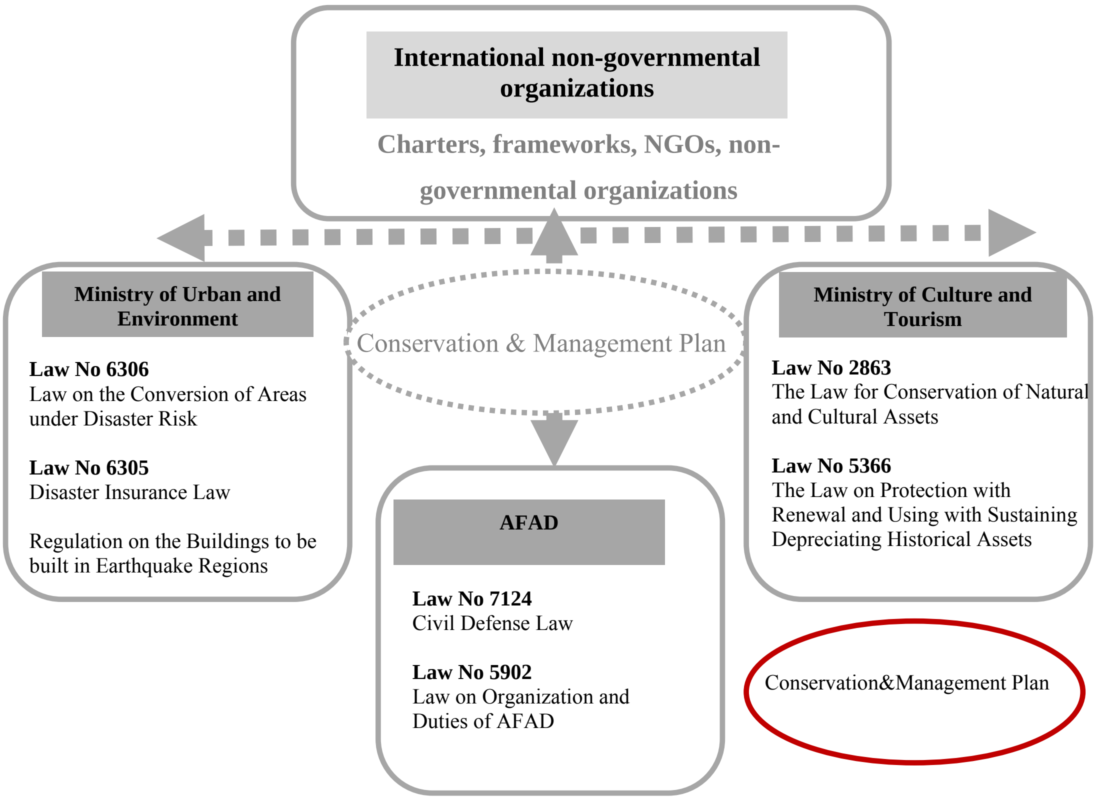


Figure 24 Existing Legal and Institutional Order in terms of Risk Management and Conservation of Cultural Heritage (Uluç and Şenol Balaban, 2017a)

In 2012, *No. 6306 Law on the Conversion of Areas under Disaster Risk* included the issue of reserve building area, risky area, definition of risky structure, and disruption and transformation in the case of the building in a risky area. This approach may contribute to the risk of transformation and destruction of heritage. In 2014, in the decision of the Constitutional Court, this was changed into risk reduction (Zıvralı and Cabbar, 2015)

In 2012, *Law No 6305, Disaster Insurance Law,* does not include any arrangement for cultural assets. On the other hand, in Law No 6546, which was organized for Çanakkale War Gelibolu Historic Area, the site manager was authorized to conduct geological, geophysical, geotechnical, marine sciences, and other scientific research and survey for historic areas. It is also tasked with identifying and monitoring the rules governing the construction and approval of risk management and conservation plans, making, carrying out, and approving the geological and geotechnical surveys. With these responsibility descriptions, it can be determined that the execution of risk management and conservation plans in historic areas is beginning to take place in the law (Zıvralı and Cabbar, 2015).

Briefly, when Turkey's Legal and Administrative Framework were analyzed in terms of risk management and conservation of cultural heritage, some factors increased the vulnerability of heritage places. Namely, from a conservation perspective, the insufficient administrative coordination between local and central government, the inadequacy of financial sources of the local and central government, the inadequacy of people's awareness, and no consistency and coordination between regional, urban, and conservation plans are some challenges faced. While there is already a duality between planning and preservation, disaster management emerges as the third legal tool and system (Gülersoy Zeren and Günay, 2005, cited in Uzer Von Busch, 2010). In addition, although the necessary precautions are emphasized, there seem to be limited policies regarding what to do, how to do it, and who will accomplish it.

#### 2.3.4.2.Fire Safety Regulations for Cultural Heritage in the Legal Documents in Turkey

Anatolia, especially the Ottoman cities, was formed by the structures built with timber-frame construction systems. The combination of these structures with adjacent order and destructive fires was encountered in history. From past to present, it has been aimed to reduce fire risk, with both building-scale and city-scale regulations. As a result, different regulations were published against fires (Ceylan and Arpacıoğlu, 2017). These regulations, which emerged in the 19th century, addressed the measures to reduce the increased fires due to the increase in population and the construction density in Istanbul (Gürses Söğüt, 2019, p.54).

Earthquakes that caused severe consequences in Istanbul also influenced the emergence of the regulations in this period. For example, after the Istanbul earthquake of May 22, 1766, although it was obligatory to make masonry, which is more resistant to fire, the wood material with higher resistance to earthquakes continued to be preferred by the community (Afyoncu and Mete 2000, cited by Özata and Limoncu 2014).

The Ebniye Regulation of 1848 is the first regulation in planning and construction. This regulation had precautions regarding street arrangement, material use, and measures. The regulations between 1839 and 1848 included adapting the existing transportation structure according to the new transportation requirements and the measures against unavoidable fires (Özcan, 2006).

1858 Regulations on Streets, 1863 Turuk and Ebniye Regulations, 1875 Regulation on the Construction of Ebniye in Istanbul and Bilad-ı Selase, and 1877 Dersaadet Municipal Law emphasized the same issues (Çelik, 1996, p.42, cited in Ceylan and Arpacıoğlu, 2017, p.150). In these regulations, streets were classified according to their widths, and new regulations for streets in areas where fires happened were addressed (Ceylan and Arpacıoğlu, 2017, p. 150). On the other hand, it is known that more than 20 thousand buildings were destroyed in 80 fires that took place in Istanbul between 1909-1922 (Ürekli, 2010, p.117). Following these, various developments have occurred in disaster risk management and conservation of cultural heritage.

The fundamental law of conservation of cultural heritage in Turkey, No. 2863, does not have a policy for conserving cultural heritage against disasters. In the seventh part of this law, a statement regarding cultural heritage faced natural disasters exist. Accordingly, for immovable cultural assets that are privately owned and were located in areas where natural disasters happened, the Ministry can carry out required projects free of charge and without the consent of the owners and other concerned parties.

However, considering that the fire is not a natural disaster or it is a secondary disaster that may occur after an earthquake, it can be said that there are uncertainties about what to do before, during, and after a fire incident. Also, fire protection of cultural heritage in Turkey does not have a separate regulation, and it is assessed as part of the current fire regulation. In this context, a chapter (Chapter 11) was added to the Fire Regulations for historical buildings in 2009. In this section, three fundamental issues are discussed. The first includes the definition of the historic building. Second, the principles of fire precautions to be followed for historical buildings, and thirdly, the applications in historical buildings are explained. In the Principles for fire measures, it was stated that the Regional Conservation Board of Cultural Properties is consulted for installations to be constructed.

In addition, Article Change: 16/3/2015-2015/7401 K. indicated that protecting historic structures is essential during fire safety measures. Accordingly, the relevant technical consultancy firm's fire evacuation, detection, and extinguishing installation projects should follow the building's physical and visual aspects. Furthermore, interventions should not damage the structure, and the opinion of the relevant fire brigade about the prepared projects should be taken.

In addition, the deficiencies in handling the fire risk in conservation and development plans prepared for cultural heritage also appear as a problem. It is emphasized that cultural heritage is more resilient and safer against fire in Article 6 of the Regulation on the Procedures and Principles Regarding the Preparation, Display, Implementation, Inspection of Conservation and Development Plans and Landscaping Projects *(Koruma Amaçlı İmar Planları ve Çevre Düzenleme Projelerinin Hazırlanması, Gösterimi, Uygulaması, Denetimi ve Müelliflerine İlişkin* Usul ve Esaslara Ait *Yönetmelik)*. Strategies to make historic buildings and environments more resilient to fire and safer need to be clearly stated. However, it is unclear what strategies, how, and by whom this will be conducted. In the third part, which is Article 167/C – (Annex: 10/8/2009-2009/15316 K.), including implementation for historic structures, it was stated that:

> 1) Unless otherwise specified in this section, the provisions of the 10th Section are applied to protect historical buildings from fire.

(2) Apart from their ground floors, the other floors of historical buildings, whose bearing columns and main beams are wooden, cannot be used as healthcare with accommodation facilities, nursing homes, kindergarten, primary school, and dormitory.

(3) During the repair of a historical building, provided that it is compatible with the original structure, the same or similar materials can be used in the building construction.

(4) In historical buildings, which are open to society with more than one floor, if the bearing columns are wooden, during restoration, the primary bearers should be insulated to be resistant to fire for at least 90 minutes.

(5) Fire escape hall is not compulsory if the escape stairs in historical buildings are reached by passing through corridors, halls, lobbies, or similar standard volumes.

(6) If half of the stairs are preserved, regardless of the height of the building, other unprotected stairs are accepted as escape routes, escape distance is applied in two directions, and circular stairs are accepted.

(7) If the number of users on one floor exceeds 100 people, the escape doors are changed to open in the escape direction, or a staff is kept during the use of the building.

(8) The electrical cables used in the wooden parts of the historic building should be resistant to fire for at least 60 minutes and pass through a steel pipe. Junction boxes and cases must be made of fireproof material.

(9) In wooden structures, easily flammable and combustible materials cannot be used for protection or painting of wooden material.

(10) Keeping flammable and explosive materials in historical buildings is impossible without creating a separate fire compartment.

(11) (Annex: 16/3 / 2015-2015 / 7401 K.) In cases where there is no possibility of change in terms of physical and visuality of historical buildings, the existing stair is considered a fire stair and escape.

On the other hand, there is a need for a fire regulation focusing on historic urban tissue and buildings since the construction system and material and their production process are different from current urban forms and buildings. In addition, the diversity of cultural heritage should be considered as well. Principles regarding before, during, and after a fire should clearly be defined concerning historic environments and buildings' unique characteristics. Furthermore, since the restoration process is also an event that may cause fire, the principles and tools for mitigating fire risk should be followed during restoration lack in this fire regulation.

## 2.4. Comparison of International Policies, England and Turkey and Policy Framework How to Deal with Fire Risk in Heritage Places

When the case of England and Turkey is compared, the lack of legal and administrative regulations can be seen in Turkey. Only having a chapter in the current Fire Regulation of Buildings (BYKHY) is insufficient when considering the diversity of heritage places in terms of scale and spatial character. In England's case, planning policies on coping with fire risk of heritage places at a regional scale regarding FRM of CH is needed.

Table 11 Comparison of Different Regulations Addressing Fire Risk of Historic Buildings and Environments

| | Questions | International Policies | | England | Turkey |
|---|---|---|---|---|---|
| | | CFPA-E | NFPA | | |
| **Legal and Administrative Regulations** | Are there guidelines/regulations addressing Fire Risk Management (FRM) for the cultural heritage? | Yes | Yes | Yes | No. There is a special section devoted to fire regulations. |
| **Planning** | Are there principles regarding FRM at a regional scale? | No | No | No | No |
| | Are there principles regarding FRM at an urban scale? | No | No | Yes | No |
| | Are there principles regarding FRM at the building scale? | Yes | Yes | Yes | No |
| | Are there principles regarding the FRM Plan? | No | Yes (Building scale) | Yes (Building scale) | No |
| | Are there principles to be applied during the restoration/building repair? | Yes, but only for heat applications | Yes | Yes, but only for heat applications | No |
| | Is a multi-actor/participatory process defined for FRM of cultural heritage? | Not Applicable | Not Applicable | No | No |
| **Past Fire Incidents Database** | Is there a national database of past fires faced by the cultural heritage? | Not Applicable | Not Applicable | No, however, there are statistics prepared by a private consulting firm. | No |
| **Technical Capacity** | Is there a need to develop technical capacity? | Not Applicable | Not Applicable | Yes | Yes |

As seen in Table 11, comparisons were conducted regarding legal and administrative regulations, planning, past fire incidents database, and technical capacity of fire emergency services. By looking at this table, it can be said that international documents regarding FRM of CH are limited in terms of policies related to planning, a database including past fire incidents, and the technical capacity of emergency staff.

The main deficiencies in cultural heritage fire risk management are lack of or insufficient legal and administrative regulations, planning studies on different scales dealing with fire risk management of cultural heritage and database of past fire incidents, and insufficient technical capacity. Also, international policies regarding cultural heritage fire risk management seem insufficient. There should be detailed guides to direct states on managing the fire risk of cultural heritage.

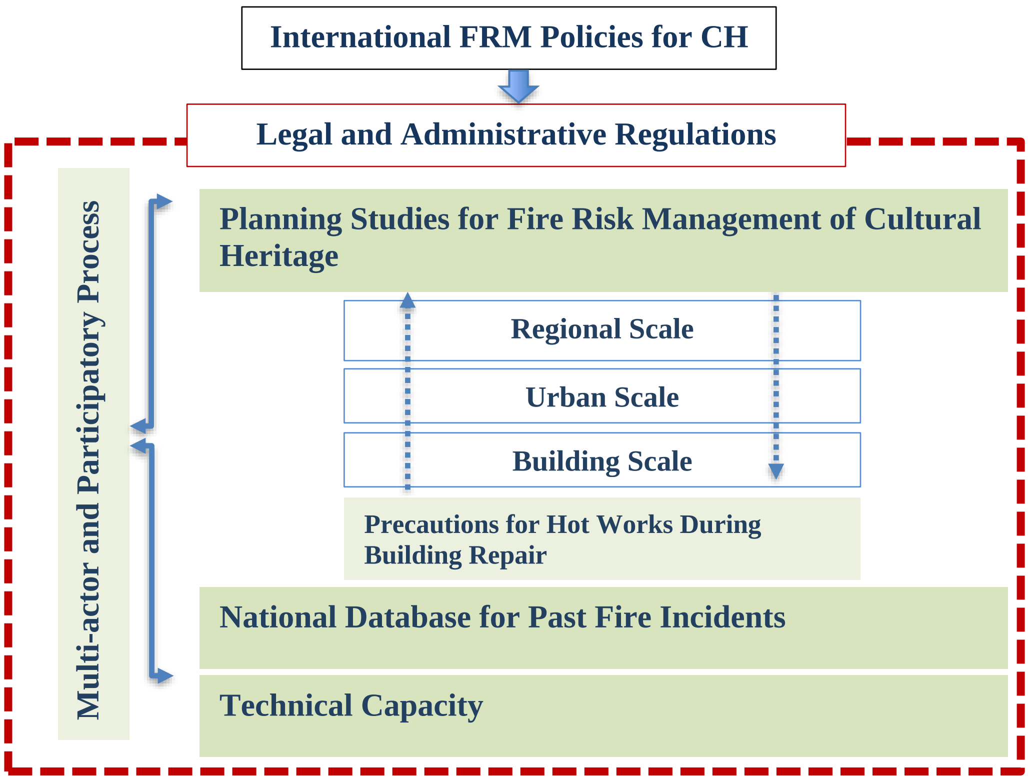


Figure 25 A Proposal for Policy Framework for Fire Risk Management of Cultural Heritage (prepared by the author)

Therefore, a policy framework is needed, including legal and administrative regulations, planning studies on different scales, a national database of past fire incidents, effective and efficient technical capacity, and multi-actor and participatory processes (Figure 25). Other states could try this policy framework, and the deficiencies in the policy framework could be solved.

**a. Legal and Administrative Regulations**

Although England has various legal and administrative regulations for conserving cultural heritage, these do not include fire safety, and the legal regulations on fire do not include cultural heritage (Twilt and Lostetter, 2005, p. 9). It can be considered a deficiency that Historic England's advisory documents on fire safety are not legally binding. In the case of Turkey, the "Regulation on the Protection of Buildings from Fire (BYKHY)" is the legal document for the precautions that can be taken against fire risk. There is also a section on cultural heritage in this document. However, there is a need for more detailed and explanatory legally binding regulations due to the diversity of cultural heritage and the presence of various factors that may cause fire at different planning scales. Due to the inadequacy of the current fire regulations, comprehensive regulations in line with the Turkish Cultural Heritage Conservation and Disaster Management legislation are required under the leadership of international policies.

**b. Considering Cultural Heritage Fire Safety in Different Planning Scales**

Understanding, managing, reducing, and responding to disaster risks are essential to consider in an integrated manner in planning studies at different scales. Considering the factors that cause fire risk and increase fire vulnerability, it is seen that some aspects are the subject of planning studies at the regional scale, area (site) scale, and building scale. It is possible to reduce the potential risk by including all kinds of interventions within the scope of fire risk management in regional and urban planning.

**Regional Scale:** In land-use decisions for urban and regional development on a regional scale, explosives and flammable materials should not be allowed near the heritage sites. In addition, considering the recent increase in forest fires, fire prevention measures should be taken for the built heritage near the forest land. Furthermore, transportation decisions should be made to ensure the access of fire fighting services to the historic buildings and environment in case of a fire. Attention should be paid to solving existing transportation and infrastructure problems. In the case of both England and Turkey, the lack of regulations on a regional scale regarding the fire risk faced by historic buildings and environments is noteworthy. In both examples, fire safety regulations are dealt with on a building scale.

**Urban (Site) Scale:** Different measures can be taken on the urban scale. First, attention should be given to land use decisions near historic buildings and environments, such as dangerous uses that may cause a fire. Another measure is the *accessibility* to cultural heritage. Accessibility is an essential factor during fire combat. Therefore, in the event of a fire, historic buildings and the environment must be accessible by fire brigade services. In cases where the roads' width, slope, and volume do not allow, fire extinguishers that can adapt to these conditions should be supported. As Orhan (2018, p.206) emphasizes, the current status of the roads and infrastructure that provide an adequate response in a disaster should be determined, and alternative routes, accessible open spaces, and infrastructure systems should be designed if needed. It can be said that the principles of land use and transportation are valid on the regional scale as well. Intervention and evacuation plans on a single building scale should also be prepared on an area scale. Attention should be paid to cultural heritage sites while determining land-use decisions at the site scale. Hazardous uses - highly hazardous places due to producing, storing, filling, unloading, and selling flammable and explosive materials and fuels (Regulation on Protection of Buildings from Fire, Article 17) - should be located away from cultural heritage sites. In addition, the choice of fire brigade location in land use is also vital in terms of an effective response to fires. In this context, there should be a fire brigade or branch near the historical environments where the buildings built with timber-frame construction systems are intense. There is a need for principles describing explanatory and comprehensive measures taken for fire safety in historical environments.

**Building Scale:** Various measures can be applied at the building scale. Marrion (2020) evaluated building-scale fire risk management strategies under four main topics. These are determining fire safety objectives, making a hazard assessment, determining prevention and reduction alternatives, evaluating fire risk reduction alternatives, and developing strategies. Fire safety purposes include ensuring the safety of the residents and emergency response teams, preventing interruptions in business continuity, and protecting the heritage. In assessing the hazard, it is stated that the factors that will cause fire are determined, and measures should be taken. Prevention and mitigation alternatives include compartmentation, detection, warning systems, exit, extinguishing, smoke management, and fire extinguishing equipment. Strategy development includes long-term strategies that need attention during restoration, evacuation, emergency response, rescue, awareness-raising, and training. In addition, Marrion (2020) stated that it is possible with detection/alarm systems, fire extinguishing systems, compartmentation/fire separation, emergency response teams, structural durability, and management plans to reduce fire risk. Kidd (1995) also stated fire safety components as fire precautions, management policies for fire safety, fire prevention, fire protection, and facilities for fighting (Figure 26).

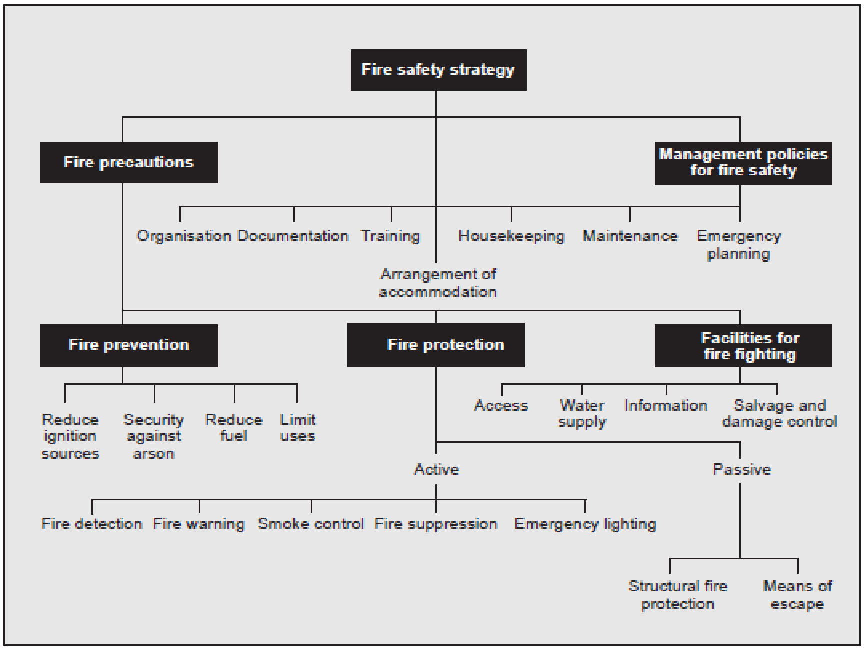


Figure 26 Components of Fire Safety (Kidd, 1995)

In the case of England, it has various documents in terms of measures that can be taken at the building scale. These documents are Fire Safety Guide in Thatched Buildings, Protection of Life and Heritage in the North West to reduce the risk of deliberate fires, Fire Safety for Traditional Church Buildings, Fire Safety: Heat Operations and Historical Buildings, and Fire Safety Guide: Heritage and Special Buildings. In addition, the checklist for fireworks use, bonfires, and sky lanterns to be used in historical environments and the principles to be considered in preparing emergency plans are also specified. In Turkey, the building scale considerations are limited by the current National Fire Code. While the principles in the England example should be legally binding, there is a need for advanced regulations regarding historical structures in the Turkish case. Different kinds of policies can be applied to intervene with fires. Fire pumps, fire piping, fire cabinets, and fire suppression systems are examples of fire intervention tools.

**Ensuring Multi-Actor Participation Process**

The inability of the relevant actors responsible for protecting the historic structure and the environment and fire risk reduction to participate actively in the fire risk management process is also one factor that increases the fire risk of cultural heritage. Although it is thought that the most considerable responsibility belongs to the fire brigades, the process can be considered multi-actor and complex. It is vital to regularly hold informative meetings by ensuring coordination and cooperation among different actors such as the local government, public, and response teams. In the case of England, the property owner and central and local government are responsible for the fire safety of cultural heritage (Twilt and Lostetter, 2005, p. 35). However, there are uncertainties about the coordination of actors and actors' roles in the fire safety process. In Turkey, there is no legal statement about this. In both examples, it is seen that there are deficiencies in terms of the participatory process, including different stakeholders.

**Determining Principles to be Considered and Implemented in Building Repair Applications**

One of the fire causes in historic buildings is the procedures applied during the building repairs. To reduce this risk, a policy of avoiding heat treatments should apply, unless it is necessary in the England example. Suppose it is compulsory to use, as in the England example. In that case, a "Work Permit" must be obtained, and this permit should include the location and content of the work requiring the intended heat, the proposed time and duration of the work, the time limits for which the permit is valid, and the person directly controlling the work [URL 26]. In addition, the necessary licenses for heat treatments during the restoration should be clearly stated in the contracts, and whether they are paid attention to should be checked by experts. In the case of Turkey, there is no regulation on this issue.

**c. Increasing and Developing Technical Capacity dealing with Fire Safety of Cultural Heritage**

Due to not being constructed according to current motorized traffic tools with narrow and dead-end streets, the cultural heritage sites' authentic and traditional urban pattern is unsuitable for the existing fire intervention tools. Therefore, it is necessary to provide vehicles compatible with the historic environment. The difficulty is that the technical personnel responding to the fire have insufficient capacity and equipment. Since historical settings with various values differ from the existing city, it is required to focus on training and awareness on fire intervention for different actors enrolled in fire safety of cultural heritage.

**d.Establishing National Database on Past Fires Encountered by Cultural Heritage**

Preparing a national database of past fire incidents in historic buildings and environments facilitates fire risk assessment. Huang et al. (2009, p.75) emphasized that the basic features of historic buildings and material information can contribute to fire risk assessments.

In the case of Turkey, there is no attempt at the database of past fires encountered by historic buildings and environments. Therefore, there is a need for a national database that has been prepared and updated regularly with the support of the AFAD Presidency, Provincial AFAD Directorate, Fire Brigade, The Ministry of Culture and Tourism, Regional Conservation Councils, and KUDEB.

Although there is no national database of past fire incidents faced by cultural heritage in England, there are statistics prepared by a private consulting firm. This database provides essential information about fire incidents' reasons and possible precautions.

## 2.5. Fire Safety Policies for UNESCO World Heritage Properties

The concept of World Heritage was described in the 1972 Convention concerning the Protection of the World Cultural and Natural Heritage (UNESCO, 1972). Accordingly, those heritage has values for all humanity, which means its conservation and management are more than national significance (UNESCO, 2013). Many regulations, manuals, and charters on conserving World Heritage properties have been published since 1972. The Committee develops operational guidelines to preserve the outstanding universal value of world heritage. These guidelines include practical advice to apply and implement principles identified in Convention (UNESCO, 2013). On the other hand, those documents have no policies about fire risk management for the conservation of cultural heritage.

The advisory bodies to the World Heritage Committee are ICCROM, ICOMOS, and IUCN. Partners in the conservation and development of cultural heritage are local communities, governmental, non-governmental, and private organizations and owners (WHC, 2012). Including multi-actors in preserving the cultural heritage brings different roles and responsibilities to each actor.

In the 2012 Operational Guidelines, it was stated that each property should have an appropriate management plan or other management systems (WHC, 2012). In this guideline, for the management plan and process of World Heritage properties, a management system for the responsibility of State parties should include (WHC, 2012, Article 111):

- a thorough shared understanding of the property by all stakeholders;
- a cycle of planning, implementation, monitoring, evaluation, and feedback;
- the monitoring and assessment of the impacts of trends, changes, and proposed interventions;
- the involvement of partners and stakeholders;
- the allocation of necessary resources;
- capacity-building; and
- an accountable, transparent description of how the management system functions.

As stated in UNESCO, ICCROM, ICOMOS, and IUCN (2010), one of the difficulties of an effective DRM is the lack of coordination between site management and organizational systems. Therefore, it was also claimed that the DRM process should be integrated into the site management of heritage places. However, some World Heritage properties do not even have site management plans. The absence of site management plans can also be evaluated as a potential risk to heritage properties.

In preparing DRM for heritage places, many actors can be related to the conservation of cultural heritage and disaster risk management. According to UNESCO, ICCROM, ICOMOS, and IUCN (2010, p.20), site managers, local actors, including municipalities, community leaders, scientists, disaster management agencies, police, health services, and emergency response teams. In the case of fire risk management, integrating fire brigades into DRM becomes a significant issue.

## 2.6.Concluding Remarks

There are different national and international policies for cultural heritage fire risk management. However, comprehensive regulatory documents are limited at the national and international levels.

Fire risk may become even more complex for the cultural heritage in urban areas. Different land uses, accessibility problems, and technical capacity inadequacies in urban areas can also increase fire risk. Legal and administrative regulations are needed to support integrated policies that reduce such risks to cultural heritage in urban areas. Accordingly, legal and administrative documents supporting integrated policies become essential to reduce the fire risk of cultural heritage.

As seen in this chapter of the study, fire has been an important issue discussed in the example of England and Turkey throughout history. However, historic buildings and environments in these two countries still face a severe fire risk, as was discussed, and are damaged or destroyed to a great extent. This situation shows that those two countries' current policies and practices are insufficient. As was discussed, both cases lack explanatory and legally binding regulations on managing fire risk for cultural heritage.

When the example of England is examined, it is noteworthy that there are various regulations especially prepared by Historic England against the fire risk faced by historic buildings and environments. Still, these regulations are handled independently of the planning and are not legally binding. Although the existence of such regulatory documents is critical, not being binding may leave the fire risk management of cultural heritage to the initiative of the users. On the other hand, it can be said that what kind of measures to be taken for fire safety of the cultural heritage on an urban scale is insufficient. Regulatory documents generally remain limited to policies at a single structure.

On the other hand, in the case of Turkey, there is a need for legal and administrative regulations explaining the measures to be taken to manage the fire risk faced by the cultural heritage. Considering that the diversity of cultural heritage and the actions that can be taken may differ accordingly, the issue is only dealt with in the "Regulation on the Protection of Buildings from Fire," which shows that there are many steps to be taken for fire risk management of cultural heritage. The destruction of two or three traditional buildings every year in Safranbolu due to fire (Karabük Provincial AFAD Directorate, Personal Interview, 2019) shows an urgent need for policies and practices at the national level regarding the fire risk to cultural heritage. It is essential to adopt these policies to avoid losing historic buildings and environments due to fire, which can be prevented.

# CHAPTER 3

# A METHODOLOGY FOR ASSESSING FIRE VULNERABILITY OF HERITAGE PLACES AT AN URBAN SCALE

## 3.1.The Concept of Vulnerability

As a part of risk assessment, evaluating vulnerability and identifying vulnerability indicators is a significant and obligatory step that should be carried out. Vulnerability is *"the degree of loss sustained by an element from an earthquake of given intensity"* (Feilden, 1987). Stovel (1998) described the concept as *the ''estimation of the level of loss associated with particular hazards''.* In addition, it is explained as ''*the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard''* (UNISDR, 2009, p.30). However, this perspective is criticized since the vulnerability concept should not be limited to the degree of damage (Kappes et al., 2012). Bernardini (2017) defines vulnerability as the possibility of a given element suffering a certain damage level when a disastrous event occurs. Vulnerability is related to different characteristics of the architectural space, such as built elements and circulation spaces such as single buildings or urban spaces concerning disaster (Bernardini, 2017).

Vulnerability assessment requires multidisciplinary studies. According to Paupério, Romão, and Costa (2012), the vulnerability assessment process includes engineering areas, conservation areas, and urban areas. Meteorologists, climatologists, seismic engineers, hydrologists, public health experts, epidemiologists, and sociologists can enroll in the DRM process (UNESCO et al., 2010). Urban areas in this multidisciplinary approach include urban location, the risks of the surrounding area, accessibility, infrastructures, and urban plan (Figure 27). In this sense, covering those subjects in vulnerability assessment analysis is essential.

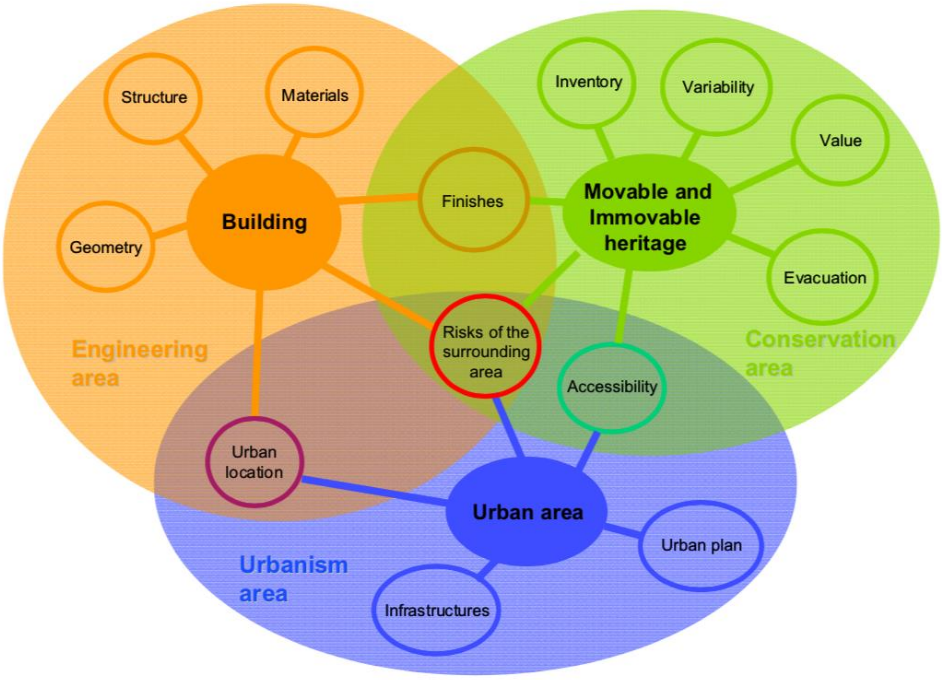


Figure 27 Multidisciplinary connections of vulnerability assessments (Paupério, Romão, and Costa, 2012)

The community's physical, economic, political, or social susceptibility to natural or human-induced hazards was also emphasized (UNESCO et al., 2010; Cardona, 2003). In this sense, the description of physical, economic, political, and social factors became an important issue. Vulnerability is related to different aspects of settlements. On the other hand, the challenges for vulnerability assessment on different scales were identified as gathering accurate, reliable, and accessible data (Birkmann, 2013).

Over the past years, various studies defined vulnerability parameters of historic buildings to varying risks on different scales. Some of those researches are hazard-specific, and some deal with more than one threat. Accordingly, vulnerability indicators are identified for climate change (Perry, 2011), earthquakes (Ravankhah et al., 2017), landslides, and snow avalanches (Alcaraz Tarragüel et al., 2012). Kappes et al. (2012) proposed leading indicators for vulnerability analysis for avalanche, rockfall, flood, shallow landslides, debris flow, and flash floods. Carroll and Aarrevaara (2018) proposed a numeric scale for urgency to react to threats caused by climate change to distinctive building materials. Forino et al. (2016) emphasized a new risk assessment index for climate change-related risk to protect cultural heritage. Another research conducted by Delmonaco, Margottini, and Falconi (2009) includes vulnerability and exposure parameters for landslides for Machu Picchu. Each methodology and indicators used by those methodologies differ from each other. Even for the same disaster, vulnerability indicators may vary. At this point, identifying standard vulnerability parameters of heritage places for the same disasters is crucial.

### 3.2.Methods for Fire Vulnerability Assessment of Cultural Heritage

Fire vulnerability assessment is one step of fire risk assessment. For fire vulnerability assessment, there are different methods and indicators used in these methods. Each method has advantages and disadvantages. Different fire risk assessment methods, such as qualitative, semi-quantitative, and quantitative, are discussed in the literature. In addition, they were classified as regulations and checklists, ranking methods, and quantitative methods (Larrson, 2000, cited in Giusti, 2012). Simon Lee (2018) evaluated prescriptive, objective, and performance-based methods for the safety of heritage buildings. The FRAME [URL 32], one of the most known methods in the literature, was based on the fire probability, the severity of the consequences, and the exposure level. It was initially made for the property fire risk.

After analyzing the suitability of 16 methods, Paul (2007 cited in Huang et al. 2009) stated the most suitable methods for fire risk assessment for historic buildings as Event Tree Analyses, the Fire Risk Index Method, and the Fire Risk Method of Engineering. Paul (2007, cited in Huang et al., 2009) proposed a quantitative decision support process ‘’FIRETECH Decision Supporting Procedure’’ based on the Event Tree Analysis, Fire Risk Index Method, and Engineering Fire Risk Assessment Method.

Salazar et al. (2021) categorized fire risk assessment methods for heritage places as follows: methods for museums, methods for churches, methods for historic buildings, methods for historic city centers, and methods for existing and new buildings.

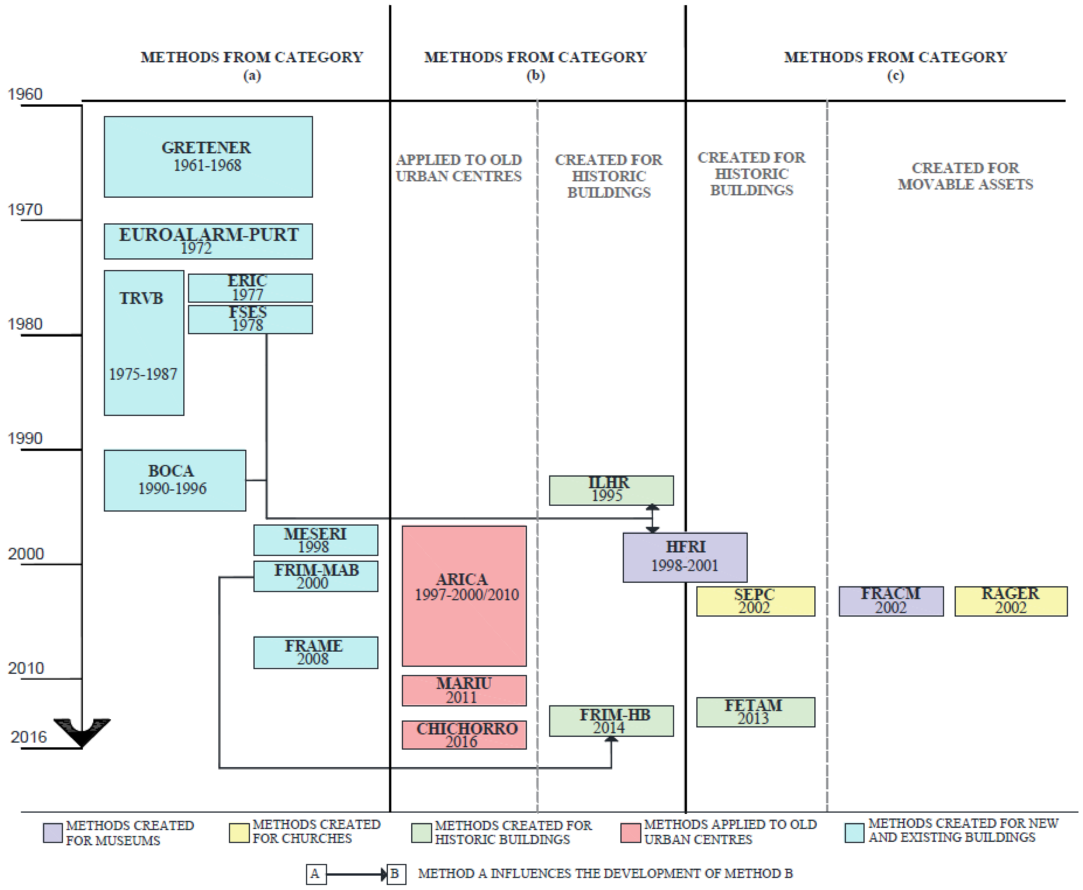


Figure 28 Different FVA methods (Salazar et al. 2021, p.6)

As seen in Figure 28, fire risk assessment methods arose in the 1960s with the GRETENER method, developed for new and existing buildings. Most methods are based on quantitative calculations via formulas. In quantitative methods, attributes are numerically weighted. Information for qualitative evaluation of fire risk for building major parts is based on different aspects, including ignition sources, flammable materials, building construction, means of escape facilities, active fire protection systems, and fire prevention measures (Ramachandran, 1999, p. 365).

### 3.2.1. Fire Vulnerability Assessment on a Building Scale

Fire risk management was discussed in the 1960s for existing buildings. The GRETENER Method (Kaiser, 1969) can be evaluated as early fire risk assessment methodologies developed for new existing buildings. Many studies consider fire risk for cultural heritage on a building scale (Watt and Kaplan, 2001; İbrahim et al., 2011; Beilicke, 1991), wooden Churches in Sweden (Arvidson, 2006; Arvidson, 2008).

In the 1990s, some existing methods were applied to historic buildings or environments. For example, ARICA (Ferreira et al. 2016) was used for historic environments. The FRAME (FRAME, 2008), the FRIM (Larrson, 2000), the Fire Risk Index Method (Granda and Ferreira, 2019a, 2019b), and The CHICHORRO Method (Goncalves and Correia, 2016) are used for historic buildings and environments. As discussed in 3.2.2. Fire Vulnerability Assessment on an Urban Scale section, some are applied on larger scales (Granda and Ferreira, 2019a, 2019b; Goncalves and Correia, 2016).

Algorithmic Models are also used in fire risk assessment (CFPA EUROPE, 2010; West Yorkshire Fire and Rescue Service, 2011). These models are developed for existing buildings. However, due to their simple application and cost-effectiveness, they can also be used for historic buildings and the environment.

Indexing methods include analyzing and scoring threats to assess fire risk simply and rapidly (Šakėnaitė and Vaidogas, 2010). Various fire risk indexing methods exist, such as The Gretener Method (Kaiser, 1979) and FRIM-MAB Method (Hultquist and Karlsson, 2000). In addition, some were used for assessing fire risk in historic buildings, such as FRIM-HB (Arborea, Mossa, and Cucurachi, 2014) and Risk Index for historic buildings (Watts and Kaplan, 2001). Some methods used for building scale cultural heritage fire risk assessment can be seen in Table 12.

Table 12 Some Methods for Fire Vulnerability Assessment of Cultural Heritage on a Building Scale

| Scale | Authors | Article Title | Method Used | Risk Formula | Main Notes |
|---|---|---|---|---|---|
| BUILDING | Arborea, Mossa and Cucurachi (2014 | Preventive Fire Risk Assessment of Italian Architecture Heritage: An Index-Based Approach | -The Fire Risk Index Method for Historic Buildings (FRIM-HB) Derived From FRIM-MAB[28]<br>-Using Delphi Panel of Experts | [25] $RI = 5.00 - S = 5.00 - \sum_i w_i x_i$ | It Shows Whether Buildings Are Safer Than Other Buildings Or Not. |
| | Kaiser (1979) | Experiences of The Gretener Method | Gretener Method | B = P/ (N x S x F) [26] | Grading Elements of A Building and Their Performance |
| | İbrahim et al. (2011a) | The Development of Fire Risk Assessment Method for Heritage Building | -Analytical Hierarchy Method<br>-ExperChoice2000 software | | Analyzing Structured Interviews and Opinion Surveys of Expert Panels Analyzed Using Ahp with The Help of Expetchoice 2000 |
| | Watts and Kaplan (2001) | Fire Risk Index for Historic Buildings | -Using professional judgment and past experience<br>-Attributes for fire prevention, building significance, fire Growth Rate, Emergency Response<br>-Combining Boca And Fses Parameters | $E(x_1, \ldots, x_i, \ldots, x_n) = \sum_{i=1}^{n} w_i R_i(x_i)$ [27] | Linear Additive Model of Multiple Attribute Evaluation to Produce A Measure of Relative Fire Risk |

[25] where S =the safety score of the building, x= the grade for parameter (i), wi= the relative weight of factor i.

[26] Fire risk= Probability of fire occurrence X fire hazard, degree of danger or probability severity with: P = potential hazard which is a function of the building and its contents that influence fire ignition and spread of fire
N = "normal measures" like fire extinguishers, fire hydrants, trained personnel,
S = "active measures" like fire detection, alarm, type of fire brigade, sprinkler, smoke and heat vents,
F = "passive measures" like supporting structures, surrounding walls and ceilings,
sizes of fire compartments, P as "potential danger" is a function of the building and its contents that influence fire ignition and spread of fire and can be written as: P = q x c x f x k x i x e x g ( q = fire load, c = burning behavior, f = smoke production, k = content of corrosive agents in the smoke, Building: i = fire load in building construction, e = storey, basement, storage height, g = size of fire compartmentation, ratio between length and width)

[27] If there are *n* attributesfor a decision problem, *x*1,*x*2,*x*3…*xn*, then an evaluation function *E x*1,*x*2,*x*3…..*xn* needs to be determined over these measures in order to conduct a performance assessment. A linear measure of the overall outcome of a system is given by where the *wi* are weighting constants and the *Ri xi* are normalizing functions of the attributes' grades (Watt and Kaplan, 2001).

[28] Fire Risk Index Method for Multi-storey Apartment Buildings

### 3.2.1.1. Algorithmic Models for Assessing Fire Risk of Buildings

Algorithmic models are used to assess the fire risk of buildings. Those methods are based on questions about flammable materials, ignition sources, and active fire precautions systems. It is a qualitative method of assessing fire risk by checking the existence or absence of attributes.

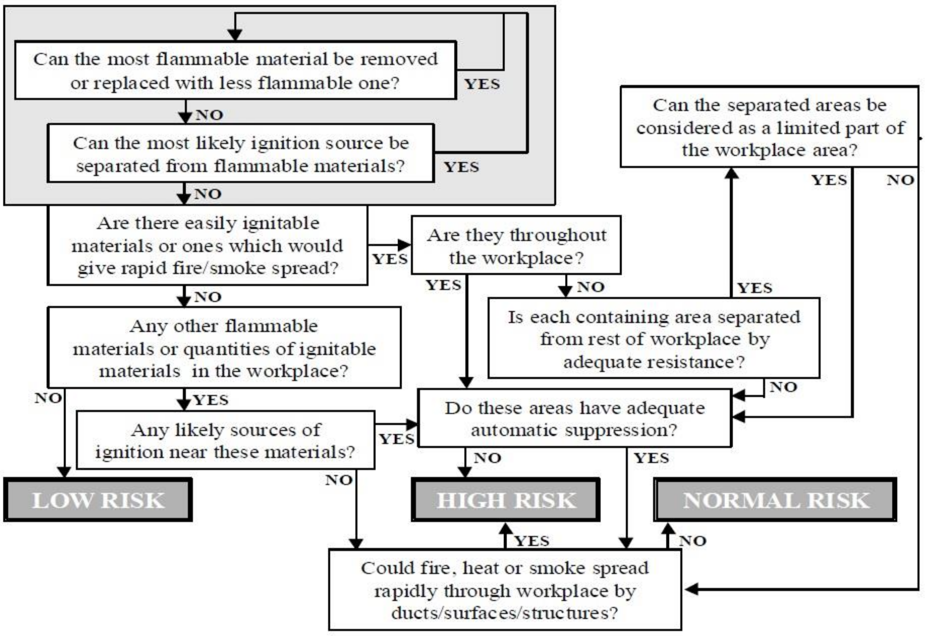


Figure 29 Risk categories (CFPA EUROPE, 2010, p.8)

An algorithm is defined by CFPA EUROPE, as can be seen in Figure 29. This algorithm was based on the use of flammable materials. The level fire risk categories could be obtained by answering different questions as yes or no, such as low risk, normal risk, and high risk.

An algorithmic model for fire risk assessment is also identified by West Yorkshire Fire and Rescue Service (2011) (Figure 30). This two-dimensional diagrammatic model represents the steps for making a decision, solving a problem, or carrying out a process (West Yorkshire Fire and Rescue Service, 2011). Similar to the CFPA EUROPE model, this model is also based on flammable materials, ignition sources, and fire combat within the building.

| A Fire Risk Assessment Algorithm | | | |
|---|---|---|---|
| 1 | Can most flammable materials be removed? | Yes - Remove flammables | No - Go to 2 |
| 2 | Can the most likely ignition source be separated from the flammable materials? | Yes - Separate and go back to 1 | No - Go to 3 |
| 3 | Are there easily ignited materials or ones which would give rapid fire/smoke spread? | Yes - Go to 4 | No - Go to 9 |
| 4 | Are they throughout the workplace? | Yes - Go to 7 | No - Go to 5 |
| 5 | Is each containing area separated from the rest of workplace by 1 hour resistance? | Yes - go to 6 | No - Go to 7 |
| 6 | Do the separated areas exceed 10% of the workplace area? | Yes - Go to 7 | No - Go to 8 |
| 7 | Do these areas have automatic suppression? | Yes - Go to 8 | No - Go to 9 |
| 8 | Will fire, heat and smoke spread rapidly through workplace by ducts/surfaces/ structures? | Yes - Go to 11 | No - Go to 12 |
| 9 | Any other flammable materials in the workplace? | Yes - Go to 10 | No - Go to 13 |
| 10 | Any likely sources of ignition near these materials? | Yes - Go to 11 | No - Go to 8 |
| 11 | HIGH RISK | | |
| 12 | NORMAL RISK | | |
| 13 | LOW RISK | | |

Figure 30 Fire Risk Assessment Algorithm (West Yorkshire Fire and Rescue Service, 2011)

When considering the comprehensive process of fire risk assessment with different actors such as fire brigades, municipalities, and residents, the existence of such models easily understood becomes a significant issue. The logic of these algorithms could be adapted to the buildings in historic environments by considering essential parameters related to building and urban characteristics and infrastructure. Easy application of those models by different users could facilitate historic buildings and environment fire risk assessment.

The method of the algorithm is based on the identification of flammable materials, sources of fire ignition, and the existence of fire suppression systems within the buildings. In this method, the logic depends on the presence of fire ignition sources, combustible materials, and fire combat within the building. The questions were designed to learn whether to remove flammable materials or not. Questions were repeated until no more flammable materials could be removed (West York Shire Fire and Rescue Service, 2011, p.8). However, indicators in the neighborhood scale are not assessed in this method. For example, accessibility to buildings, distance to a fire station, and emergency staff's technical capacity are not considered.

#### 3.2.1.2.Fire Risk Indexing Methods (Indicator-based Methods)

The indexing assessment approach provides design tools to facilitate different users for minimum regulatory requirements (Koutsomarkos, Rush, Jomaas, and Law, 2019). Indexing methods are alternative to existing expensive, and human resources needed fire risk assessment methods, and they allow simple ranking of fire threat. They evaluated cost-effective FRA prioritization and screening tools (Šakėnaitė and Vaidogas, 2010). These methods are assessed as heuristic models of fire safety (Koutsomarkos, Rush, Jomaas, and Law, 2021; Šakėnaitė and Vaidogas, 2010). Heuristic models focus on fire safety measures (Koutsomarkos, Rush, Jomaas, and Law, 2021).

The Gretener Method is an indexing method that uses complex variables related to building characteristics (Kaiser, 1979). It was evaluated as the first rating scheme for fire risk. This method considers the ratio of potential fire hazard and protection measures to decide fire severity (Koutsomarkos, Rush, Jomaas, and Law, 2019). Fire Risk Index for historic buildings is discussed by Watts and Kaplan (2001). Each parameter has weight and grade in FRIM-MAB Method (Fire Risk Index Method for Multi-Storey Apartment) (Hultquist and Karlsson, 2000). The sum of these weighted grades results in a single index value for a building. This method was adapted to historic buildings such as FRIM-HB (Arborea, Mossa, and Cucurachi, 2014).

Another study by Watt and Kaplan (2001) focused on the fire risk index for historic buildings. This study combined FSES (The Fire Safety Evaluation System) and BOCA evaluation systems to create a new fire risk index. This fire risk indexing method for historic buildings depends on a linear additive model of multiple attribute evaluation to measure relative fire risk. This study is based on a formula. The parameters can be seen in Table 13.

Table 13 Indicators for fire vulnerability assessment (Watt and Kaplan, 2001)

| **Indicators for FVA (Watt & Kaplan, 2001)** (combined BOCA and FSES parameters) |
|---|
| Vertical openings |
| Building height/construction |
| Sprinklers/Automatic Sprinklers |
| Building Area |
| Maximum Travel Distance/Exit Access |
| Corridor Walls/Corridor/Room Separation |
| Fire Alarm System/ Fire Alarm |
| Means of Egress/Exit System |
| Automatic Fire Detection/ Smoke Detection |
| Spec Occ Area Prot/Segregation of Hazards |
| Compartmentation |
| HVAC Systems |
| Smoke Control/Smoke Control |
| Dead Ends/Exit Access |
| Interior Finish |
| Mixed-Use Groups |
| Occupant Emergency Program |
| Unit Separations |
| Elevator control |
| Egress Emergency Lighting |

In addition, the Fire Risk Index Method for heritage on the site scale is elaborated (Neto and Fereira, 2020; Ferreira et al., 2016). These studies are mainly based on the ARICA method. ARICA is based on two main factors: the global risk factor and the global efficiency factor. Global risk factor includes sub-factors such as fire ignition, fire propagation, and evacuation; global efficiency factor includes sub-factors such as fire combat (Ferreira et al., 2016).

Vulnerability indicators reveal factors that reduce or increase fire threats (Salazar et al., 2021). Salazar et al. (2021) analyzed 19 semi-quantitative fire vulnerability assessment methods and indicators. Salazar et al.'s (2021) study categorized and combined indicators, reaching 22 fire vulnerability indicators (Table 14). Although those indicators are very detailed, assessing vulnerability regarding those indicators on an urban scale will be time-consuming and costly.

Table 14 22 FVIs identified by Salazar et al. (2021) (based on existing FVIs)

| **Fire Vulnerability Indicators (FVI)** |
|---|
| FVI-1 Fire Load Density |
| FVI-2 Fire Resistance |
| FVI-3 Finishes and Linings |
| FVI-4 Compartmentation |
| FVI-5 Adjacent Structures |
| FVI-6 Vertical Propagation |
| FVI-7 Conservation Status |
| FVI-8 Firebreaks/Buffer Zones (horizontal propagation) |
| FVI-9 Electrical Installations |
| FVI-10 Gas Installations |
| FVI-11 Heating, Ventilation, and Air Conditioning (Heating Equipment) |
| FVI-12 CCTV Systems |
| FVI-13 Alarm and Detection System |
| FVI-14 Smoke Control System |
| FVI-15 Active Suppression System |
| FVI-16 Water Supply |
| FVI-17 Fire Rescue Services |
| FVI-18 Emergency Planning |
| FVI-19 Compartment Height Level |
| FVI-20 Evacuation and Egress Routes |
| FVI-21 Signage and Emergency Lights |
| FVI-22 Cultural Value: Movable and Immovable Assets |

The indicators related to the urban fabric are lacking in these assessments. As can be seen from the table, all the indicators are related to building characteristics. However, some indicators at the urban scale may also contribute to fire vulnerability assessment that provides easier and faster analysis.

### 3.1.1. Methods for Fire Vulnerability Assessment of Cultural Heritage on an Urban Scale

Even fires start on buildings or outside; they can easily sprawl to close surroundings due to their propagation quickly in case of combustible materials next to fire ignition sources. Therefore, fire risk management should also be considered on an urban scale; different studies focus on urban scale vulnerability assessment (Table 15).

Various elements of the urban environment can be assessed in fire risk management. Granda and Ferreira (2019a) emphasized that fire risk assessment is related to urban areas and their inner characteristics. Accordingly, buildings with risk, old electrical installations, structural safety, fire loads, insufficient fire detection, alert and alarm systems, and constrained or inaccessible evacuation routes are factors considered on an urban scale fire vulnerability assessment of cultural heritage (Granda and Ferreira, 2019a).

Ferreira et al. study's (2016) provided a platform for risk mitigation at an urban scale, allowing city councils or regional authorities to plan interventions based on a spatial view and emergency planning in case of an urban fire (Masoumi et al., 2019)

In Granda and Ferreira's study (2019b), neighborhoods were chosen as units of analysis, and representative buildings were selected from those neighborhoods. The Fire Risk Index is compared with neighborhoods' total population, disabled people, sociodemographic vulnerability values, and crisis management vulnerability indicators. Furthermore, schematic evaluation of the Historic Center of Quito in the different periods was represented related to urban development.

Goncalves and Correia (2016) showed the combination of measures reducing the fire hazard of a particular building. They produce a fire risk map and intervention plans for better response and mitigating effects of fires. Furthermore, they proposed specific criteria considered relevant for maintaining desirable environmental conditions for building evacuation.

Table 15 Different FRA and FVA Studies for Historic Buildings and Environments on an Urban Scale

| Scale | Authors | Article Title | Number of Buildings | Method Used | Risk Formula | Main Notes |
|---|---|---|---|---|---|---|
| **URBAN** | Granda and Ferreira (2019a) | Assessing Vulnerability and Fire Risk In Old Urban Areas: Application to the Historical | 436 Buildings | Index-based fire risk assessment based on ARICA | $R_I = \frac{(1.20 \times SF_I + 1.10 \times SF_P + SF_E + SF_C)/4.0}{FR_R}$ | -the inner characteristics of urban areas affect fire risk. Buildings with high-extreme risk derelict and obsolete electrical installations, structural safety issues, significant fire loads, lack of or inoperability of fire detection means, alert and alarm systems, constrained/inaccessible evacuation routes |
| | Ferreira et al. (2016) | Urban Fire Risk: Evaluation and Emergency Planning | 500+ Buildings | Based on ARICA | $= \frac{(1.20 \times SF_I + 1.10 \times SF_P + SF_E + SF_C)/4.0}{FR_R}$ | -providing a platform for risk mitigation at an urban scale, allowing city councils or regional authorities to plan interventions based on a spatial view and emergency planning in case of an urban fire (Masoumi et al., 2019) |
| | Granda and Ferreira (2019B) | Large-Scale Vulnerability and Fire Risk Assessment of the Historic Centre of Quito, Ecuador | 20 Buildings as a Sample for 14 Neighborhoods | Fire Risk Index Method | $R_I = \frac{(1.20 \times SF_I + 1.10 \times SF_P + SF_E + SF_C)/4.0}{FR_R}$ | -Neighborhoods were chosen as units of analysis, and representative buildings were selected from those neighborhoods.<br>-The fire Risk Index is compared with the total population of neighborhoods, disabled people, sociodemographic vulnerability values, crisis management vulnerability indicators<br>Schematic Evaluation of the Historic Center Of Quito In the different periods was represented related to urban development. |
| | Goncalves and Correia (2016) | A Risk Assessment of Urban Fire-Method for The Analyses and Management of Existing Buildings | 266 Buildings | The CHICHORRO Method | FR = PXG<br>FR = fire risk<br>P = probability of fire occurrence<br>G = Severity of Fire Consequences | -producing a risk map and intervention plans for better response and mitigating effects of fires<br>-proposing specific criteria considered relevant for the maintenance of desirable environmental conditions to evacuate the buildings<br>showing the combination of measures reducing the fire hazard of a particular building |

Granda and Ferreira (2019b, p.106) developed a GIS tool to combine spatial data, including building stock, use type, conservation state, exposure level, and fire risk. The fire risk index method consists of global factors, sub-factors, and partial factors. Accordingly, those factors are defined in Table 16 (Granda and Ferreira, 2019b).

Table 16 Sub-factors and Partial Factors (Granda and Ferreira, 2019b)

| Sub-factor | Partial Factor |
|---|---|
| Global risk factor (FGR) | |
| Fire ignition (SF1) | Building conservation state<br>Electric installations<br>Gas installations<br>Fire load nature |
| Fire propagation | The gap between aligned openings<br>Safety and security teams<br>Fire detection, alert, and alarm<br>Fire compartmentalization<br>Fire loads |
| Evacuation | Evacuation and escape routes<br>Building properties<br>Evacuation correction factor |
| Global efficiency factor | |
| Fire Combat | Building external fire combat factors<br>Building external fire combat factors<br>Security teams |

Furthermore, fire vulnerability indicators for Zeyrek UNESCO World Heritage site are defined by Gündoğdu (2014) as narrow streets, distance to fire stations, the width of streets going to fire stations, traffic density, the density of houses with timber-frame construction systems in the area, the lack of fire hydrants in the streets, risky urban functions and vulnerabilities derived from buildings.

Granda and Ferreira's research (2019b) calculates the fire risk index from the equation (Figure 31, Figure 32). $SF_I$ and $SF_P$ are subfactors. $SF_E$ shows the subfactor evacuation, SFC shows sub-factor fire combat, and $FR_R$ reveals a reference risk factor.

$$FR_I = \frac{(1.20 \times SF_I + 1.10 \times SF_P + SF_E + SF_C)/4.0}{FR_R}$$

Figure 31 Fire risk equation (Granda and Ferreira, 2019b)

Granda and Ferreira evaluate fire vulnerability using a formula based on the Portuguese Fire Regulation, Frame, and Frim Method.

| Sub-factors | | Partial factors |
|---|---|---|
| Global risk factor (FGR) | Fire ignition ($SF_I$) | Building conservation state ($PF_{A1}$)<br>Electric installations ($PF_{A2}$)<br>Gas installations ($PF_{A3}$)<br>Fire load nature ($PF_{A4}$) |
| | Fire propagation ($SF_P$) | Gap between aligned openings ($PF_{B1}$)<br>Safety and security teams ($PF_{B2}$)<br>Fire detection, alert and alarm ($PF_{B3}$)<br>Fire compartmentalization ($PF_{B4}$)<br>Fire loads ($PF_{B5}$) |
| | Evacuation ($SF_E$) | Evacuation and escape routes ($PF_{C1}$)<br>Building properties ($PF_{C2}$)<br>Evacuation correction factor ($PF_{C3}$) |
| Global efficiency factor (FGE) | Fire combat ($SF_C$) | Building external fire combat factors ($PF_{D1}$)<br>Building internal fire combat factors ($PF_{D2}$)<br>Security teams ($PF_{D3}$) |

Figure 32 Fire Risk Index method: Global factors, sub-factors, and partial factors (Granda and Ferreira, 2019b, p.2)

In Granda and Ferriara's (2019) study, the value of partial factors for escape and evacuation routes is defined in Figure 33. Widths of corridors/parts and openings lower than 0.90 m, number of existing lower than the minimum regulatory required, slope of vertical escape routes higher than $45^{0,}$ and nonexistence of light-signaling emergency systems when required are defined in partial factor of evacuation and escape routes.

| Conditions of the evacuation and escape routes | $PF_{C1}$ |
|---|---|
| Widths of corridors/paths and openings lower than 0.90 m | 0.25 |
| Number of exits lower than the minimum regulatory required | 0.25 |
| Slope of vertical escape routes higher than 45° | 0.25 |
| Nonexistence of light-signalling emergency systems when required | 0.25 |

Figure 33 Description of partial factor $PF_{C1}$: Evacuation and escape routes (Granda and Ferreira, 2019b, p.3)

Height, width, clear height, and slope are evaluated for accessibility and evacuation routes to get accessibility parameter values (Figure 34).

| Accessibility and evacuation route conditions | | | | |
|---|---|---|---|---|
| Height [m] | Width [m] | Clear height [m] | Slope [%] | Accessibility parameter value |
| ≤ 9.00 | ≥ 3.50 | ≥ 4.00 | ≤ 15.00 | 1.00 |
| | ≥ 3.50 | ≥ 4.00 | > 15.00 | 1.50 |
| > 9.00 | ≥ 6.00 | ≥ 5.00 | ≤ 10.00 | 1.00 |
| | ≥ 6.00 | ≥ 5.00 | > 10.00 | 1.50 |

Figure 34 Features and values for evaluating the accessibility parameter (Granda and Ferreira, 2019b, p.3)

| | Building use | |
|---|---|---|
| Reference risk factor | Residential | Service or industrial spaces, libraries and archives |
| $FR_R$ | $0.915 + 0.25 \times F_c$ * | $1.10 + 0.25 \times F_c$ * |

* $F_C$ is a correction factor that can assume the values of 1.10, 1.20 or 1.30, for buildings with up to 3, up to 7 or more than 7 floors, respectively.

Figure 35 Reference risk factor, $FR_R$, for different types of building use (Granda and Ferreira, 2019b, p.4)

In this method, they consider fire ignition, including building conservation state, electric installations, gas installations, and fire load nature, and it is the most weighted parameter with a 1,20 value. Fire propagation includes the gap between aligned openings, safety and security teams, fire detection, alert and alarm, fire compartmentalization, and fire loads. These parameters are weighted with 1,10 values. Evacuation and fire combat parameters do not take weight in the formula.

In addition, the reference risk factor is evaluated by building use (Figure 35). If use is service or industrial spaces, libraries, and archives, the reference risk factor increases by adding 1,10 values to the equation while adding 0,915 values for residential uses. On the other hand, the height of the floor also increases the reference risk factor. The number of floors was multiplied by 0,25 and added to 0,915 or 1,10.

Fire risk index results were combined with sociodemographic data, including the total population of the neighborhood disabled population in Granda and Ferreira's research (2019b). In addition, building stock, accessibility, and crisis management were also evaluated as factors affecting vulnerability (Granda and Ferreira, 2019b). In addition, although adjacent plots are not considered, it was stated that adjacent buildings with high-risk potential should also be assessed in fire vulnerability assessment (Ferreira et al., 2014).

Another study by Uzer and Zeren Gülersoy (2011) assesses the fire risk of cultural heritage. Accordingly, fire risk in Büyükada was assessed with the AHP model by Uzer and Zeren Gülersoy (2011). The factors that increase the risk of fire spread are the slope, wind, climate, vegetation parameters, type, and condition of the burning material in residential areas, as emphasized below:

- *Buildings with explosive or flammable materials* are considered potential fire exit points from the land use analysis data. Areas closer to 30 meters are defined as high risk, between 30-100 meters as medium risk, and distances higher than 100 meters as low risk (Zeng et al., 2003; Vadrevu et al., 2009, cited in Uzer and Zeren Gülersoy, 2011, p. 21).
- In building style and *building condition analyses,* due to the potential of buildings with timber-frame construction systems in poor condition to become fire exit points and their effects on increasing the spread of fire, they were assessed as high-risk areas/parcels.
- *An increase in the slope* is a parameter that affects the speed and direction of the fire. The fire moves faster in the slope direction in areas with high slopes (Rothermel, 1983; Kushla and Ripple, 1997; Zeng et al., 2003, cited in Uzer and Zeren Gülersoy, 2011, p. 21). With every 10° increase in slope, the rate of fire doubles (Zeng et al., 2003, cited in Uzer and Zeren Gülersoy, 2011, p. 21).
- Vegetation type was also considered in Uzer and Zeren Gülersoy's research.

Some studies not developed for historic urban landscapes were analyzed regarding their application to settlement scale in this research. Accordingly, Masoumi, van Genderen, and Maleki (2019, p. 5) analyzed the fire risk regarding urban infrastructure and high-rise building characteristics. In this sense, necessary spatial data concerning urban infrastructures which affect the fire risk is defined as below:

- The position of CNG and gas stations
- The position of gas transmission pipes
- The position of gas substations
- The position of high voltage power transmission

- The position of electric power substations
- The position of flammable stores
- The position of industrial land-use
- Distance to the electric poles
- The position of firefighting stations
- The position of fire hydrants

In addition, attribute data of high-rise building characters in terms of fire is identified as (Masoumi, van Genderen, and Maleki, 2019) entry and exit access, fire alarm system, fire extinguishing system, technical specifications of the building, and social training and periodic visits.

Vulnerability factors are defined by Srivanit (2011, p.120) as building height, building density, population density, building hazard occupancy, and distance to the available fire source. Furthermore, the capacity of mitigation factors is identified by Srivanit (2011, p.120) as *accessibility by road, distance to fire stations, distance to hydrants, fire history,* and *distance to a water supply*. In addition to building characteristics, urban form, use, and user can also affect the vulnerability of heritage places to fires. Urban conditions and configuration features could be used in fire risk assessment (Srivanit, 2011, p.115). Srivanit (2011) stated that a lack of good urban planning, inefficient land use, and relevant property and safety regulations due to high population density cause an increase in the vulnerability to urban fires.

In Srivanit's (2011) research, risk factors were selected according to stakeholder analysis, including urban planners, fire wardens, residents, and local government officials. The analytical hierarchy process (AHP) was used to identify the score and weight of each factor. A weighted linear combination combines factors by applying a weight to each, followed by a summation of the results to yield a fire hazard assessment model (Srivanit, 2011). AHP and GIS were used to evaluate the fire risk of Chiang Mai Municipality.

In another study, factors of fire vulnerability are described as a type of construction, the number of storey, floor area ratio, fire sources in the building, fire sources around the building, and accessibility (Rahman, 2014). Fire vulnerability indicators included adjacent road width, building type, number of storeys, building floor area, plot area, current land use, adjacent land use, staircase width, and the existence of fire source in the building and front of the building (Rahman, 2014). Indicators of fire risk are emphasized in the literature in Alam, Chakraborty, Noyon, Hosen, and Haque's study (2019) (Table 17).

Table 17 Indicators for fire risk (Alam, Chakraborty, Noyon, Hosen, and Haque, 2019)

| Indicator | |
|---|---|
| Distance from fire station | Rahman et al., 2017; Alam and Haque,2018 |
| Space between adjacent building | Yan, Zhang and He,2014; Rahman et al.2017; Alam and Haque 2017 |
| Distance to fuel station | Chhetri and Kayastha, 2015; Rahman et al.2015) |
| Distance to Road | Rahman et al.2017; Yagoub and Jalil,2014 |
| Distance to hospital | Yagoub and Jalil,2014, Sen et al.2011 |
| Distance to high voltage electric pole | Rahman et al.2017, Rahman et al.2015 |
| Distance gas pipe line | Khatsü,2005 |
| Distance water body | Maniruzzaman and Haque,2007 |
| Building storey | Rahman et al.,2015 |

Rahman, Aktar, and Ashikuzzaman (2017) stated vulnerability factors fires as the distance from hazardous buildings, space between structures, distance from electric poles, and proximity to roads. In addition, they identified sub-criteria related to those factors and weighted both main criteria and sub-criteria.

Many factors related to urban scale issues affect the fire vulnerability of structures. Accordingly, the densification of buildings increases urban fire exposure (Mtani and Mbuya, 2018). Tomar et al. (2018) prepared a fire hazard zonation map regarding fire incidents, land use, number of deaths, and injuries.

Fire safety requires different planning scale policies and interventions. Developing road networks and separate lanes for fire responders, strengthening the electricity infrastructure, establishing sub-fire stations, fire brigade technological equipment and geospatial technologies, and arranging underground water tanks (Tomar et al. 2017, p.135-136) constitute the subjects of planning studies on different scales. Nişancı et al. (2012) emphasized the determination of the optimum route, accessibility analysis, emergency response management applications, and the existence of fire hydrants for the Trabzon city center.

*The position of industrial land-use/CNG and gas stations* is emphasized in FVA (Masoumi, van Genderen, and Maleki, 2019)**.** *Distance to electric power/The position* *of high voltage power transmission/The position of electric power substations* is emphasized by Masoumi, van Genderen, and Maleki (2019, p. 5). *Distance to gas pipe line* is paid attention by Khatsü, 2005 cited in Alam, Chakraborty, Noyon, Hosen, and Haque, 2019; Masoumi, van Genderen, and Maleki, 2019)**.**

*Distance to fire station* is considered in FRA (Srivanit, 2011; Masoumi, van Genderen, and Maleki, 2019; Durak, Erbil, and Akıncıtürk, 2011). *Past fire incidents* are taken into account in FRA (Tomar et al., 2018; Yagoub and Jalil, 2014; Tomar et al., 2017; Nişancı et al., 2012; Srivanit, 2011).

As seen in Table 18, many indicators are discussed in the literature for fire risk assessment. On the other hand, when considering the characteristics of urban cultural heritage, some of them are inapplicable for cultural heritage. The causes of fires in cultural heritage also show the most critical parameters for fire vulnerability of cultural heritage.

Table 18 Indicators/Parameters emphasized for FVA in the literature (prepared by the author)

| Vulnerability | Parameter | | Sub-parameters | Scientists emphasized that parameter |
|---|---|---|---|---|
| **Physical Vulnerability** | **Building Characteristics** | **Exterior** | Construction technique/*building material type* | (Gündoğdu, 2014) (Watt and Kaplan, 2001) (Rahman, 2014) (Salleh and Ahmad, 2009) (Kidd, 2010a) *(Srivanit, 2011)* |
| | | | Number of storey / Building height | (Srivanit, 2011) (Rahman, 2015) (Alam, Chakraborty, Noyon, Hosen, and Haque, 2019) (Salleh and Ahmad, 2009) |
| | | | Building conservation state/ Structural Condition | (Granda and Ferreira, 2019) (Goncalves and Correia, 2016) (Uzer and Zeren Gülersoy, 2011) (Salazar et al., 2021) |
| | | | Historical Significance | (İbrahim et al., 2011) |
| | | **Interior** | Not considered in this research | |
| | **Urban Environment** | **Landuse** | Hazardous uses | (Masoumi, van Genderen, and Maleki, 2019) (Uzer and Zeren-Gülersoy, 2011) (Gündoğdu, 2014) (FIRETECH, 2003:9) (Rahman et al., 2017) (Srivanit, 2011) |
| | | | Use | (Goncalves and Correia, 2016) (Salleh and Ahmad, 2009) (NFPA 914, 2019) |
| | | | The position of flammable stores<br>The position of industrial land-use<br>The position of CNG and gas stations | (Masoumi, van Genderen, and Maleki, 2019) |
| | | | Vacant Buildings | (Gündoğdu, 2014) (Santos et al. 2013) |
| | | | Distance to a fire station | (Srivanit, 2011) (Masoumi, van Genderen, and Maleki, 2019) (Durak, Erbil, and Akıncıtürk, 2011) |
| | | **Infrastructure** | Distance to electric power/pole<br>The position of high voltage power transmission<br>The position of electric power substations | (Masoumi, van Genderen, and Maleki, 2019, p. 5) |
| | | | Distance to fire hydrants | (Srivanit, 2011) (Masoumi, van Genderen, and Maleki, 2019) (Goncalves and Correia, 2016)[29] (Santos et al. 2013) (Nişancı et al. 2012)[30] |
| | | | Distance to gas pipeline | (Khatsü,2005 cited in Alam, Chakraborty, Noyon, Hosen, and Haque, 2019) (Masoumi, van Genderen, and Maleki, 2019) |
| | | | Access to streets/Distance to road | (Rahman et al., 2017; Yagoub and Jalil,2014) (Goncalves and Correia, 2016)[31] |
| | | | Site Accessibility | (İbrahim et al., 2011) (Salleh and Ahmad, 2009) (Srivanit, 2011) (Rahman, 2014) |
| | | | Street width | (Rahman et al., 2017) |
| | | | Space between adjacent buildings<br>Adjacent use<br>Adjacent Building | (Yan, Zhang and He,2014) (Rahman et al., 2017) (Alam and Haque 2017 cited in Alam, Chakraborty, Noyon, Hosen, and Haque, 2019) (Marrion, 2020)[32]<br>(Rahman, 2014)<br>(NFPA 914, 2019) (Salazar et al., 2021) |
| | **Past Fire Incidents** | | (Tomar et al, 2018) (Yagoub and Jalil, 2014) (Tomar et al., 2017) (Nişancı et al., 2012) (Srivanit, 2011) | |
| | **Distance to water supply** | | (Srivanit, 2011) | |
| **Social Vulnerability** | | | The level of preparedness of Fire Brigade | (Tomar et al., 2017) (Stovel, 1998: 47) (CFPA-E, 2013) |
| | | | The level of preparedness of users | (CFPA-E, 2013) |

[29] In this research, the exxistence hydrants are emphasized and there is no assessment related with distance to hydrants.
[30] In this research, the location of hydrants is presented and there is no assessment related to distance to hydrants.
[31] In this research, accessibility is evaluated according to accessibility of firefighters as PA: Possible Access, ALFV: Access to Light Firefighting Vehicles, NO: No Access possible.
[32] Adjacent Structures were assessed as a casue of fire.

### 3.2.Evaluation of Fire Vulnerability Assessment Methods and Indicators for Cultural Heritage on an Urban Scale and A Proposal for a New Method

In the case of having too many heritage buildings, simplified preliminary risk assessment methods to mitigate the risk and figure out heritage buildings that need further detailed analysis are crucial (Romão et al. 2016). Although Romão et al. (2016) tested the simplified method for seismic risk assessment, the need for simplified methods is also valid for FVA of CH. In addition, as Romão et al. (2016) emphasized, qualitative assessment methods using non-numerical estimation contribute to this process. Quantitative methods are evaluated as expensive and time-consuming (Giusti, 2012).

Kaplan (2003) evaluates qualitative methods for fire risk assessment of historic buildings. He claimed that those methods provide checklists that identify crucial fire safety issues, assess maintenance and management of types of equipment and systems, and many responsible actors for cultural heritage fire risk management can use them.

While most of those studies focus on fire risk assessment, the previously mentioned studies' characteristics vary in scale and methods used. While some of those studies focused on single buildings (Watt and Kaplan, 2001; İbrahim et al. 2011a; İbrahim et al. 2011b), some evaluated fire risk on an urban scale (Granda and Ferreira, 2019a; Granda and Ferreira, 2019b; Ferreira, 2016; Goncalves and Correia, 2016).

Most fire risk management methods focus on evaluating single buildings or new buildings. Therefore, they are unsuitable for applying to old masonry buildings or larger scales (Ferreira et al., 2016, p.740). The technical attributes of fire risk assessment, including nonlinear and multidimensional interaction, are complex. Therefore, existing fire risk assessments are limited (Julià and Ferreira, 2021). Torero (2019) stated that every building faces fire in its entire life. Its probability is higher than the other hazards (Torero, 2019). This situation shows that there is always a fire risk for a historic building.

Indicator-based fire risk assessment methods for existing structures are simple and reliable (Salazar et al., 2021). Indicator-based methods are semi-quantitative because numerical expressions do not show the real feature (Salazar, 2021). Although there are different indicator-based fire risk assessment methods (Arborea et al., 2014; Watts and Kaplan, 2001; Granda and Ferreira, 2019a; Granda and Ferreira, 2019b; Ferreira et al., 2016), they are complicated and not easy to apply cultural heritage on an urban scale.

Julià and Ferreira (2021) stated that risk and vulnerability assessment on an urban scale needs technical knowledge and human and financial sources. On the other hand, historic urban landscapes are more complicated due to characteristics of historic buildings concerning material complexity, construction technique, and difficulty in assessing heritage values. Due to high complexity and difficulty, simplified vulnerability assessment methods become more important to apply (Julià and Ferreira, 2021). In classical fire risk assessment methods, reliable and numerical procedures are needed to assess the probabilistic threat, vulnerability, and resilience. For cultural heritage, these are complex, and resources are required (Romão et al. 2016, p.697). In the case of fire vulnerability assessment for historic environments, there are many complex parameters, so more errors may occur in calculating fire risk (De Smet, 1999, cited in Santana et al., 2007).

Simplified FVA method that this study proposed enables the identification of Highly Vulnerable Areas on a neighborhood scale. The need for fire risk assessment methods that are applicable across many cultural heritage sites and do not need excessive human and financial support is achieved by simplified methods (Romão et al., 2016).

As Salazar et al. (2021) emphasized, buildings with high fire risk should be identified for the fire safety of historic urban landscapes. The methods were mainly developed to evaluate single buildings, and they are limited in terms of simplified fire vulnerability assessment on an urban scale. Due to time and cost obstacles, they have barriers to assessing fire risk on a larger scale.

Although Fire Risk Index Method (Granda and Ferreira, 2019a; Granda and Ferreira, 2019b) aims to assess fire risk and vulnerability on a larger scale, it has some challenges to be applied. Firstly, it needs many input data gathered from the sites.

Obtaining these data is time-consuming, and excessive human and financial resources are needed. Secondly, having too many indicators can cause errors in calculations. Therefore, simplified fire vulnerability assessment methods for larger scales that identify highly vulnerable areas with fewer indicators are needed on an urban scale. Simplified methods require fewer input data and calculations to assess risk (Cox et al., 2005). They can be evaluated as a more user-friendly approach.

#### 3.2.1. A Proposal for A Fire Vulnerability Assessment Method on an Urban Scale

This research method was mainly based on assessing four categories of indicator sets related to fire vulnerability. Those indicator sets cover the existence of ignition sources, the presence of combustible materials, fire combat within the building, and fire combat within the neighborhood. Those four categories of indicators include parameters related to building characteristics, urban environment, and social factors that have been discussed in the literature. Parameters/indicators used in this research for FVA of CH at a neighborhood scale can be seen in Table 19. This research assessed the existence or absence of each parameter. As was discussed, fire risk indexing methods need expert judgments regarding method design and the weight of parameters (Koutsomarkos, Rush, Jomaas, and Law, 2021). In this research, each parameter is evaluated equally in its category.

In this study, indicators are classified within building characteristics, urban environment, and social factors to assess the fire vulnerability of cultural heritage. *Building characteristics include* construction technique and material, structural condition, being in use or not (vacant), and maintenance work where heat or flammable materials are used. Furthermore, *the urban environment* has building use, including ignition sources or hazardous use, adjacent buildings, and plots. *Infrastructure* in the urban environment comprises accessibility to the building, distance to a fire station, and water supply. In this sense, the logic of the algorithmic and fire risk index method was used in this research. The hierarchy of questions was based on the fire risk assessment.

The logic of the Yıldırım Esen (2014) method was adapted to the Fire Vulnerability Assessment of Heritage Places in this research. Yıldırım Esen (2014) developed a simplified model for risk assessment of archeological sites at a territorial scale. She identified natural, institutional, and human-induced hazards to which archaeological sites in İzmir were exposed. She evaluated the vulnerabilities of those sites through physical, institutional, and social factors by the method that she developed and assessed risks accordingly. Her approach was based on four vulnerability categories: low, medium, high, and very high (Figure 36) (Yıldırım Esen, 2014).

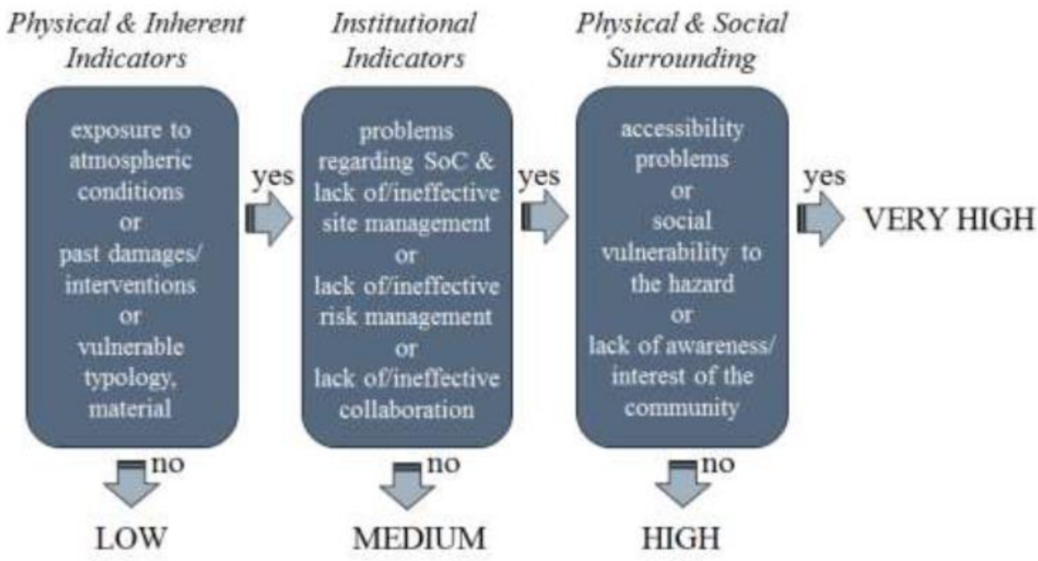


Figure 36 Natural Hazards Vulnerability Assessment method developed by Yıldırım Esen (2014, p.197)

The method of this study was based on five categories of vulnerability, including very low, low, medium, high, and very high (Figure 37). The categories were based on the literature review of indicators used for fire vulnerability assessment. Those indicators are gathered into four categories: the existence of ignition sources, the presence of combustible materials, fire combat within the building scale, and fire combat within the neighborhood scale.

The method is based on a qualitative approach since it aims to understand and describe the fire vulnerability of traditional buildings and environments. In addition, indicators are assessed in each category concerning meeting the criteria defined in the fire safety regulations. Assessment of some of the indicators is based on a qualitative approach. For example, expert judgment is required for elaborating the conditions of historic buildings.

This simplified vulnerability assessment method will be straightforward for heritage places exposed to fire risk on an urban scale. It classifies the fire vulnerability of cultural heritage following meeting criteria related to those indicators both inside and outside heritage buildings. This simplified FVA method contributes to identifying the most vulnerable traditional areas that need a further detailed and refined fire risk assessment. This method evaluates indicators related to the built environment and firefighting measures within the building and neighborhood scales in FVA.

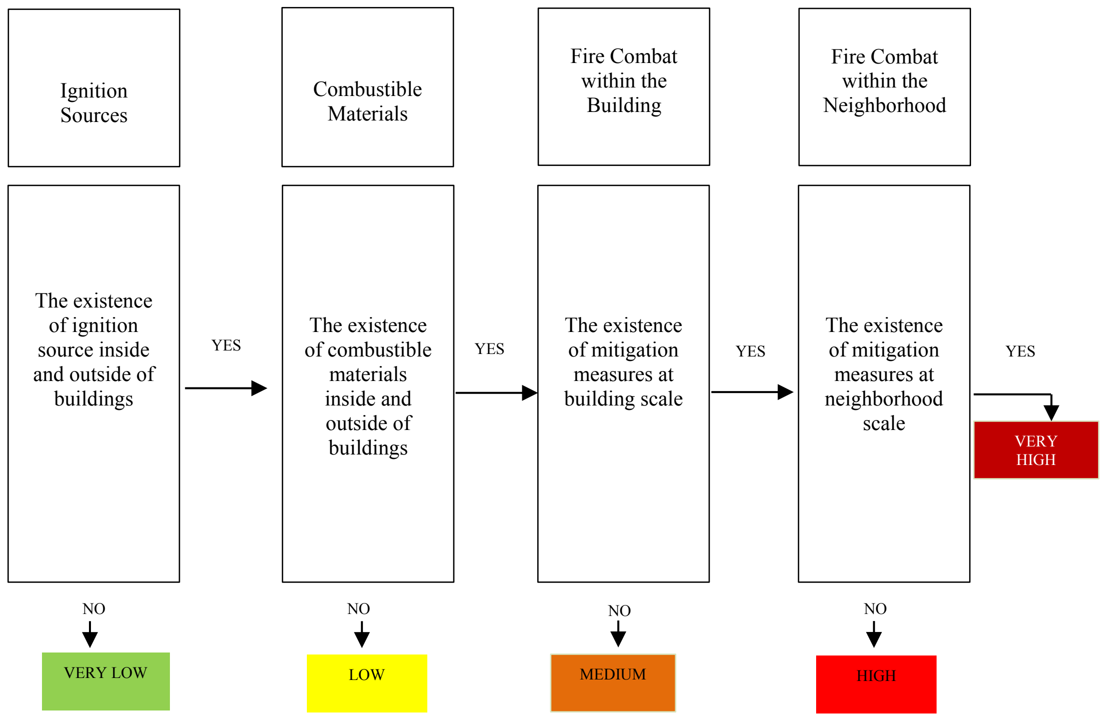


Figure 37 A Proposal for Fire Vulnerability Assessment Algorithm for Heritage Places (prepared by the author)

Table 19 Parameters evaluated and used in the thesis for larger-scale FVA of CH (prepared by the author)

| Parameter | Sub-parameter | Name of the Indicator | Explanation of the Indicator | Use of Ind. | Data |
|---|---|---|---|---|---|
| **Building Characteristics** | **Exterior** | **flammable materials (construction technique/** building materials) | This indicator reveals the materials used in properties. The existence of combustible materials in properties increases the vulnerability. This indicator is evaluated as the existence of flammable materials in buildings' construction systems. Building including timber reveals the presence of flammable materials. The causes of fires are related to building characteristics. For example, the fire reasons in Ancient Rome were construction materials (Canter, 1932). | Yes | Site Survey Conservation Plan |
| | | **conservation status/structural condition** | This indicator shows the current situation of the immovable cultural heritage. The condition of properties was based on good, average, poor, ruin, and restoration. The categories are defined according to survey results in the site survey. The existence of cracks and decays can result in exposing combustible materials (Salazar et al., 2021). | Yes | Site Survey |
| | | **vacant** | This indicator evaluates the vacant situation since vacant buildings are described as the most vulnerable (Gökcü, 2020). | Yes | Site Survey |
| | | **maintenance works** | This indicator evaluates any other maintenance/restoration that heat or flammable materials are used. | Yes | Site survey |
| | | **building height/ number of storey** | This indicator evaluates the height of the building. However, in this research, the building height is not considered since the height of buildings does not change significantly. Most buildings are 2 or 3 floors. At the center, there are also 1 storey buildings. However, buildings above the 14th floor are not accessible for fire brigade services (Srivanit, 2011, p.120). | No | - |
| **Urban Environment** | **Use** | **hazardous uses** | This indicator evaluates the existence of hazardous uses in buildings or plots next to the building. | Yes | Site Survey |
| | | **adjacent building/plot** | This indicator evaluates the existence of hazardous uses/being empty and the combustible materials in adjacent plots. | Yes | Site Survey |
| | **Infrastructure** | **accessibility to building** | This indicator addresses accessibility regarding street width. According to the Turkish Fire Regulation of Building, the street's width should be at least 4 m, and when a dead-end street exists, the width should be 8 m. The capability and effectiveness of firefighting depend on accessibility (Rahman, 2014). | Yes | Site Survey |
| | | **electric power/gas line** | This indicator assesses the distance to electric power. | No | - |
| | | **fire hydrant** | This indicator addresses the existence of fire hydrants as an exterior fire combat element. 50m distance to fire hydrant is taken into account. | Yes | Site Survey |
| | | **fire station** | It evaluates to distance to the fire station. | Yes | Site Survey |
| | | **natural water supply** | This indicator assesses the distance to the natural water supply for firefighting. | Yes | Site Survey |
| | | **fountain** | It accounts for the existence of a fountain near the building. | Yes | Site survey |

Table 19 continued

| Parameter | Sub-parameter | Name of the Indicator | Explanation of the Indicator | Use of Ind. | Data |
|---|---|---|---|---|---|
| **Social Infrastructure** | **Actors** | **The level of preparedness of the Fire Brigade** | This indicator evaluates the awareness of fire brigade staff on how to intervene in traditional buildings and environments fire. This indicator covers the technical capacity of the fire brigade as well. | No | No data collected |
| | | **The level of preparedness of users** | This indicator assesses the awareness of users of traditional buildings users about what to do during a fire. | No | No data collected |

Instead of weighing all indicators, in this study, four categories of indicators are prioritized by simply evaluating parameters respectively to evaluate the fire vulnerability of traditional buildings and the environment.

It is unclear who is responsible for output in most fire risk index methods (Koutsomarkos V., Rush, Jomaas, and Law, 2021). In this study, in the conclusion part, based on indicators evaluated, policies for different actors enrolled in the fire risk management process are assessed both for Turkey and the international context. Although policies can change from country to country context, policies of this study concerning a method developed can provide a general fire vulnerability assessment method and fire mitigation policies at different planning scales.

This method allows different actors involved in cultural heritage fire risk management to use this simplified method. Koutsomarkos, Rush, Jomaas, and Law (2021) stated that for unregulated users, the method should be kept simple since a simple index can allow users to understand the logic of the technique and its shortcomings.

The absence or existence of an indicator can increase or decrease the fire vulnerability of a traditional building. Accordingly, the method of this thesis is to emphasize significant fire vulnerability assessment indicators. Different users of this simplified method can know what to do to mitigate the fire risk of the traditional building by evaluating the absence or existence of indicators in each category.

#### 3.2.1.1.The Existence of Ignition Sources Inside and Outside of Traditional Buildings

When ignition sources interact with flammable materials, a fire can happen in historic buildings and environments. Ignition sources inside and outside traditional buildings category include hazardous uses and other sources that can ignite a fire (Figure 38).

*The existence of hazardous uses* inside and outside of traditional buildings can ignite a fire incident. *Hazardous uses* are discussed in many fire risk and vulnerability assessment studies (Masoumi, van Genderen, and Maleki, 2019; Uzer and Zeren Gülersoy, 2011; Gündoğdu, 2014; FIRETECH, 2003, p.9; Rahman et al., 2017; Srivanit, 2011). Namely, high dangerous places are described as where flammable and explosive substances and fuels are manufactured, stored, filling-unloading, and sales are carried out according to Turkish Fire Regulation, Building Use Categories.

In the ignition sources category, *building use* is also evaluated. It is one of the critical vulnerability indicators discussed by many scientists (Goncalves and Correia, 2016; Salleh and Ahmad, 2009; NFPA 914, 2019). Building use can show whether buildings have hazardous use or any ignition sources. In Turkish Fire Regulation, the use category of the buildings is defined as below:

a) Residential,
b) Accommodation buildings[33],
c) Institutional buildings[34],
ç) Office buildings[35],
d) Commercial buildings,
e) Industrial buildings,
f) Buildings for gathering purposes[36],
g) Buildings for storage purposes[37],

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[33] Accomadtion buildings are classified as hotels, motels, thermal facilities, resort, pension, camping, students' dorms, and camps (BYKHY, 2009).
[34] Institutional buildings include education, healthcare, and prison (BYKHY, 2009).
[35] Office buildings consist of Bank, exchange, public service buildings, general office buildings, doctor and dentist offices (BYKHY, 2009).
[36] Building for gathering puposes comprises catering facilities, entertain places, museum and exhibition places, places of worship, sport field, stations, and airport (BYKHY, 2009).
[37] Building for storage puposes include storages and parking areas (BYKHY, 2009).

ğ) High danger places[38],
h) Mixed-use buildings[39]
(BYKHY, 2009, p. 5250, Building Use Categories, Article 8)

As discussed before, traditional buildings were not constructed according to modern requirements. Furthermore, cultural heritage is subject to increasing tourism demand due to its various values. This demand brings the transformation of many traditional residential uses into new functions. However, Beilicke (1991, p.57) stated that potential fire risk increases when original and present use differs. Different *contributory events* such as weddings and Christmas organizations that may ignite a fire can be adapted. In this case, any negligence can result in destructive fires.

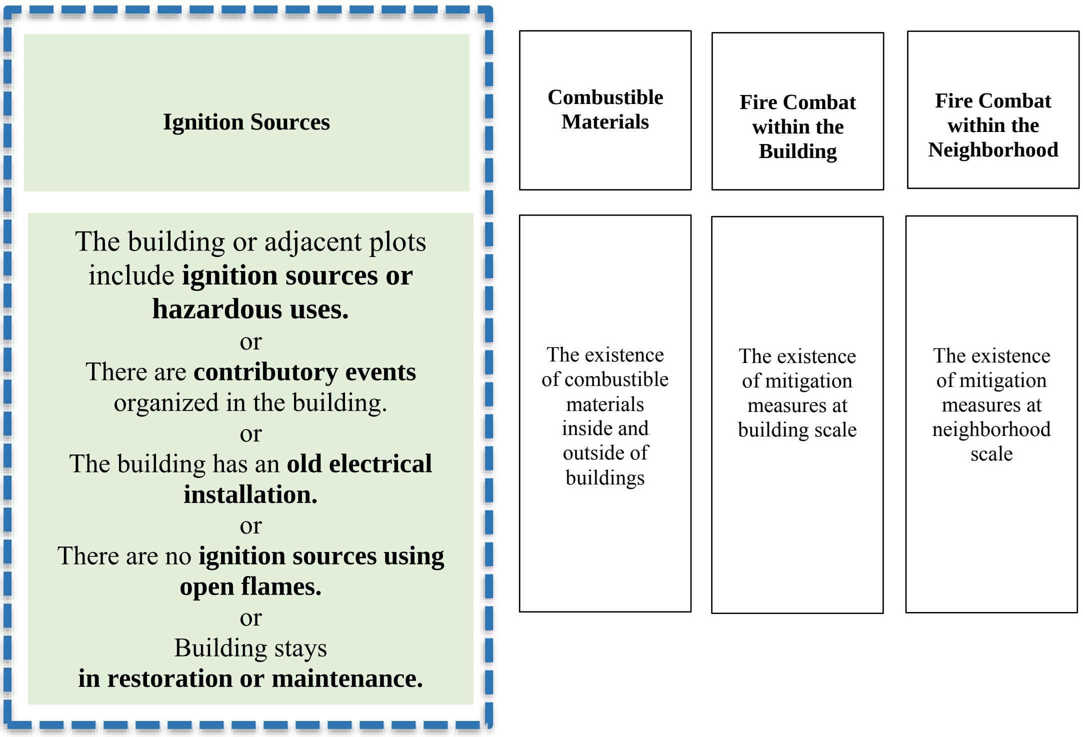


Figure 38 Indicators in the category of the existence of ignition sources (prepared by the author)

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[38] The places where flammable and explosive substances and fuels are manufactured, stored, filling-unloading and sales are carried out (BYKHY, 2009).
[39] If there are sections and these sections cannot be separated from each other by a fire compartment suitable for a higher hazard class, or if it is not possible to apply different protection measures due to being intertwined, the rules on classification requiring higher protection measures are used for the whole building (BYKHY, 2009).

*The electrical system* in traditional buildings can cause fires. *Electrical faults* are a significant fire threat (London Fire Brigade, 2015)**.** 60-70 % of ignition sources are electrical, arson, heating equipment, and open flames (Marrion, 2020). Fires with severe consequences have occurred in historical buildings due to outdated, faulty electrical installations and incorrect use of electrical appliances. The electrical installations have rusted, uninsulated pipes, damaged switch and distribution boxes, and other deficiencies resulting in fires in historic buildings (Alkış, 2013). In this case, electrical devices can start a fire in a traditional building. Kitchens, stoves or heating rooms, electric heaters, and chimneys where the necessary precautions cannot be taken are major sources of fire. Especially fires caused by obsolete electrical installations have a high rate. Electrical installations, roofs, walls and ceilings, installation shafts, and chimneys for lighting purposes are other fire causes (Alkış, 2013). For example, thirteen of 102 fires in Safranbolu happened due to electrical failure (FireSkill Project).

Accordingly, the electrical system in traditional buildings must comply with "Electric Heavy Load Installation Regulation (Elektrikli Ağır Yük Kurulumu Yönetmeliği), Indoor Electrical Installation Regulation (İç Mekan Elektrik Tesisatı Yönetmeliği ), Grounding Regulation in Electrical Installations (Elektrik Tesislerinde Topraklama Yönetmeliği). Local authorities should regularly check whether laws and regulations are followed or not.

In addition, *different types of ignition sources* such as open flames/ chimneys/smoking/candles/grills/grate/hearth can cause fires in traditional buildings. These ignition sources should also be evaluated as one of the origins of fire ignition in historic buildings and environments. Chimney fires are one of the most frequent fire reasons in traditional buildings. For example, 7 out of 102 fires occurred due to *chimneys* and eight due to wrong *stove* usage between 2013 and 2017 in Safranbolu (FireSkill Project Report).

*Restoration/maintenance that different flammable materials and heat appliances are used* is another factor that can ignite a fire in traditional buildings. Ignition sources and flammable materials used during those implementations can start a fire (Marrion, 2016, p. 747; Marrion, 2020; Kılıç, 2011, p.36; Alkış, 2013). During restoration implementations, fires, especially welding or soldering work, can quickly turn into large fires that result in extensive damage to traditional buildings. Objects furnished with combustible materials are hit by the dispersion of overflowing sparks or welding pieces. The fire can cover all combustible materials in a short time, often with strong smoke generation, causing extensive damage (Alkış, 2013).

Due to the touristic demand for many historic buildings and environments and their economic contribution to cities, there are always restoration projects on cultural heritage sites. As mentioned before, for example, it was considered that restoration and construction works were the cause of the Notre Dame Cathedral fire in 2019 (Ferreira, 2019). According to Fire Protection Association in Scotland, about 20 % of fires in listed heritage buildings occurred because of construction or maintenance works (Kidd 2010b, p.7).

##### 3.2.1.2. The Existence of Combustible Materials Inside and Outside of Traditional Buildings

Combustible materials inside and outside heritage buildings can affect the fire vulnerability of historic buildings and environments. Their existence in properties increases the vulnerability of buildings to fire incidents. Therefore, their presence is evaluated in fire vulnerability assessment. Accordingly, several indicators within and outside of heritage buildings are assessed in the scope of combustible materials in this study (Figure 39).

*The presence of flammable materials inside and outside of traditional buildings* also creates a fire risk. In this parameter, materials used in the construction system of traditional buildings were evaluated. In addition, the existence of flammable materials next to traditional buildings also create a fire risk for traditional building. Therefore, *flammable materials in adjacent plots* are also evaluated as fire vulnerability parameters. This indicator assesses whether or not flammable materials exist in buildings’ construction systems.

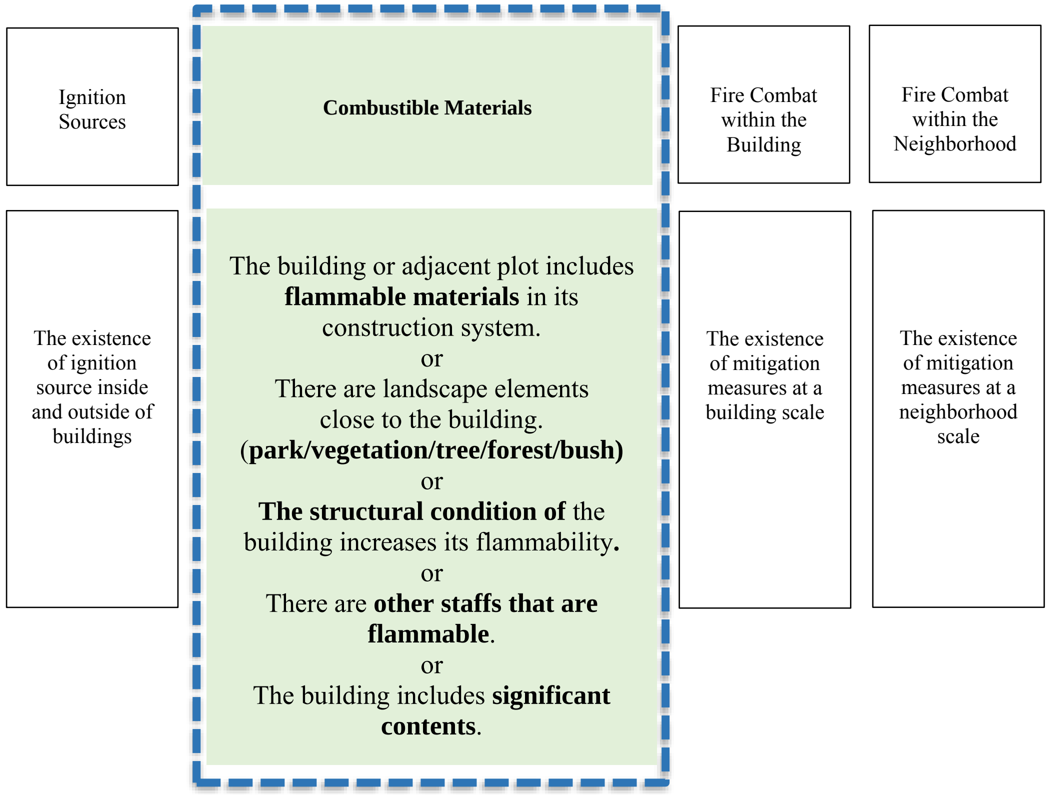


Figure 39 Indicators in the category of the existence of combustible materials (prepared by the author)

Accordingly, *construction systems* were assessed for traditional buildings and buildings next to traditional ones as a source of flammable materials. *The construction technique or building material* in fire risk assessment is emphasized by many scientists (Gündoğdu, 2014; Watt and Kaplan, 2001; Rahman, 2014; Salleh and Ahmad, 2009; Srivanit, 2011; Kidd, 2010a). In fire events, the materials used in the buildings can perform as fuel, and construction materials affect fire risk (Alkış, 2013). Buildings, including timber and other combustible material, reveal the existence of flammable materials. Since the ignition temperature of the wood is lower than other materials, the fire can grow more quickly in these types of buildings (FIRESKILL, 2017).

Parallel to construction systems, Kidd (2010a) stated that some structural elements of traditional buildings negatively affect fire risk. He describes those elements as timber floors and staircases, walls lined with plaster on timber laths, timber-framed internal load-bearing partitions, masonry walls with timber elements, interconnected flues and voids, combustible linings, large, interlinked roof voids, timber support structures, timber doors, old electrical system and unprotected iron and steel supporting structures (Kidd, 2010a). All of these interior elements also affect the fire risk of traditional buildings. On the other hand, in this research, the interior characteristics[40] of traditional buildings were not assessed.

In addition, *the state of conservation/structural condition* can be discussed as another indicator of vulnerability (Granda and Ferreira, 2019; Goncalves and Correia, 2016; Uzer and Zeren Gülersoy, 2011; Salazar et al., 2021). This indicator shows the current structural condition of the immovable cultural property. The existence of cracks and decays can result in exposing combustible materials (Salazar et al., 2021). In addition, with the increase in building age, if necessary maintenance works are not conducted, the materials of the building change. For example, drying and shrinkage of timber elements reduce the fire performance of heritage buildings (Kidd, 2010). The structural condition[41] of traditional buildings was evaluated regarding being good, average, poor, ruin, and restoration.

> **Buildings in Good Condition:** No structural problems are apparent in the facades of building[42].
>
> **Buildings in an Adequate Condition**: No structural problems, but minor problems apparent on the facade and some surface deterioration.
>
> **Buildings in Poor Condition:** Structural problems, material loss and decay to the facades.
>
> **Ruined Buildings:** Buildings that have suffered considerable destruction.
>
> **Buildings in Restoration/Maintenance Process:** Buildings that undergoing restoration.
>
> **Buildings in Construction Process:** Buildings that are undergoing construction with concrete systems.

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[40] At this point, it should be stated that interior characteristics of traditional buildings are also important factors contributing to increasing fire risk of traditional buildings. However, this research focused on urban scale fire vulnerability assessment. Therefore, gathering interior data for an urban site is time-consuming and financial supports are needed. In further researches, interior elements of traditional buildings should be taken into account.

[41] The category of condition of the building is based on (Uluç, 2022). The Repair, Maintenance, and Restoration of Traditional Housing and the Related Legal Framework: Antalya Kaleiçi, in Housing in Turkey: Policy, Planning, Practice, (Ed. Ö. Burcu Özdemir Sarı, Esma Aksoy Khurami and Nil Uzun).

[42] Structural problems refer to cracks and decay to columns and beams, and large-scale cracks and deteriorations to roofs

*The presence of park/vegetation/tree/rubbish inside and outside traditional buildings* is another indicator of fire vulnerability assessment. In addition, overgrown vegetation inside the plot of historic buildings can be assessed in this parameter. Dense vegetation can burn, especially in summer when the weather is warm. As was discussed during the site survey, dry grass in the Çeşme Neighborhood results in fires in Safranbolu (Personal Interview, 2020). Accordingly, between 2015 and 2020, 31 grass and 14 rubbish fires happened in Çarşı Region (Fire Brigade Archive). These are critical numbers when considering Safranbolu's dense traditional urban tissue.

#### 3.2.1.3.Fire Combat within the Building Scale

Fire combat within the building scale also affects the fire vulnerability of historic buildings and environments. Some factors and measurements affect fire combat within a building scale (Figure 40).

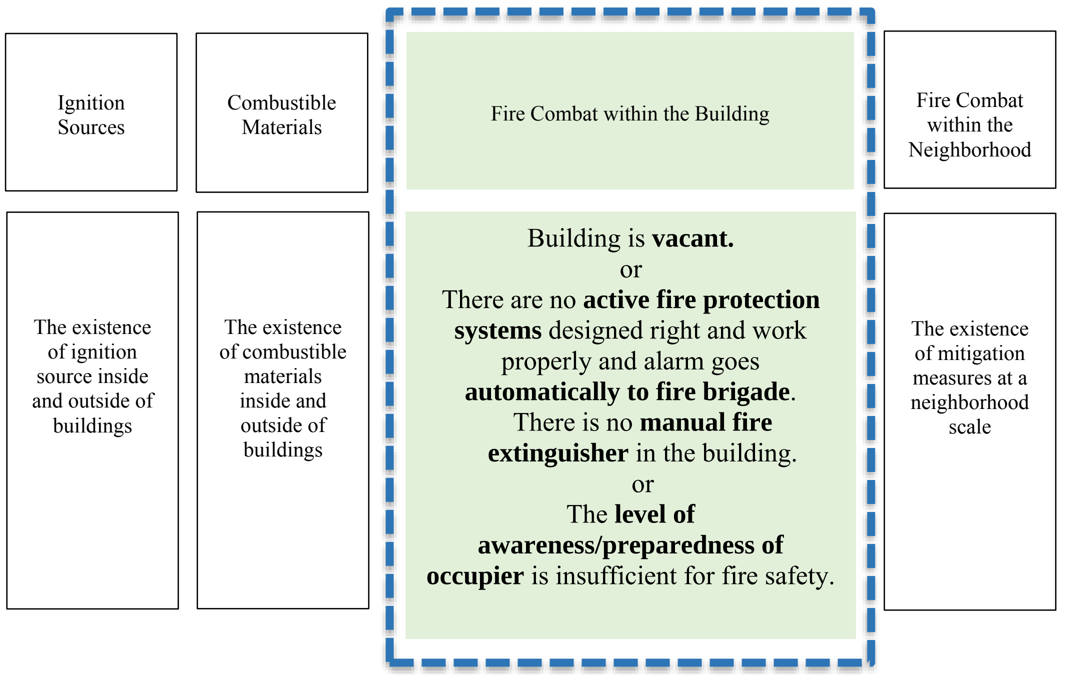


Figure 40 Indicators in the category of fire combat within the building scale (prepared by the author)

*The level of preparedness of different actors* involved in fire risk management of traditional buildings is another factor evaluated in fire combat within the building scale category. In this regard, *the awareness of users* becomes essential. CFPA-E (2013) states that good housekeeping and simple protection actions are the most cost-effective. Good housekeeping includes regular cleaning, proper storage, controlling electric installations and equipment, cutting grass around the building, and recording past incidents (CFPA-E, 2013, p.7).

*The level of preparedness* of different actors is another critical factor for the fire vulnerability of heritage places. For example, for firefighters, regular fire drills should be organized at different times, such as at night, on weekends, early in the morning, during rush hour, or during the existence of visitors (CFPA-E, 2013). The preparedness level of the users of traditional buildings affects fire vulnerability. Residents should know how to raise and react to building fire detection systems.

The lack of *appropriate active fire protection systems* such as fire alarm/detection systems and fire suppression systems and not realizing fires on time may cause the spread of fire. Therefore, appropriate initial emergency response can be evaluated as a mitigation measure within the building. Installing modern *fire detection and suppression systems* is one of the fire combat tools within the building scale. Many scholars emphasize its necessity (Kidd, 2010b; Akashah, Wan-Teh, and Baaki, 2016; Marrion, 2020). The application of fire suppression systems can reduce fire loss and have fewer impacts compared to conventional approaches (Kidd, 2010b). It is the first firefighting defense before fire brigade services intervene in fire events (Akashah, Wan-Teh, and Baaki, 2016). In addition, manual fire extinguishing systems are also used for fire combat within the building. They can also serve as preliminary fire extinguishing tools.

In BYKY (2009) for detection and alert systems, it was stated that:

> a) Except for residences, in all buildings between two and four floors with a floor area of more than 400 m2,
> b) Except for residences, in all buildings with more than four floors,
> c) In all high-rise buildings, including residences.

Different fire risk mitigation tools can be applied to traditional buildings[43]. However, considering the fire risk of cultural heritage with timber frame construction systems, detection and alarm systems should be applied to all traditional buildings. On the other, it should be kept in mind that various values of traditional buildings should be taken into account during implementation of those suppression systems.

If a building is unoccupied, it becomes vulnerable to damage and decay (Pickles, 2018)**.** *Being vacant* can also be evaluated as an indicator of fire vulnerability (Gündoğdu, 2014; Santos et al., 2013). It is impossible to follow precautions for fire combat within building and neighborhood scales when a building is empty. A fire in a vacant building is less likely to be detected in an early stage, so a greater risk of significant damage occurs (Pickles, 2018). Therefore, *the existence of vacant buildings* increases the fire vulnerability of historic buildings and environments.

#### 3.2.1.4. Fire Combat within the Neighborhood Scale

Fire combat within the neighborhood is another factor evaluated in the fire vulnerability of historic buildings and environments. Several aspects are assessed in fire combat within the neighborhood scale (Figure 41).

*Accessibility,* as an indicator of fire risk assessment, was emphasized by many scientists**.** Access to streets/distance to the road (Rahman et al., 2017; Yagoub and Jalil,2014; Goncalves and Correia, 2016), site accessibility (İbrahim et al., 2011; Salleh and Ahmad, 2009; Srivanit, 2011), street width (Rahman et al., 2017) were discussed. Accessible streets are required for effective rescue and firefighting (CFPA-E, 2013). Firefighters' access to buildings during a fire depends on different aspects of the *accessibility* concept. Namely, the width of streets and the slope of streets affect the accessibility of firefighters to buildings. Since traditional urban patterns are not

[43] For further information information see Appendix H. Fire Suppression Systems that can be used during Firefighting.

constructed according to motorized traffic needs, the fire brigade faces difficulties during an emergency. In addition, the topography of historic settlement located affect accessibility as well. For effective firefighting, accessibility should be planned before a fire incident occurs (Kincaid, 2019b). Planning of accessibility to historic environments should be considered on different planning scales of cities.

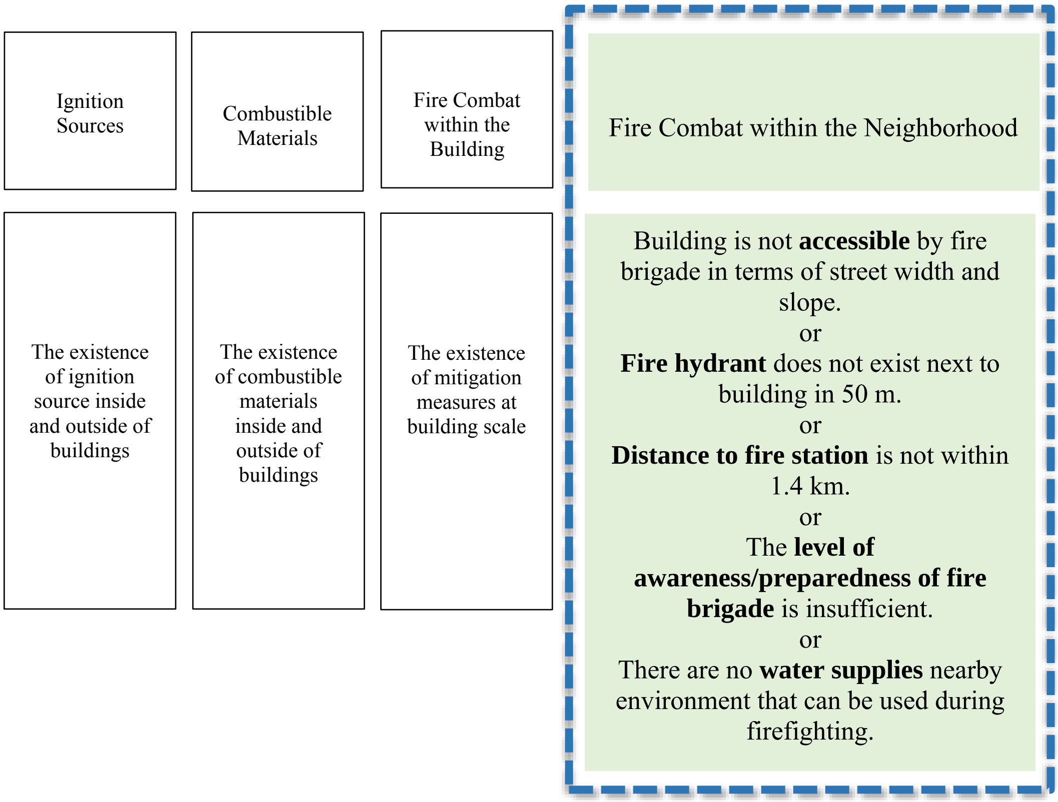


Figure 41 Indicators in the category of fire combat within the neighborhood scale (prepared by the author)

In addition, in the Fire Regulation of Turkey, for accessibility, it was emphasized that:

- The width of the streets should be enough for firefighters. It should be paid attention to parking on the streets.
- The horizontal distance from the last point that fire trucks can approach to any point on the exterior of the building can be at most 45 m.
- Inland transport roads provide access to any building from the main road. The usual width is at least 4 m on internal access roads and at least 8 m in case of dead-end streets. The inner radius in the bend is at least 11 m, the outer radius is at least 15 m, the slope is at most 6%, and the vertical curve is at least R = 100 m radius. The free height is at least 4 m, and the payload is at least 15 tons, considering the 10 tons rear axle load.
- If the angled distance required for access to the building from the internal access road is farther than the access possibilities of the fire trucks, the walls that may prevent the fire truck from approaching the building are made weakly. In that case, they can be easily demolished by the

fire truck. The wall section made poorly in this way is at least 8 m long; It is shown by placing a red cross mark that can be easily seen, and the vehicle cannot be parked in front of it.

(BYKHY, 2009, p. 5254, Article 22)

*Fire hydrants* are one of the critical intervention tools during fires. It was emphasized by many scholars (Srivanit, 2011; Masoumi, van Genderen, and Maleki, 2019; Goncalves and Correia, 2016; Santos et al., 2013; Nişancı et al., 2012). It is vital to place fire hydrants at regular intervals in these areas. According to the Fire Regulation of Buildings in Turkey (BYKHY), it was stated that:

- The hydrants are to be placed so the fire brigade and vehicles can easily approach and connect.
- The distance between hydrants is 50 m in high-risk areas, 100 m in risky areas, 125 m in medium-risk areas, and 150 m in low-risk areas.
- Under normal conditions, hydrants are placed at an average distance of 5 to 15 m from the protected buildings.

(BYKHY, 2009, Article 95, p. 5289)

Traditional environments have spatial characteristics of the urban tissue. They are shaped according to distinctive topographical features. Namely, buildings are very close to each other in some parts while in some they are distant. Accordingly, in this research, instead of taking a 15 m distance from protected buildings, the distance is defined as 50 m from a traditional building. Therefore, taking 15m In addition to fire hydrants, different fire risk mitigation tools can be applied on an urban scale[44].

*Distance to fire station* is emphasized by Srivanit, 2011; Masoumi, van Genderen, and Maleki, 2019; Durak, Erbil, and Akıncıtürk, 2011). This factor can affect the speed of fire combat of fire brigade services. Therefore, fire stations should be provided close to historic environments. In this sense, 1,4 km was taken as a standard for fire station distance in this research. As Srivanit (2011) stated, this standard was based on the

[44] For further information, see Appendix H. Different Fire Suppression Tools applied in Historic Environments

effectiveness of the firefighting service; NFPA, Jaimchaisri, 2006, fire station should be located within less than 1400 m for low fire risk.

The fire brigade can be critical in providing fire safety in historic buildings and environments. *The capability of fire brigade services* is also an essential factor for fire combat within a neighborhood. Firefighters should be invited during planning, supervision, and exercises (FIRESKILL, 2017). Parallel to this, *technical capacity* is also a significant indicator of fire vulnerability. Due to the spatial characteristics of historic environments, special fire trucks are needed. For example, in the case of Italy[45], demand for new fire trucks emerged in different aspects: narrow and congested streets, vehicles creating travel difficulties, short radius curves, difficulty in reaching residential blocks, steep hills, and insufficient and unavailable water sources (FIRESKILL, 2017). Since historic environments are not constructed according to the requirements of motorized traffic systems and tools, demand for new fire trucks suitable for historic environments is one of the critical factors in the fire vulnerability assessment of traditional buildings and environments. Accordingly, sufficient firefighting staff and necessary equipment are essential for fire combat.

*The existence of water supplies* that firefighting services use is another important factor (Kincaid, 2019b) that should be considered during fire combat within the neighborhood scale. If there is no sufficient water supply for firefighting services, alternative water supplies such as swimming pools, lakes, and underground cisterns should be provided (CFPA-E, 2013). In addition, as seen in the City of Safranbolu World Heritage Site, fountains can also be evaluated as a water source for fire combat within the neighborhood scale.

*The level of preparedness of different actors within the neighborhood scale* is another critical factor in fire combat within the neighborhood scale. Training for fire brigade

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[45] Accordingly, when designing new vehicles, the Italian Fire Department focused on technical features of new fire trucks that have mobility in historic cities. These features are classified as small size, high maneuverability, good power-to-weight ratio, high security, easy to use and low maintenance cost. (FIRESKILL, 2017)

staff is essential for a historic building (CFPA-E, 2013). Using too much water during fire extinguishing can negatively affect traditional buildings. In addition, it is also vital to act in the right way for the evacuation of artifacts in historic buildings.

### 3.2.2. Application of the Method

In the first category, indicators related to ignition sources inside and outside heritage buildings were assessed. If those indicators confirm the decline in FVA of a traditional building or all statements in this category are assessed as no, then the fire vulnerability assessment level was defined as *very low* because there are no ignition sources inside and outside of historic buildings (Table 20).

Table 20 Traditional Building in a Very Low Category (prepared by the author)

| **VERY LOW** |
| --- |
| The building or adjacent plot use includes *ignition sources (hazardous use/ contributory events).*<br>The building has a new *electrical* installation system.<br>There are no ignition sources using *open flames.*<br>The Building does not stay in *restoration or maintenance*. |

If one or more indicators in the first category increase the fire vulnerability of the traditional building or are elaborated as yes, then second category indicators related to combustible materials inside and outside the traditional building are assessed. If those indicators confirm the decline in fire vulnerability or the statements are answered as a no, the vulnerability category is decided *low* (Table 21). In this category of fire vulnerability, there are ignition sources; however, there are no combustible materials inside or outside the traditional building in terms of its construction system and nearby environment. Flammable materials in the construction system of traditional buildings and flammable materials close to traditional buildings, including flammable materials, are considered. If a building does not include flammable materials in its constructed system, it is assessed in the low category; other parameters are not assessed for this category of buildings.

| LOW |
|---|
| The building or adjacent plots do not include *flammable materials* in their construction system.<br>There is no *park/vegetation/tree/forest/bush/rubbish close to the building***.**<br>*The structural condition* of the building does not increase its flammability.<br>There are no other *staffs that are flammable.*<br>The building does not include *significant contents.*<br>**<u>However;</u>**<br>The building or adjacent building/plot use includes *ignition sources (hazardous use/ contributory events).*<br>or<br>The building has an old *electrical* installation system.<br>or<br>There are ignition sources using *open flames.*<br>or<br>The Building stays in *restoration or maintenance*. |

Table 21 Traditional Building in a Low-Level Fire Vulnerability Category (prepared by the author)

On the other hand, if one or more indicators in the combustible materials category increase traditional buildings' fire vulnerability, indicators related to fire combat within the building are evaluated. In other words, if one of the statements of parameters is evaluated as yes, then statements related to fire combat within the building are assessed. However, if all statements are evaluated as no, the vulnerability category becomes *medium* (Table 22). It means all statements contribute to a decrease in the fire vulnerability of the traditional building.

| MEDIUM |
| --- |
| The building is not *vacant.*<br>There are *active fire protection systems* designed right and work properly, and the alarm goes automatically to the fire brigade. /There are *manual suppression tools* in the building.<br>The *level of awareness/preparedness of the occupier* is sufficient for fire safety.<br>**<u>However;</u>**<br>The building or adjacent plots include *flammable materials* in their construction system.<br>or<br>There is *park/vegetation/tree/forest/bush/rubbish close to the building***.**<br>**or**<br>*The structural condition* of the building increases its flammability.<br>or<br>There are other *staffs that are flammable.*<br>*or*<br>The building includes *significant contents.*<br>or<br>The building or adjacent building/plot use includes *ignition sources (hazardous use/ contributory events).*<br>or<br>The building has an old *electrical* installation system.<br>or<br>There are ignition sources using *open flames.*<br>or<br>The building stays in *restoration or maintenance*. |

Table 22 Traditional Building in a Medium-Level Fire Vulnerability Category (prepared by the author)

If one of the indicators in the category of fire combat within the building scale increases fire vulnerability, indicators in the fourth category related to mitigation measures at the neighborhood scale are elaborated. If those indicators confirm the decrease in fire vulnerability of the traditional building, the fire vulnerability category is evaluated as *high* (Table 23). In this category, there are no problems related to mitigation measures at a neighborhood level; however, there are problems related to mitigation measures at a building level, and there are ignition sources and combustible materials in or outside the traditional building.

| **HIGH** |
|---|
| The building is *accessible* by the fire brigade in terms of street width and slope.<br>A *fire hydrant* exists next to the building within 50m.<br>*The distance to the fire station* is less than 1.4 km.<br>The *technical capacity of the fire department* is sufficient.<br>The *level of awareness/preparedness of the fire brigade* is sufficient.<br>There are *water supplies* nearby the environment.<br>**<u>However;</u>**<br>The building or adjacent plots include *flammable materials* in their construction system.<br>or<br>There is *park/vegetation/tree/forest/bush/rubbish close to the building***.**<br>or<br>*The structural condition* of the building increases its flammability.<br>or<br>There are other *staffs that are flammable.*<br>*or*<br>The building includes *significant contents.*<br>or<br>The building or adjacent building/plot use includes *ignition sources (hazardous use/ contributory events).*<br>or<br>The building has an old *electrical* installation system.<br>or<br>There are ignition sources using *open flames.*<br>or<br>The building stays in *restoration or maintenance*.<br>or<br>The building is *vacant.*<br>or<br>There are no *active fire protection systems* designed right and work properly, and the alarm goes automatically to the fire brigade. /There are no *manual suppression tools* in the building.<br>or<br>The *level of preparedness of the users* is insufficient for fire safety. |

Table 23 Traditional Building in a High-Level Fire Vulnerability Category (prepared by the author)

If one of the indicators in fire combat within the neighborhood category increases the fire vulnerability of the traditional building, the fire vulnerability category of the traditional building becomes *very high* because fire combat both at the building and neighborhood scale is limited. There are ignition sources and combustible materials inside or outside of the traditional building (Table 24). With the help of this new novel method, it is easy to identify Highly Vulnerable Areas, buildings, and the required interventions.

| VERY HIGH |
|---|
| The building or adjacent plots include *flammable materials* in their construction system.<br>or<br>There is *park/vegetation/tree/forest/bush/rubbish close to the building***.**<br>or<br>*The structural condition* of the building increases its flammability.<br>or<br>There are other *staffs that are flammable.*<br>*or*<br>The building includes *significant contents.*<br>or<br>The building or adjacent building/plot use includes *ignition sources (hazardous use/ contributory events).*<br>or<br>The building has an old *electrical* installation system.<br>or<br>There are ignition sources using *open flames.*<br>or<br>The building stays in *restoration or maintenance*.<br>or<br>The building is *vacant.*<br>or<br>There are no *active fire protection systems* designed right and work properly, and the alarm goes automatically to the fire brigade. /There are no *manual suppression tools* in the building.<br>or<br>The *level of awareness/preparedness of the occupier* is insufficient for fire safety.<br>or<br>The building is not *accessible* by the fire brigade in terms of street width and slope.<br>or<br>A *fire hydrant* does not exist next to the building within 50m.<br>or<br>*The distance to the fire station* is more than 1.4 km.<br>or<br>The *level of preparedness of the fire brigade* is insufficient.<br>or<br>There is no *water supplies* nearby environment. |

Table 24 Traditional Building in a Very High-Level Fire Vulnerability Category (prepared by the author)

### 3.1.Concluding Remarks

There are different methods used for fire risk assessment and fire vulnerability assessment of traditional buildings and environments in the literature. Some of the methods used for risk assessment, such as the ABC and impact assessment methods, are not suitable for fire vulnerability assessment of traditional buildings.

The existing methods used for fire vulnerability and risk assessment are limited in different aspects. Due to time and cost limitations, there is a need for simplified fire vulnerability assessment methods for heritage places on larger scales. With this point of view, this thesis proposed a simplified fire vulnerability assessment method for heritage places on larger scales. The simplified method proposed in this research can be used as a preliminary assessment tool for areas that need further investigations for fire risk management. This method is based on four categories of indicator sets: the existence of ignition sources, the presence of combustible materials, fire combat within the building scale, and fire combat within the neighborhood scale. In each category, different indicators are evaluated.

The first category is related to the existence of ignition sources. In this category, different indicators are included. Any uses include ignition sources in buildings or adjacent plots, the presence of old electrical installation systems, appliances that can start a fire, ignition sources using open flames, and buildings in the restoration process.

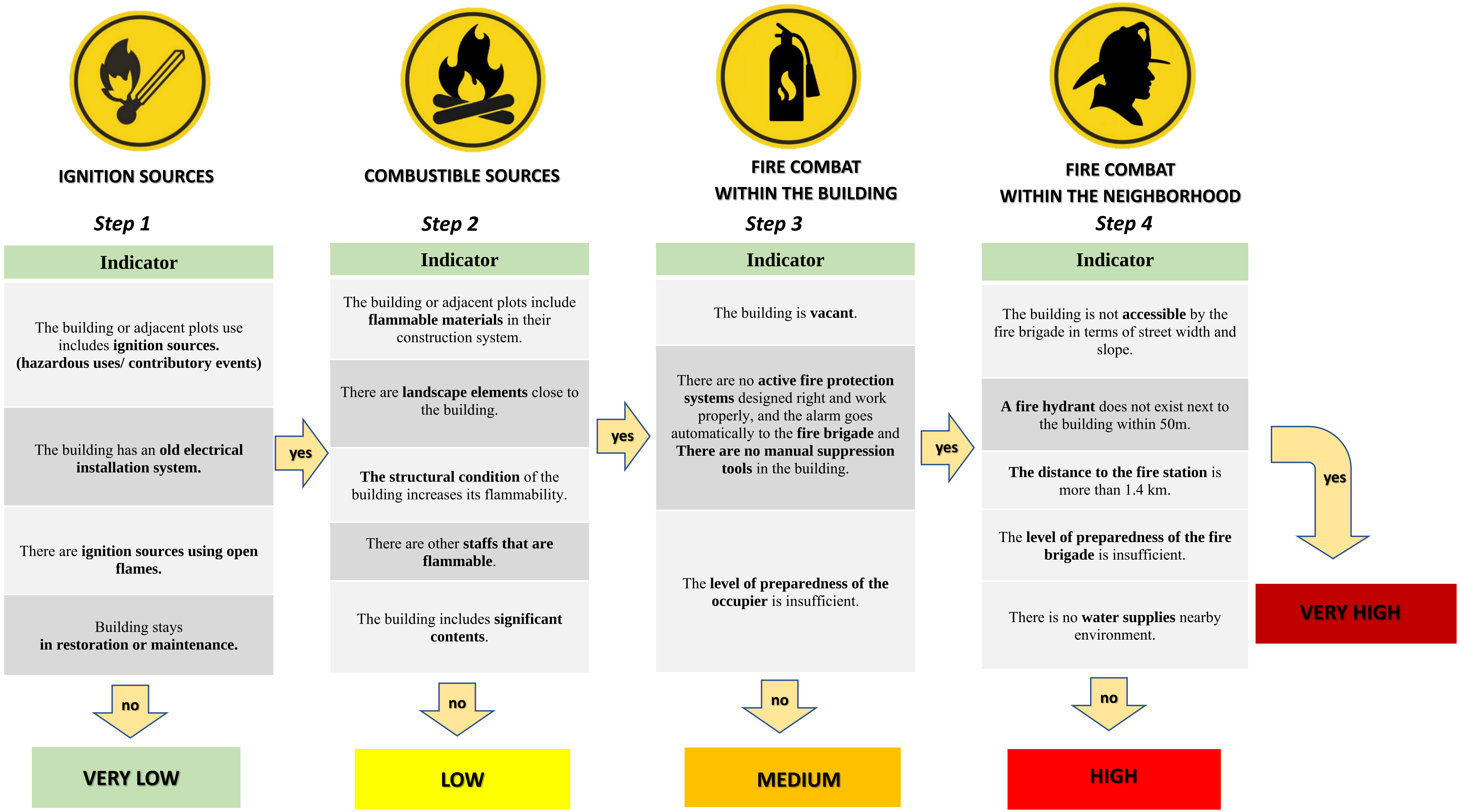
In the second category, indicators related to the existence of combustible materials are evaluated. Flammable materials in the building or adjacent building/plot, park/vegetation/tree/forest/bush/rubbish/garbage close to the building, the structural condition of the building, existence of other flammable staffs, significant contents (museum/critical buildings) are assessed.

In the third category, fire combat within the building is elaborated. Those indicators are the vacancy situation of the building and the existence of active fire protection systems. In addition, the level of awareness/preparedness of occupiers for fire safety is taken into account

In the fourth category, fire combat within the neighborhood scale is assessed. Building accessibility by the fire brigade in terms of street width and slope, the existence of a fire hydrant next to a building in 50 m, distance to the fire station, the level of preparedness of the fire brigade, water supplies nearby environment that can be used during firefighting are assessed.

In accordance with the existence or absence of these parameters, the fire vulnerability degree of traditional buildings was assessed. Five levels, including very low, low, medium, high, and very high, are classified for the level of fire vulnerability degree of traditional buildings (Table 25).

Table 25 Fire Vulnerability Assessment Methodology for Heritage Places on a Neighborhood Scale (prepared by the author).



## CHAPTER 4

## FIRE VULNERABILITY ASSESSMENT FOR THE CITY OF SAFRANBOLU WORLD HERITAGE SITE

### 4.1.The Context of the City

Safranbolu is located in Karabük, in the north part of Turkey in the Black Sea Region (Figure 42). The population of Karabük is 244,453 (TÜİK, 2017) and the population of Safranbolu is 65,350 (TÜİK, 2017).


Figure 42 Location of Karabük and Safranbolu [URL 33]

### 4.1.1. Brief History of Safranbolu

Safranbolu was established on the slope of a valley with water resources and fertile lands (Oral, 2019). The region's history where the Safranbolu settlement is located extends up to 3000 BC. It has hosted many civilizations, from the Hittites to the

Romans, Byzantines to the Ottomans. The first known written sources about Safranbolu belong to the Roman Imperial Period (Oral, 2019).

It is known that Teodora, an Ionian princess, founded Safranbolu. After the rule of Gasgas, Hittites, Cimmerians, Lydia, Medes, Cappadocians, Hellenistic Roman, Byzantine, Seljuk, and Candaroğulları were settled. In 1460, Fatih Sultan Mehmet included Safranbolu in the Ottoman Empire borders (SKAİPAR, 2010).

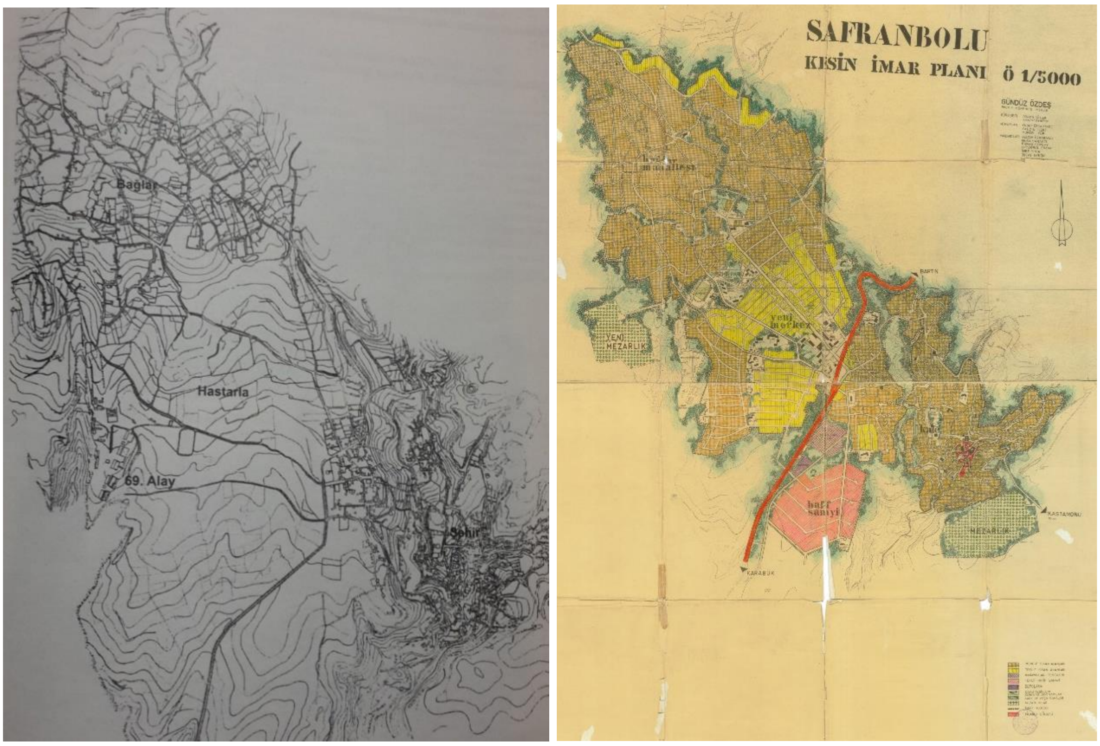
Safranbolu Traditional Houses were mainly built in the 18th and 19th centuries during Ottoman Period. They were constructed with architectural knowledge that reflects the history, culture, economy, technology, and way of Turkish life (KSEAAAR, nd). At the beginning of the 20th century, Safranbolu looked like an Ottoman city with its architectural features, streets, houses, places of worship, cultural assets, life, and social and economic aspects. The city preserved its natural structure in the Ottoman Empire and later in the republican period and did not undergo rapid changes due to the absence of rapid changes in the population growth rate (Kaştan, 2017).

Trade, handicrafts, tannery, and timber trade were developed in the city. It is a city that does not need outside and constantly exports to other cities. The city also has sea transportation due to the port of Bartın. Since agriculture and animal husbandry developed around Safranbolu, the surrounding villages generally evaluated their products and labor by bringing them to the Safranbolu market. Production and trade supported each other by controlling each other within the guild system. They were in economic and commercial cooperation with the villages around Safranbolu. The layout of the houses, the distances from the fountains, the water channels, the bath culture, the condition of the garden walls, and the marketplace places were well-developed. Furthermore, it was quite advanced in terms of socio-economic status compared to other cities in its period (Kaştan, 2017).

During the construction of Safranbolu houses, their settlement patterns, positions, relations with the green texture, and adaptation to the environment and climate were considered. The materials and components used in the buildings are designed to provide thermal comfort in the spaces. Summer spaces that can stay cool in summer and "winter rooms" that are warmer than other rooms in winter and do not lose their heat quickly when heated are elements of rational design (Ulukavak, 2010, cited in Bogenç and Sabaz, 2019). Approximately 2000 traditional buildings and about 800 of them are under legal protection as they were registered as cultural property (KSEAAAR, nd).

### 4.1.2. Planning and Conservation Activities in Safranbolu

The city developed without much change until the 1940s with maintenance and repair works. In 1936, Emek Neighborhood was defined as a new development area, and new development areas around historic centers because of the opening Demir-Çelik Industry that would produce new housing demand were occurred in this period (Yetiş et al., 2018) (Figure 43a).




(a) (b)

Figure 43 (a) Safranbolu in 1936 (Ongun, 1936; Kuş, 2019 cited in Yetiş et al, 2018) (b) 1967 Plan (Safranbolu Municipality Archive)

With the establishment of the Iron-Steel industry on these dates, Karabük witnessed rapid urban development and started to become a new attraction center in the region.

In this way, in the post-1950 period, when rapid urbanization and change were experienced in Turkey, Safranbolu did not experience any deterioration risk. Urbanization was concentrated in Karabük and the Kıranköy-Hastarla, which later formed a separate part of Safranbolu (KSEAAAR, nd).

Later in 1965, İller Bankası asked six well-known Turkish city planners to submit proposal master plans for the Karabük - Safranbolu integrated area at a 1/25000 scale. In these plans, the Karabük urban growth direction was determined through Safranbolu (Çabuk, Demir, and Gökyer, 2016) (Figure 43b). In addition, in this plan, due to Safranbolu's traditional houses with their authentic architecture, it was desired to conserve the unique character of Safranbolu (Çabuk, Demir, and Gökyer, 2016). This project attempt was evaluated as a first sensitivity to emphasizing the institutional conservation of Safranbolu (Canbulat, 2016).

Gunduz Ozdes Plan won the competition (Figure 44). The rational solution to the workplace-housing relationship, the construction of linear development, the selection of suitable places for the development of housing areas, the correct positioning of the industrial and small industrial areas, the idea of an industrial area in Safranbolu, the new settlement area in Safranbolu was handled in a way that would not damage the historical part (Çabuk, Demir, and Gökyer, 2016).

The commercial center of Karabük was located in the direction of Safranbolu, especially the physical conditions and landslide data were considered in the design. Today, Karabük and Safranbolu are almost integrated into each other. This plan, prepared in line with the jury and municipalities' requests, came into effect in 1968, but very few decisions were implemented (Çabuk, Demir, and Gökyer, 2016).

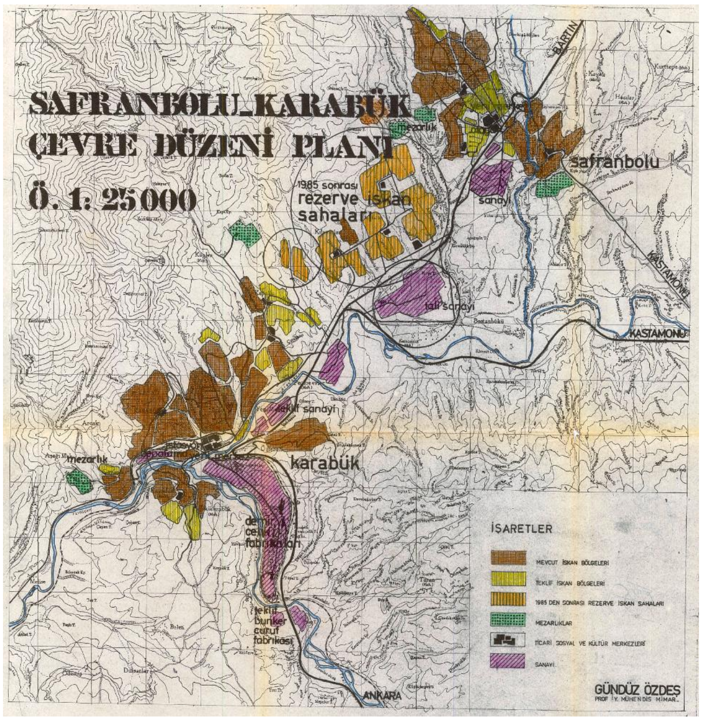



Figure 44 Prof. Gündüz Özdeş 1968 Karabük - Safranbolu Development Plan on 1/25000 (Suat Çabuk Archive cited in Çabuk, Demir, and Gökyer, 2016)

In 1975, conservation activities with the local administration and universities were supported under the mayor's leadership. The Real Estate, Antiquities and Monuments High Council took a conservation decision for Safranbolu on October 8, 1976. This first conservation decision explained the cultural, historical, and legal reasons and the transition period for construction conditions as described until planned conservation activities. The buildings to be conserved are determined, and the street pattern, the natural view, and the infrastructure elements will be conserved (KSEAAAR, nd).

On May 2, 1985, the High Council of Immovable Cultural Heritage decided to register 810 civil architecture examples and 165 monuments within the borders of two urban sites and natural sites located in the Bağlar and Çarşı region. With the same decision, it was adopted that the municipality should make the city conservation and development plan. Accordingly, Safranbolu Conservation Development Plan was accepted and implemented in 1990 (KSEAAAR, nd).

After 1975, when Safranbolu was one of the example conservation implementations in Turkey, the Ministry of Culture and Tourism restored several traditional buildings on the site. Within the scope of the Safranbolu Rehabilitation Project, the exterior of about 30 traditional houses was rehabilitated. Afterwards, the General Directorate of Foundations restored the Cinci Bath, Köprülü Mehmet Pasha, İzzet Mehmet Pasha, Kütükçü, Kilci, Ulucami, Yıldız, Değirmencioğlu, Mescit Mosques (KSEAAAR, nd).

In 2008, the Conservation Plan was approved by The Regional Conservation Council. For more efficient and integrated conservation within the property, a buffer zone was identified during the preparation process of the conservation plan [URL 34].

In 2010, Revision Conservation and Development Plan for Safranbolu WHS was prepared and implemented. Accordingly, a buffer zone around historic sites was defined. Planning border includes 3 ha 1st Degree Archaeological Site, 77 ha Natural Site, 180 ha Urban Site, 440 ha Buffer Zone. In addition, 1/5000 and 1/1000 plans were prepared. On the other hand, there are no policies about natural and human-based threats that Safranbolu is subject to in this plan.

The city's membership in UNESCO WHS, the successful destination promotion, and the high touristic image of Safranbolu at the national and international level has increased the demand for Safranbolu. Increasing visitor demand and commercial concerns have led to the unplanned development of tourism, and the balance between protection and use in the historical city has often been ignored (Ceylan and Somuncu, 2016, cited in Bogenç and Sabaz, 2019).

Various plans on different scales were prepared for the City of Safranbolu from the past to the present. When they are analyzed for fire risk in the city of SWHS, it can be said that all plans have indirect impacts (Table 26).

Table 26 Planning History of Safranbolu (prepared by the author concerning different data gathered)

| Year | Plan | Source | Impact on FRM of the Safranbolu | |
|---|---|---|---|---|
| | | | Direct | Indirect |
| 1936 | Emek Neighborhood is defined as a new development area.<br>New development areas around the historic center due to the opening Demir-Çelik Industry producing new housing demand | Yetiş et al., 2018 | | Yes |
| 1968 | Design competition project: In the jury report, it was stated that the city's historical pattern was considered in the planning process. | Yetiş et al., 2018 | | Yes |
| 1976 | designated as an urban site by the Ministry of Tourism | | | Yes |
| 1974s | İdil stated that he constituted conservation districts in this plan, and the plan included conservation decisions. | Baran İdil Interview, 2011 | | |
| 1978 | Safranbolu Conservation Plan by İTÜ, Doğan Kuban, Metin Sözen, Ismet Okyay<br>The plan aimed to conserve the city as it was like a monument. However, it did not allow for the sustainability of the city. | [URL 42] | | Yes |
| 1985 | On May 2, 1985, the High Council of Immovable Cultural Heritage decided to register 810 examples of civil architecture and 165 monuments in the urban sites and natural sites of the Bağlar and Çarşı region. | (SKAİPAR ,2010), p.85 | | Yes |
| 1990 | The Conservation and Development Plan of Safranbolu was approved.<br>Bağlar and Çarşi were defined as Urban and Natural sites. | | | Yes |
| | The idea of planning new settlement areas according to conservation sites was emphasized. | Yetiş et al., 2018 | | |
| | Bağlar District was seen as a Development Area. | (Okyay, 1990 cited in Yetiş et al, 2018) | | |
| 1994 | designated as a World Heritage Site by UNESCO | | | Yes |
| 2008 | The conservation plan is approved by The Regional Conservation Council.<br>For more efficient and integrated conservation within the property, a buffer zone was identified during the preparation process of the conservation plan.<br>The conservation council approved this in 2008. | [URL 34] | | |
| 2010 | Revision of Conservation Development Plan by Anakent Planlama | | | Yes |
| | -A buffer zone around historic sites was defined.<br>-Planning border includes 3 ha 1st Degree Archaeological Site, 77 ha Natural Site, 180 ha Urban Site, 440 ha Buffer Zone<br>-1/5000 and 1/1000 plan<br>-Planning area: 700 ha; 418 ha=revision, 282 ha= addition plan (ilave imar planı)<br>-There are no policies about natural and human-based threats that Safranbolu faces. | (SKAİPAR , 2010) | | Yes |

## 4.2. Identification of Heritage Components of the City of Safranbolu WHS

In this part of the study, tangible components of the City of Safranbolu WHS and being a UNESCO WHS are discussed.

### 4.2.1. Tangible Components of the City of Safranbolu WHS

Safranbolu settlement shows Anatolian culture, social cohesion, and architectural development. Safranbolu's old city texture and contribution to the country's promotion and the region's economy set an example as a conserved living settlement (SKAİPAR, 2010). The City of SWHS comprises an urban, natural, and archaeological site (Figure 45, Figure 46).

Safranbolu conserved its traditional urban pattern and elements commonly constructed in the Ottoman Period. Civil architecture examples, monumental buildings including khan, mosque, and fountains, could be experienced in many parts of the city. The City of SWHS has an urban, archaeological, and natural site.

| Borders | Area (ha) |
|---|---|
| Urban Site | ~ 180 ha |
| Natural Site | ~ 77 ha |
| Archaeological Site | ~ 3 ha |
| Transition Area | ~ 440 ha |
| Total | ~ 700 ha |

Figure 45 Conservation Sites in Safranbolu (SKAİPAR, 2010).

The City of Safranbolu WHS is a unique settlement with urban and historical areas and a natural environment. In 1976, the Ministry of Tourism designated the historic part of Safranbolu as an urban site. It was added to the world heritage list by UNESCO in 1994 due to its spatial integrity and the architecture of traditional houses.

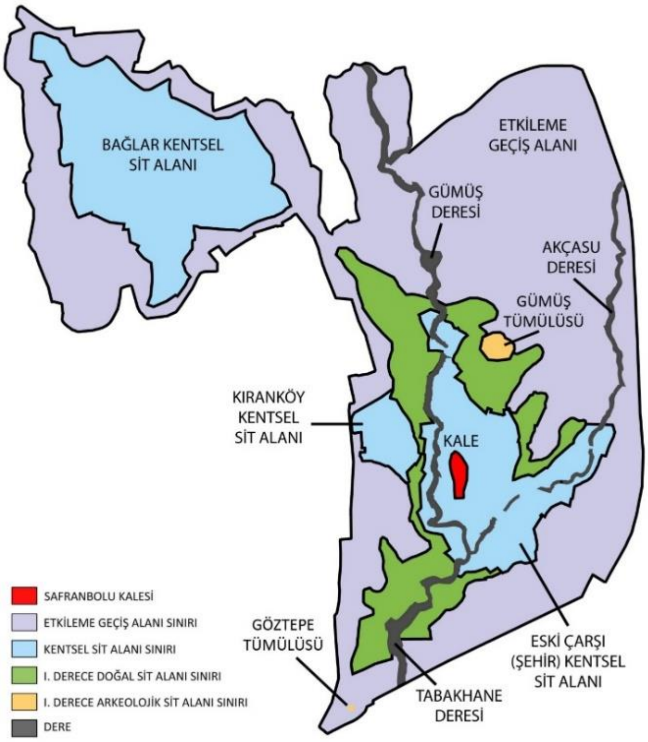



Figure 46 Safranbolu Castle and Conservation Sites (Yetiş, 2016, cited in Yetiş et al., 2018)

On May 2, 1985, the High Council of Immovable Cultural Heritage decided to register 810 examples of civil architecture and 165 monuments in the urban sites and natural sites of Bağlar and Çarşı district.

Accordingly, tangible components of the City of SWHS could be listed as civic architecture examples and monumental buildings, including mosques, khans, and fountains. In addition, the street layout also constitutes tangible components of the site. Intangible components of the site could be classified as social life and economic life conducted in the area. Today, especially in the Çarşı Region, traditional economic activities continue.

### 4.2.2. Being a UNESCO WHS

In 1994, Bağlar, Kıranköy and Çarşı were designated as a World Heritage Site by UNESCO with respect to criteria (ii), (iv), and (v) (Table 27). The relation between nature and the built-up environment could be observed and felt in a different part of the city. Typical Ottoman houses, narrow streets, dead-end streets, and important monuments constitute the traditional pattern of this city.

Table 27 The general characteristic of heritage places in the City of Safranbolu WHS (population from TÜİK, 2017)

| Heritage Place | City | Inscription Year | Criteria | | Property | Buffer Zone | City Pop. | District Pop. |
|---|---|---|---|---|---|---|---|---|
| **The City of Safranbolu** | Karabük | 1994 | (i)(ii) (iv)(vi) | Çukur (Çarşi) | 72 ha | There is no buffer zone while there is an ''interaction transition zone'' approved according to national legislation. This situation will be revised and submitted to WHC for the buffer zone. (WHC, 2014) | 244, 453 | 65,350 |
| | | | | Bağlar | 11 ha | | | |
| | | | | Kıranköy | 110 ha | | | |

Not having a buffer zone brings some threats to heritage sites. The risk and threats to cultural heritage sites can occur inside or in the surrounding environment. In this sense, the buffer zone represents an added layer of conservation. (Risk Management Plan of Petra, p.49)

UNESCO World Heritage Center states the Outstanding Universal Value of Safranbolu according to criterion (ii), criterion (iv), and the criterion (v) as below [URL 34]:

**Criterion (ii)**

By virtue of its key role in the caravan trade over many centuries, Safranbolu enjoyed great prosperity. As a result, it set a standard in public and domestic architecture that exercised a great influence on urban development over a large area of the Ottoman Empire

**Criterion (iv)**

For centuries, the caravan trade was the main commercial link between the Orient and Europe. As a result, characteristic towns developed along its route. With the emergence of railways in the 19th century, these towns abruptly lost their raison d'être, and most of them were adapted to other economic purposes. After the collapse of the caravan trade, Safranbolu's proximity to the Karabük steel works gave it as new socio-economic role, although it preserved its original form and buildings to a remarkable extent.

**Criterion (v)**

Safranbolu is a typical Ottoman city that displays an interesting interaction between its topography and historic settlement.

**Integrity**

Architectural features of buildings and street pattern constitute outstanding universal value of heritage site. Çukur, Bağlar and Kıranköy compose the integrity of the historic settlement.

**Authenticity**

The street layout and townscape of Safranbolu have been conserved.

Being a UNESCO World Heritage Site has affected the number of tourists visiting the sites. The number of tourists visiting Safranbolu in 2016 was identified as number foreign tourists was 32.069, and the number of local tourists was 173.075 and a total of 205.144 [URL 35]. Due to its popularity as a WHS, local and foreign tourists visiting the city have increased dramatically. The table below shows that the number of tourists increased each year after its designation on the WHS list in 1994.

Table 28 Tourist Statistics (1995-2017) (Safranbolu Municipality, 2018)

| Years | DomesticTourists | Foreign Tourists | Total |
|---|---|---|---|
| **1995** | 27.644 | 2.629 | 30.283 |
| **1996** | 38.745 | 3.071 | 41.776 |
| **1997** | 39.788 | 5.089 | 44.877 |
| **1998** | 40.488 | 9.932 | 50.020 |
| **1999** | 47.862 | 4.620 | 52.453 |
| **2000** | 57.261 | 5.876 | 63.137 |
| **2001** | 55.215 | 8988 | 64.203 |
| **2002** | 58.381 | 11051 | 69.442 |
| **2003** | 76.678 | 9.932 | 84.908 |
| **2004** | 78.485 | 13.610 | 92.095 |
| **2005** | 80.046 | 17.776 | 98.281 |
| **2006** | 91.098 | 17.405 | 108.503 |
| **2007** | 112.655 | 21.655 | 134.310 |
| **2008** | 125.482 | 17.130 | 142.612 |
| **2009** | 116.634 | 17.396 | 134.030 |
| **2010** | 138.121 | 22.619 | 160.740 |
| **2011** | 173.674 | 32.685 | 206.359 |
| **2012** | 183.701 | 38.681 | 222.382 |
| **2013** | 195.616 | 43.850 | 239.466 |
| **2014** | 209.843 | 53.601 | 263.444 |
| **2015** | 190.111 | 53.996 | 244.107 |
| **2016** | 173.075 | 32.069 | 205.144 |
| **2017** | 217.842 | 57.917 | 275.759 |
| Total | **2.528.445** | **501.578** | **3.030.023** |

The decision by UNESCO has increased the interest of local and foreign tourists in the city, and concordantly the efforts to conserve the city have gained more importance. At the same time, the increase in tourism investments has also positively affected the tourism activity in the district (Türker, 2002, cited in Bogenç and Sabaz, 2019).

With the resulting economic return, restoration, conservation, or consolidation, renovation and reconstruction implementations have increased, so the city has been able to conserve its original architectural texture to a large extent. These developments have affected some of the buildings built in the conservation area and the regions where the new urban texture has developed (Oral, 2019, p.599).

In this sense, it can be said that in case of fire risk, the economy of Safranbolu and Karabük will also be affected since local and foreign tourists come, visit, shop, and accommodate the city that contributes to its economy. On the other hand, adapting new tourism functions into residential buildings without required interventions brings an additional fire risk. Therefore, this duality should be considered by local actors.

## 4.3.Understanding Threats to the City of Safranbolu WHS

In this part, major natural threats that the City of Safranbolu WHS is subject to be analyzed since past incidents may increase the vulnerability of cultural heritage sites to fires and other disasters.

### 4.3.1. Past Hazard Incidents that affected the City of Safranbolu WHS

Safranbolu is subject to earthquakes, landslides, floods, and rock falls. Different analyses were conducted within Scientific Project to define various threats Safranbolu faces. In the first step, according to data taken from AFAD, an inventory of past events was superposed with the geographic coordinates of the site in the Geographical Information System (GIS). This analysis showed that within the 10 km boundary of the City of Safranbolu, rockfalls, floods, and landslides happened between 1950 and 2008 (Figure 47).

In addition, landslide susceptibility maps were prepared by AFAD. Correspondingly, the landslide susceptibility map and City of Safranbolu were superposed with the help of the Geographical Information System. As a result, three parts of these heritage sites are located at a high degree of landslide susceptibility, as shown in Figure 48. Furthermore, the City of Safranbolu superposing coordinates and past earthquakes data taken from AFAD in GIS also show different earthquakes with different magnitudes and depths. Also, the vicinity of those sites to Karabük Active Fault Line and is located in a 1st-degree earthquake zone shows the emergence of dealing with earthquake risk (Figure 49).

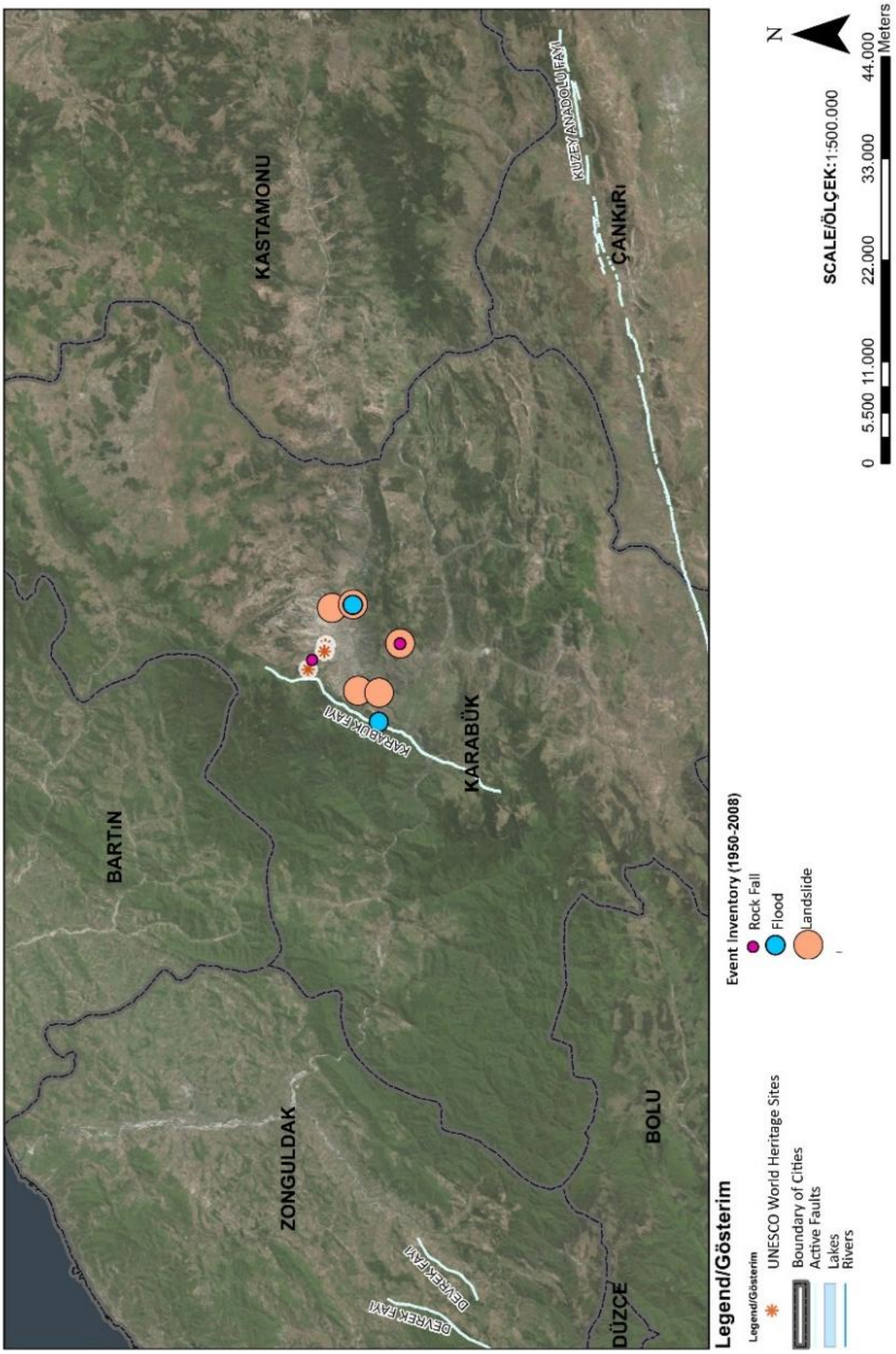



Figure 47 Past events happened 10 km boundary of the City of Safranbolu UNESCO World Heritage Site (Uluç and Şenol Balaban, 2019)

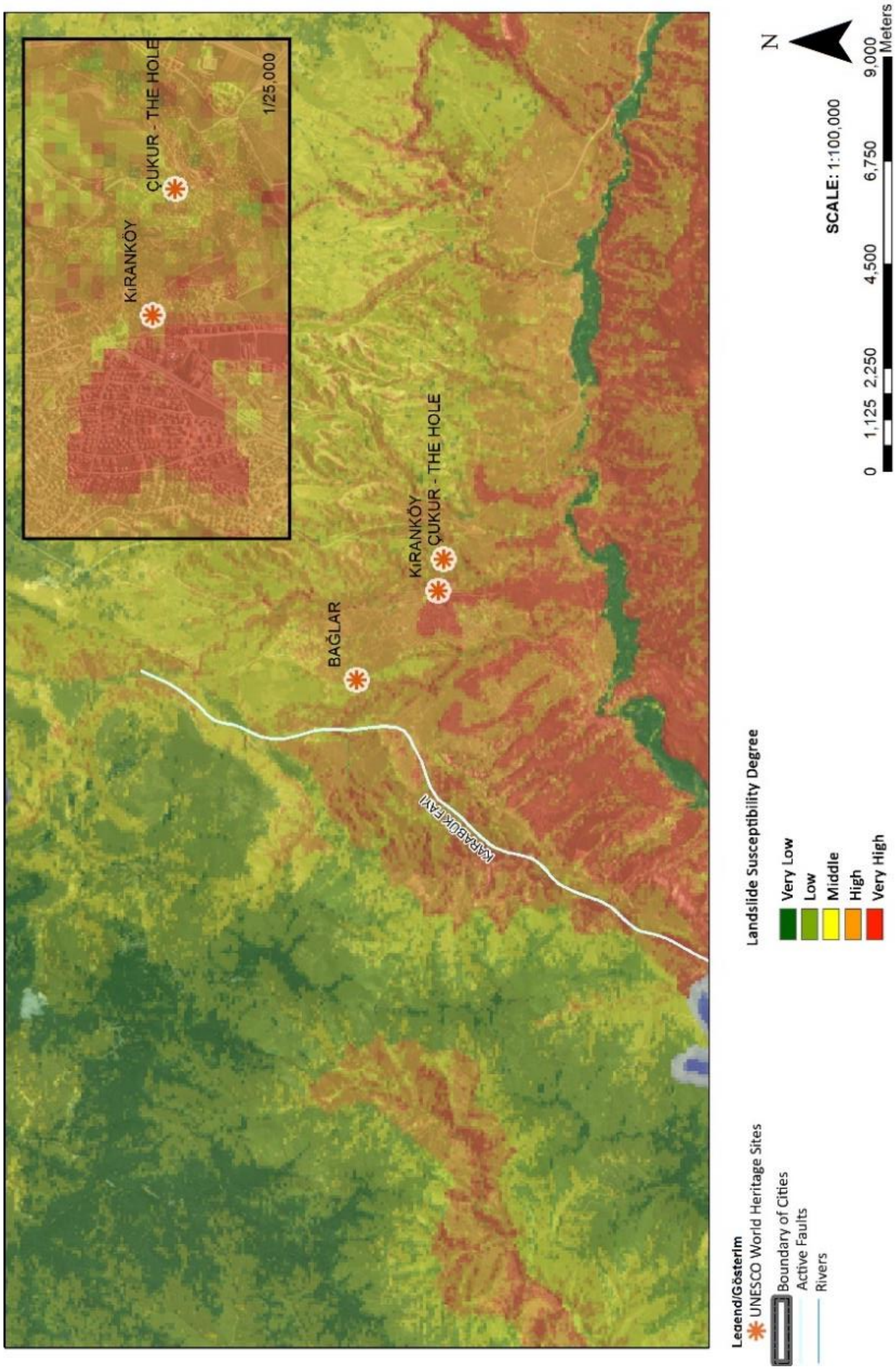



Figure 48 Landslide Susceptibility of City of SWHS (Uluç and Şenol Balaban, 2019)

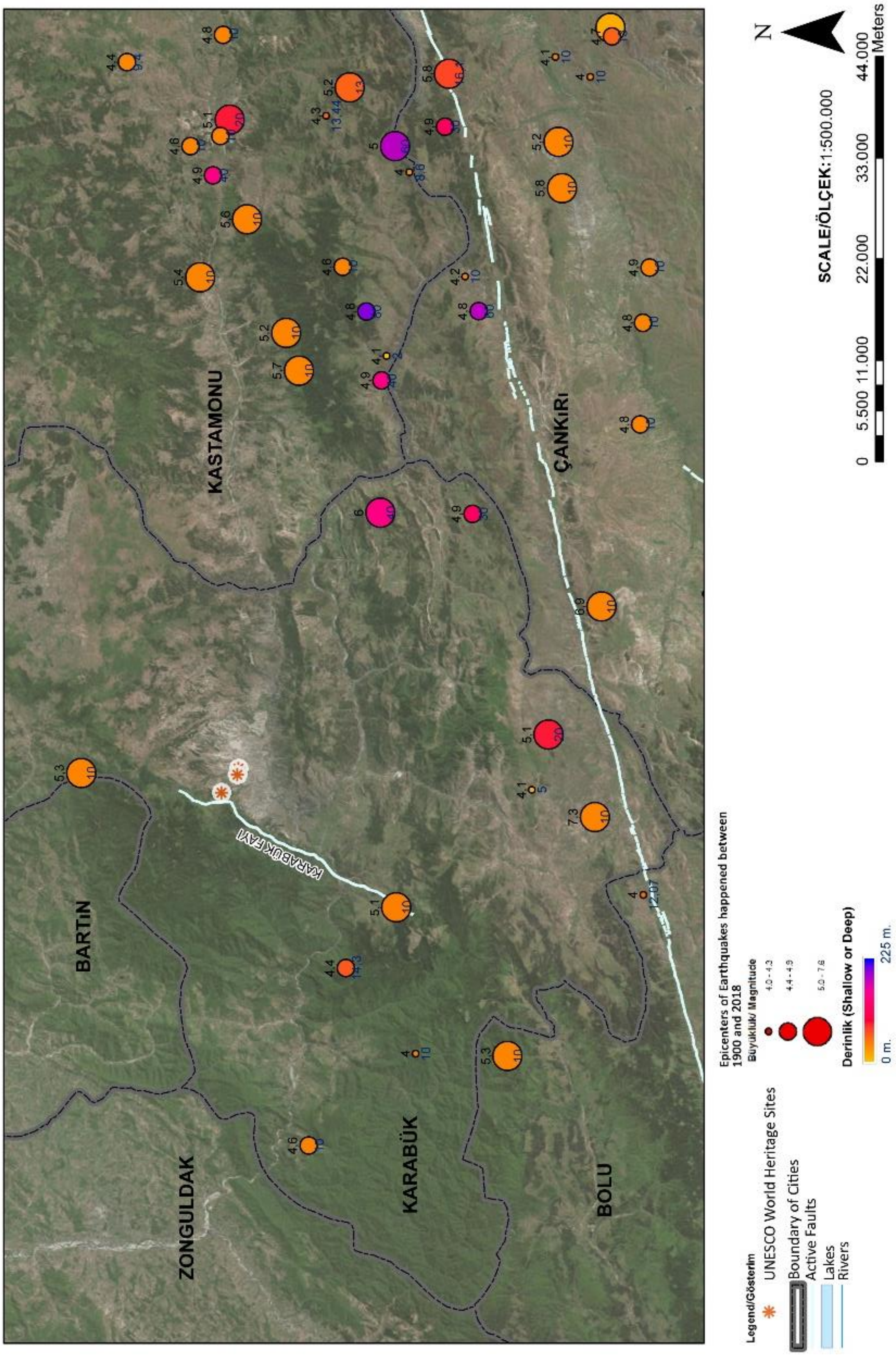



Figure 49 Past earthquakes happened close to the City of SWHS (Uluç and Şenol Balaban, 2019)

**Rockfall Risk**

Rockfall is a critical threat that should be considered for Safranbolu. During the interview with Provincial AFAD Directorate staff, it was figured out that rockfall is another major threat Safranbolu faces. Different decisions related to rockfall threat in Safrabolu existed (Table 29).

Table 29 Decisions related to Rockfall Threat in Safranbolu

| Date | Event |
|---|---|
| 24.06.2016 | Geological Report was prepared. |
| 31.10.2016 | Rockfall Hazard Area: Çavuş Neighborhood, Akçasu Neighborhood, İzzet Paşa Neighborhood<br><br>Wire Protection |
| 14.11.2016 | Disaster-exposed Area *(Afete Maruz Bölge)* by Council of Ministers Decision<br><br>Rockfall Hazard Area: Çavuş Neighborhood, Akçasu Neighborhood, İzzet Paşa Neighborhood, İsmet Paşa Neighborhood |

In the 14.11.2016 Act, previous studies for rockfall events in Safranbolu were stated. The first study regarding rockfall was conducted on 29.8.1973 in Cami-i Kebir Neighborhood. In the geological report prepared on 11.09.1973, it was noted that local interventions could prevent possible rockfall events, and the impacts of rockfall would be low.

The second study was made on 16.07.1980 for İsmetpaşa (İzzet paşa) Neighborhood, and the geological report on 10.11.1980 was prepared. In the report, it was claimed that rockfall event affects residential areas in close surroundings. In addition, it was stated that the municipality could take some precautions by itself, and proposals, including what the municipality does, were emphasized.

The third study was conducted on 10.04.1996 in Çavuş Neighborhood, and a 02.07.1996 Geological Survey Report was prepared. This report stated a rockfall risk for Kayadibi Street in Çavuş Neighborhood; however, it would not affect the residential area because the rocks were small. Nevertheless, a possible rockfall event could affect people walking in the street. It was emphasized that Municipality should have analyzed this issue, and precautions were noted.

The fourth study was conducted on 04.05.1998 for İzzetpaşa Neighborhood, and a 15.05.1998 Geological Survey Report was prepared. This report stated that a rockfall event affecting daily life did not happen; Municipality could take precautions for possible rockfall events were identified. Between 15-19.01.2013 in İzzetpaşa Neighborhood, rockfall occurred because of excess rainfall and freezing-thawing, and residential areas in this region and Kale Altı Primary School were evacuated. (14.11.2016 Act)

In addition**,** in the 14.11.2016 Act, disaster situations in Safranbolu were identified. Some of the rockfall events that happened in 2015:

> **14.01.2015-** İzzetpaşa Neighborhood- motorized and pedestrian traffic were disturbed. No loss of property and life
>
> **19.01.2015-** Camii Kebir Neighborhood- one vehicle became useless. No loss of life
>
> **Rockfall risk areas-** Eski Safranbolu Area, Çavuş Neighborhood, Akçasu Neighborhood, İzzet Paşa Neighborhood, and İsmet Paşa Neighborhood (14.11.2016 Act)

Table 30 Neighborhoods and Rockfall Events

| Neighborhood | Rockfall events and Risk | Interventions defined by Provincial AFAD Directorate |
|---|---|---|
| Çavuş and Akçasu Neighborhood | 21 residential buildings in Çavuş Neighborhood- Rockfall Risk<br>-Three residential buildings in Akçasu Neighborhood- Rockfall Risk | Çavuş Neighborhood- 250 m Wire Covering<br>-opening ditch in enough depth and width |
| İzzetpaşa Neighborhood | 13 residential buildings- Rockfall Threat | -East: 200 m Wire covering for 10-40 cm rocks at 20-10 m height<br>-Middle: Wire Covering 30 m in length and 10 m in height<br>-West: 100 m Wire covering at 20 m height |
| İsmetpaşa Neighborhood | Eight residential buildings- Rockfall Threat | -South: Wire covering 55 m length and 15 m height<br>-North: Wire covering 80 m length and 15 m height |

Some of the interventions made by the Provincial AFAD Directorate for rockfall can be seen in the picture below.

Figure 50 Interventions made by Provincial AFAD Directorate (Karabük Provincial AFAD Directorate Archive)

### 4.3.2. Evaluation of Factors affecting the City of Safranbolu WHS

Periodic Report of 2014 (Cycle 2 Section II) for the City of Safranbolu identified factors affecting the property. Those were ‘’air pollution, solid waste, valuing of heritage by society changes in traditional ways of life and knowledge system and identity, social cohesion, changes in local population and community’’. In addition, the inadequacy of the management plan and the need for a buffer zone are other factors, stated in Periodic Report, that increase its vulnerability to different threats.

Table 31 Analysis of periodic report (WHC, 2014) according to risk management (Uluç and Şenol Balaban, 2019)

| Factors affecting property (Periodic Reporting/2014) | Management Plan | RM in Management Plan | Category | Risk Preparedness (availability of professionals) / 2014 periodic reporting | Risk Preparedness (Availability of opportunities) 2014 periodic reporting |
|---|---|---|---|---|---|
| 3.4.4. Air pollution<br>3.4.5. solid waste<br>3.8.2. society’s valuing of heritage<br>3.8.4. changes in traditional ways of life and knowledge system<br>3.8.5. Identity, social cohesion, changes in local population and community | The management system/plan is inadequate. (WHC, 2014) | Not accessible | Cultural | Non-existent | Not available |

The analysis has shown different natural hazards that the City of Safranbolu faces. The existence of natural events such as earthquakes, landslides, floods, and rockfalls make Disaster Risk Assessment and Management Plans an urgent task.

As reported by WHC (2014) within the Periodic Report, risk preparedness according to availability of professionals was stated as *non-existent,* and risk preparedness according to availability of opportunities was defined as *not available*.

In addition, according to the online survey filled by local institutions of Karabük that we conducted within the Scientific Research Project, there is still no disaster risk management plan for the City of Safranbolu (Online Survey, 2018). They both emphasize the need for Disaster Management Plan for this unique and vulnerable site. On the other hand, some other analyses should be explicitly made for Çarşı, Kıranköy, and Bağlar Region in detail on different scales. If necessary precautions and actions are not applied, loss of traditional patterns, buildings, economic activities, and social life will be inevitable.

## 4.4.Understanding Fire Hazard at the City of Safranbolu WHS

As was stated before, the City of SWHS is subject to a devastating fire hazard. Past fire incident that happened in Safranbolu confirms this situation. Initiations conducted by Local Actors for Fire Risk Mitigation of the City of SWHS and Fire Skills Project are examples to fire risk mitigation of cultural heritage in Safranbolu.

### 4.4.1. Past Fire Incidents happened in Safranbolu

From past to present, fires have been one of the significant threats that Safranbolu has faced. Past devastating fires occurred in the historic settlements, and their reasons should be understood to understand fire risk. The reasons for fire can give essential precautions that should be taken to mitigate the fire risk of Safranbolu. Accordingly, in this part, past fire incidents in Safranbolu in the 19$^{th}$ century and the 2000s were analyzed.

#### 4.4.1.1.Past Fire Incidents in Safranbolu in the 19th Century

Some precautions were taken for fires in Safranbolu in the past. For example, according to a document prepared in 1834, 15 hooks, five axes, and eight claw hammers were given to a staff working in Çarşı Region, and three hooks, three axes, and two claw hammers were located in Castle (ŞSS, no.2119, 7b, cited in Turhan Sarıköse, 2020).

Table 32 Past Fires happened in Safranbolu during the 19th and Beginning of the 20th century[46]

| Date | Explanation |
|---|---|
| **1857** | Fire in Kıranköy, about 400 of 450 houses was destroyed. Limitations on using wood in roofs and regulations about tile in roofs (BOA, MVL., 593/87). |
| **3 December 1858** | a fire happened in a bakery, and more than 20 shops were destroyed. The fire was extinguished with the help of the people (BOA, A.MKT.UM.,335/97 cited in Turhan Sarıköse, 2020). |
| **18 August 1896** | One mosque, 1 Islamic Monastery, one school, 118 houses, and 40 haylofts were destroyed (BOA, A.MKT.UM,376/19 cited in Turhan Sarıköse, 2020) |

On 5 November 1859, after a fire in Kıranköy, grants were given to affected people, and those people were located in other suitable areas. In 1896, a grant commission was established to give to people affected by fire (Karacakaya et al., 2013).

#### 4.4.1.2.Past Fire Incidents happened in Safranbolu in the 2000s

There were 102 fire cases in Safranbolu between 2013 and 2017. For 46 fire events, the cause of the fire could not be determined. Twenty-six happened due to negligence, thirteen due to electrical failure, seven due to chimneys, and eight due to wrong stove usage (Safranbolu Municipality Fire Statistics cited in FireSkill Project). According to the analysis made by FireSkills Project, the number of residential fires in Safranbolu changed from 16 to 24 between 2013 and 2017.

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[46] This table was based on study of Turhan Sarıköse (2020): Natural Disasters in Safranbolu at 19th century with at the Beginning of 20th century (published in Turkish).

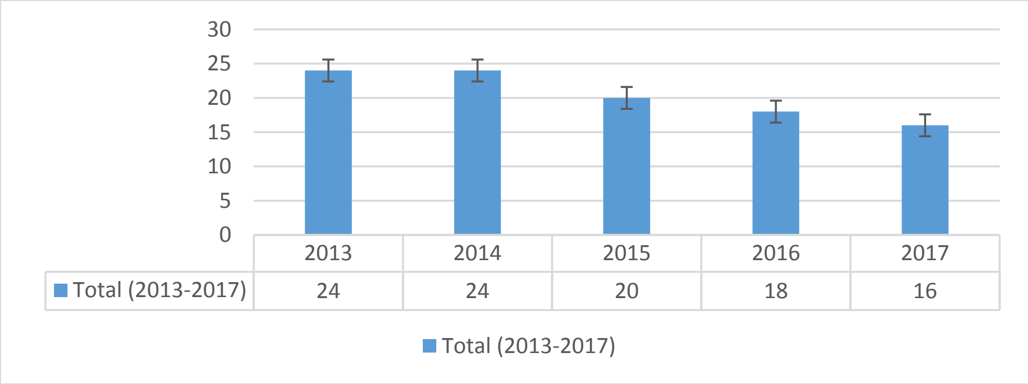


Figure 51 The Number of Residential Fires in Safranbolu between 2013 and 2017 [URL 7]

In the Provincial AFAD Directorate interview with staff, it was stated that every year, two or three konaks were lost due to fires, and fires were defined as one of the significant threats that Safranbolu is subject to (Interview, 2019). In addition, 17 of those residential fires happened in the Historical part of Safranbolu. As shown in the figure, traditional buildings are exposed to fires.

Table 33 The number of fires in Historic Safranbolu, Safranbolu, and village [URL 7]

| **Years** | **Area** | | | **Total** |
|---|---|---|---|---|
| | Historic Safranbolu | Safranbolu | Villages | |
| **2013** | 4 | 10 | 10 | 24 |
| **2014** | 1 | 15 | 8 | 24 |
| **2015** | 4 | 6 | 10 | 20 |
| **2016** | 5 | 5 | 8 | 18 |
| **2017** | 3 | 8 | 5 | 16 |
| **Total** | 17 | 44 | 41 | 102 |

Between 2013 and 2017, 17 fires happened in the Historical part of Safranbolu. While looking at fires in Historic Safranbolu, Safranbolu, and villages, 102 fires occurred in Historic Safranbolu, Safranbolu, and villages. These numbers seem to be very high.

Table 34 Causes of fires [URL 7]

| Years | Fire Cause | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Electrical | Chimney | Stove | Negligence | Collapse | Unknown | Smoking | |
| **2013** | 3 | 3 | 1 | 6 | 0 | 11 | 0 | 24 |
| **2014** | 2 | 1 | 2 | 8 | 0 | 10 | 1 | 24 |
| **2015** | 4 | 0 | 4 | 3 | 0 | 9 | 0 | 20 |
| **2016** | 1 | 2 | 1 | 6 | 0 | 8 | 0 | 18 |
| **2017** | 3 | 1 | 0 | 3 | 1 | 8 | 0 | 16 |
| **Total** | 13 | 7 | 8 | 26 | 1 | 46 | 1 | 102 |

Understanding the causes of fire incidents is important since why fires happen can help identify fire prevention measures [URL 36]. The reasons for fires are figured out in this project. The reasons are electrical, chimney, stove, negligence, collapse, smoking and unknown. Yılmaz (2018) also identified major causes for fires in Safranbolu: problems related to electrical installations, not using heating devices properly, lack of attention, neglect and arson, dissemination of chimney fires to buildings, and accidents.

While looking at fire incident times in the City of SWHS, the fire events mainly occurred from 12:00-17:59 in four years [URL 7].

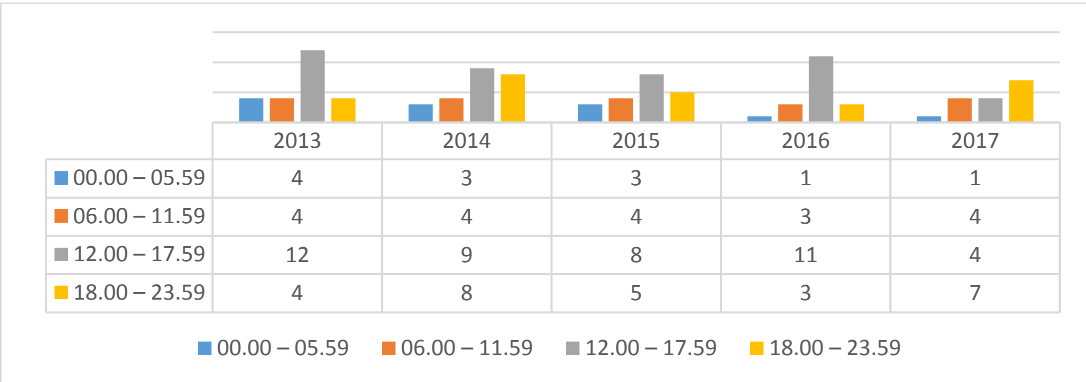


Figure 52 Incident Times [URL 7]

While looking at monthly fire incidents, fires happened in October more. This situation can be related to the temperatures of the weather in winter.

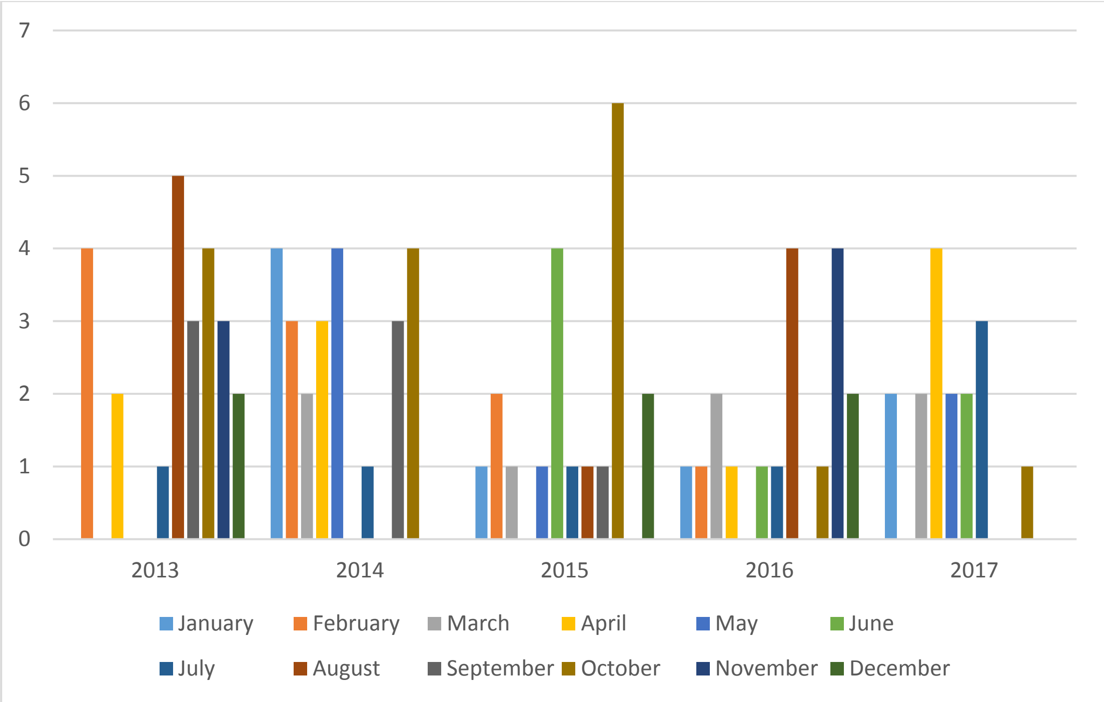


Figure 53 Monthly Fire Incidents [URL 7]

While analyzing seasonal fire incidents in the City of SWHS, the seasons of fire incidents change from year to year. In 2013, in autumn, ten fires happened. In 2014 and 2017, fire incidents occurred in the spring season. In addition, fires occurred in the summer season in 2013, 2015, 2016, and 2017. It is possible to say there is a dominancy of fire incidents that happened in autumn. Furthermore, there were fire incidents that occurred in all seasons.

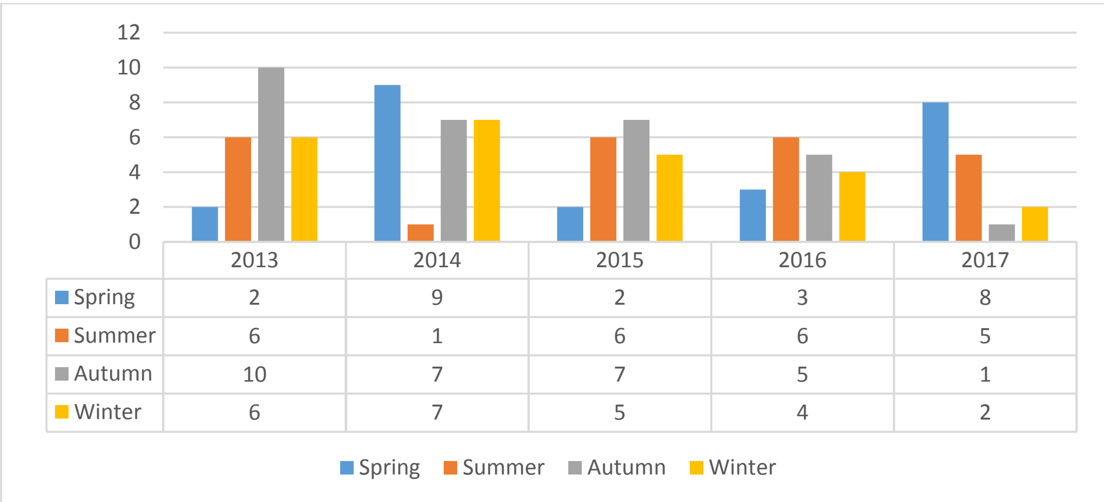


Figure 54 Seasonal Fire Incidents in Safranbolu [URL 7]

Figure 55 After Fire at Kadıoğlu Konak and the traditional building next to it on 23 July 2020 (Uluç, 2020)

On 23 July 2020, a fire happened at Kadıoğlu Konak, and as a result, two traditional buildings were destroyed. The reason for the fire was assumed as electrical installations (Personal Interview, 2020). Kadıoğlu Konak is in the restoration process after the fire, while the other traditional buildings were damaged severely and stayed in this situation.

Table 35 Past Fire Incidents (Financial Loss) [URL 7]

| **Financial Loss** | **Year** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | |
| **Unknown** | 22 | 23 | 19 | 18 | 16 | 98 |
| **Known** | 2 | 1 | 1 | 0 | 0 | 4 |
| **Amount** | 80.000 TL | 80.000 TL | 2.000 TL | 0 | 0 | 162.000 TL |
| **Total** | 24 | 24 | 20 | 18 | 16 | 102 |

When the analysis results are considered in terms of property damage, in 2013, 2014, and 2015, 3 different damages related to one fire incident were recorded. Considering that the total number of fires is 102, it is understood that the financial loss record of 97% of the fires that occurred is not known [URL 7].

In addition, based on Fire Brigade Archive, fires between 2015 and 2020 were analyzed. Accordingly, 96 fires were considered. 30 of 96 fires happened in buildings. In addition, grass, transformer, and rubbish fires also occurred in those years.

Table 36 Fires happened between 2015 and 2020 in Çarşı Region (prepared by the author based on Safranbolu Fire Brigade Archive)

| | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|
| **Fires in Buildings** | 5 | 9 | 6 | 10 | 8 | 6 |
| **Grass Fire** | 9 | 8 | 6 | 5 | 2 | 2 |
| **Transformer Fire** | - | 1 | | 1 | - | - |
| **Rubbish Fire** | 2 | 4 | 5 | 2 | 1 | - |
| **Other** | - | 1 | - | - | 3 | - |
| **Total** | 16 | 23 | 17 | 18 | 14 | 8 |

Those fires were categorized according to the neighborhood in which the fires happened. Since the research was limited to Çarşı Region in the City of SWHS, the neighborhoods in Çarşı Region were taken into consideration while analyzing archives. Accordingly, İsmet Paşa Neighborhood has the most fires. Fifteen grass fires and eight rubbish fires happened in this neighborhood. On the other hand, Çeşme Neighborhood has the most building fires in Çarşı Region. Çeşme Neighborhood is one of the crucial neighborhoods constituting a part of the historic center of Safranbolu. This neighborhood has a more mixed-use character than the other neighborhoods in Çarşı Region.

Table 37 Fires between 2015 and 2020 in Çarşı Region (prepared by the author based on Safranbolu Fire Brigade Archive)

| Name of Neighborhood | Fires in Buildings [47] | Grass Fire | Transformer Fire | Rubbish Fire | Other | Total |
|---|---|---|---|---|---|---|
| **Hacı Halil** | 4 | - | - | 1 | - | 5 |
| **Babasultan** | 4 | - | 2 | - | - | 6 |
| **İsmet Paşa** | 3 | 15 | - | 8 | 1 | 27 |
| **Çeşme** | 9 | 1 | - | - | 1 | 10 |
| **Akçasu** | 5 | 3 | - | 2 | - | 10 |
| **Camiikebir** | 1 | 2 | - | - | 1 | 4 |
| **Çavuş** | 4 | - | - | - | - | 8 |
| **İzzet Paşa** | 3 | 5 | - | 1 | - | 9 |
| **Karaali** | 1 | - | - | - | - | 2 |
| **Hüseyin Çelebi** | 1 | 1 | - | 1 | - | 6 |
| **Musalla** | 2 | 4 | - | 1 | 1 | 8 |
| **Total** | 30 | 31 | 2 | 14 | 4 | |

In addition, news on the internet was also analyzed. Safranbolu, traditional buildings, and fire keywords (in Turkish) were used to conduct this. Accordingly, seven fires that historic buildings in Safranbolu faced were investigated. News belonged to the years 2010, 2015, 2016, 2017, 2018, 2020, and 2021. In that news, when looking at their contents, it can be said that almost in each news, 'traditional building,' 'fire in the historic building,' 'fire in historic mansion' were used to describe and explain the news[48].

Insurance is available in different and various steps. Among these applications, optional private insurance, home insurance, fire insurance, and compulsory earthquake insurance (DASK) can be given as examples.

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[47] In this category, residential fires, working place fires, chimney fires were included. The data were based on Fire Brigade Inventory.
[48] For further information See Appendix K and Also some fires from 19th century to today can be found in Appendix L Since there is no spatial data, they could not be spatialized.

With fire insurance, material damages directly caused by fire, lightning, explosion or smoke, steam, and heat generated by fire are covered in the amount of the insurance fee [URL 7]. The damage caused by the fire is not only on the building, but the items inside the building can also be damaged by fire, and in this respect, it also has a broader application area. With the compulsory earthquake insurance known as DASK, material damages directly caused by fire, explosion, tsunami, and landslides caused by the earthquake and earthquake are covered in cash within limits specified in the policy (FireSkill Project Report). In the examinations of the residential fires, it was understood that there was no insurance in all 102 fire incidents [URL 7].

Table 38 The Situation of Insurance at Past Fire Incidents in Safranbolu [URL 7]

| **Insurance (Private, DASK, Fire)** | **Year** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | |
| **There is insurance.** | 0 | 0 | 0 | 0 | 0 | 0 |
| **There is no insurance.** | 24 | 24 | 20 | 18 | 16 | 102 |
| **Total** | 24 | 24 | 20 | 18 | 16 | 102 |

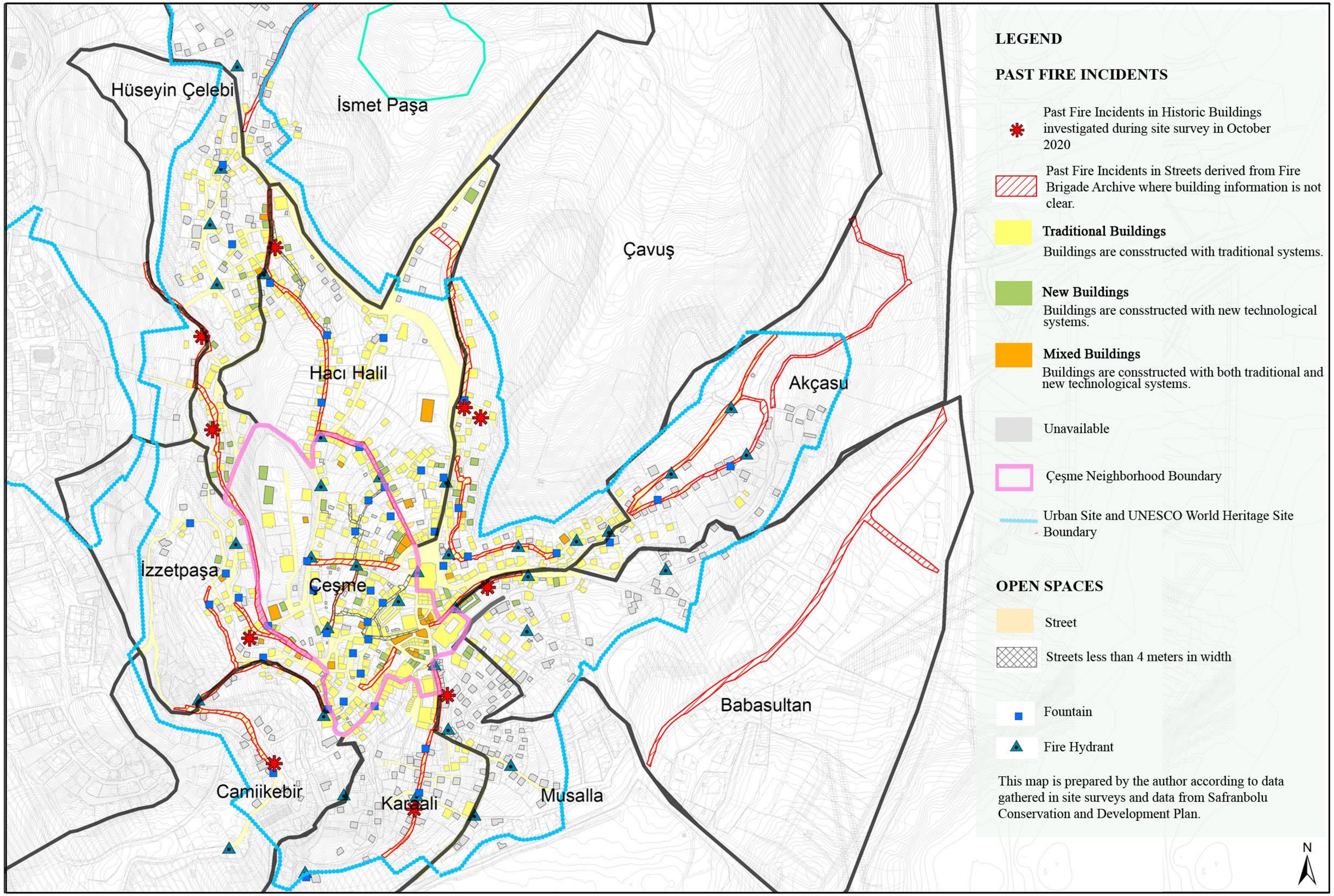



Figure 56 Past Fire Incidents in the Çeşme Neighborhood

## 4.5. Initiations conducted by Local Actors for Fire Risk Mitigation of the City of SWHS

Since fire is one of the major threats that the City of Safranbolu WHS is subject to, different attempts, including different projects and workshops, have been conducted by local actors, including the Fire Brigade, Karabük University, Safranbolu Municipality, and Provincial AFAD Directorate.

### 4.5.1. Safranbolu Fire Brigade Services and Its Activities for Fire Risk Management of Cultural Heritage

From past to present, different supports and policies have been implemented in Safranbolu to mitigate fire risk. In the 19$^{th}$ century and the beginning of the 20$^{th}$ century, the state sent fire pumps to prevent fires and tried to increase the use of tiles instead of wood in building construction. Financial aid was provided to the people affected by the fires, and necessary measures were taken to complete the rebuilding of the burned houses immediately. Lumber to be used in constructing their new houses was provided to citizens whose buildings were damaged in the fire, and no tax was collected from these timbers (Turhan Sarıköse, 2020, p.92).

As fires are one of the critical hazards affecting traditional buildings in Safranbolu, different activities and policies for fire risk mitigation are applied. Two or three traditional buildings are lost annually due to fires in Safranbolu (Personal Interview, 21019). When thinking about the scale of Safranbolu, these numbers are very critical. Therefore, awareness campaigns and projects are implemented due to the severity of fire risk. Some awareness-raising campaigns can be seen in Figure 57.


Figure 57 Some posters prepared for local people (Safranbolu Fire Brigade Archive)

Fire cabinets provide intervention in difficult access regions during a possible fire. In the City of SWHS, Safranbolu Fire Brigade implemented fire cabinets to some parts of the site.


Figure 58 Fire Cabinet in Safranbolu (Fire Brigade Archive)

In addition, there was an international project (FireSkills) for fire safety in the historic part of Safranbolu. AFAD and Safranbolu Fire Brigade were local actors who participated in this project. The project was completed in 2018.

### 4.5.2. FireSkill Project and Initiatives conducted within This Project

FireSkills Project, co-funded by the Erasmus+ Program of the European Union, aims to increase public awareness about the conservation of cultural heritage against fires in Safranbolu. The project's focus groups included staff working in public institutions, students, academicians, and technical staff at Karabük University, Safranbolu Municipality staff, and local people.

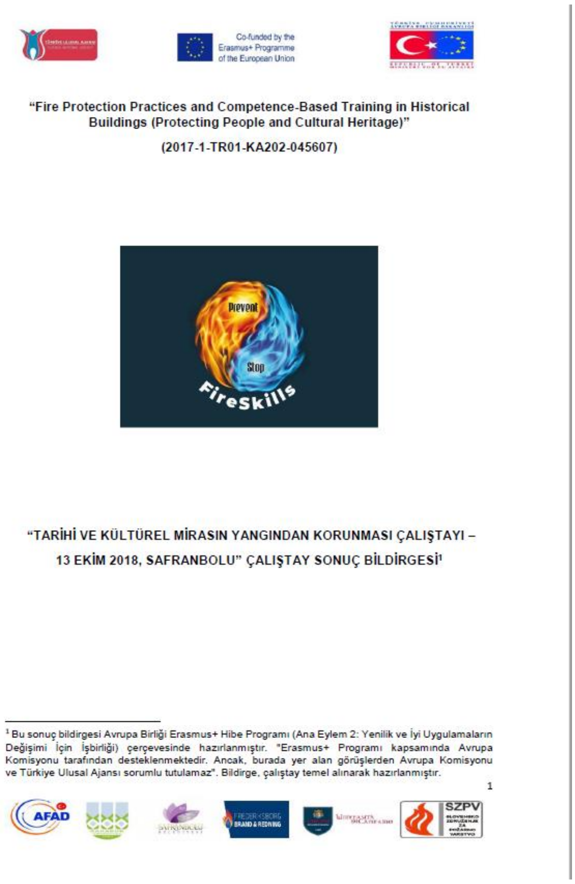
Fireskills

Fire ProtectionPracticesandCompetence-Based Training in HistoricalBuildings (Protecting People andCulturalHeritage) 2017-1-TR01-KA202-045607

Figure 59 Logo of Fireskills Project [URL 37]

Within the scope of the "Fire Protection Practices in Historic Buildings and Competence-Based Training Module" and the "Erasmusdays" activities, a workshop on "Protection of Historical and Cultural Heritage from Fire" was held in Safranbolu District in 2018. This workshop was organized in the historical Cinci Han in the old bazaar [URL 38]. It was coordinated by the Karabük Provincial Directorate of Disaster and Emergency (AFAD) and supported by the Turkish National Agency, Karabuk Governorship, Safranbolu Municipality, Karabuk University, Safranbolu Culture, and Tourism Foundation.

The findings of this workshop emphasized below were also used in proposals for fire risk management of Safranbolu.



"Fire Protection Practices and Competence-Based Training in Historical Buildings (Protecting People and Cultural Heritage)"

(2017-1-TR01-KA202-045607)

"TARİHİ VE KÜLTÜREL MİRASIN YANGINDAN KORUNMASI ÇALIŞTAYI – 13 EKİM 2018, SAFRANBOLU" ÇALIŞTAY SONUÇ BİLDİRGESİ[1]

[1] Bu sonuç bildirgesi Avrupa Birliği Erasmus+ Hibe Programı (Ana Eylem 2: Yenilik ve İyi Uygulamaların Değişimi İçin İşbirliği) çerçevesinde hazırlanmıştır. "Erasmus+ Programı kapsamında Avrupa Komisyonu tarafından desteklenmektedir. Ancak, burada yer alan görüşlerden Avrupa Komisyonu ve Türkiye Ulusal Ajansı sorumlu tutulamaz". Bildirge, çalıştay temel alınarak hazırlanmıştır.

1

Figure 60 Report of the Workshop conducted

Policies for fire ignition sources were also highlighted (Anonymous, 2018):

- ensuring the compliance of the electrical installation with the relevant legal regulations
- prohibiting gas cylinders and electric heaters
- prohibiting electric uses outside working hours
- taking precautions in restoration
- passing electricity cables through steel pipes
- preparing fire scenarios according to the adapted uses of traditional buildings and taking protection measures following this scenario

Policies related to combustible materials were also noted (Anonymous, 2018):

- painting wooden parts with fire paint
- using ex-proof materials in archives

There are policies for fire combat within the building scale (Anonymous, 2018).

- the need for **active fire protection systems** such as detection/alarm and suppression systems
- having a clean gas extinguishing system in small sealed rooms
- preventing illegal use of vacant buildings

Some highlighted points can be implemented for fire combat within the neighborhood scale (Anonymous, 2018) in the Çeşme Neighborhood of Safranbolu:

- being professional in the selection and training of firefighters
- establishing private companies and imposing sanctions for chimney cleaning
- controlling all subsystems and elements that may pose a risk
- performing repairs and renewals when necessary, ensuring their continuity
- using suitable fire trucks with air and foam systems
- establishing a traffic-free area in the historical part,
- constructing and mapping the fire hydrant system for the entire residential area
- creating fire zones to prevent fire spread
- using fire detection systems
- keeping valuable works in a separate section

Furthermore, manuals were prepared for local people living in historical buildings (Figure 71). This manual identified preparation, response, recovery, and mitigation for historic buildings' safety that residents can apply. Each title has sub-questions. Accordingly, questions related to those titles are described in Table 39.


Figure 61 A Handout for Fire Risk Management for People Live in Historic Buildings[49]

[49] This guide is prepared within the scope the Erasmus+ KA2 project of the European Union and it was distributed in Karabük International Conference.

Table 39 Preparation, response, recovery, and mitigation for historic buildings' safety that residents can apply for fire risk mitigation[50]

| | |
|---|---|
| **PREPARATION**<br>**Detection and Warning Systems**<br>• Is there a gas leak detector? /Does it work?<br>• Is there a carbon monoxide detector? /Does it work?<br>• Is there a smoke detector? /Does it work?<br>• Are there illuminated and audible alarm systems? /Does it work?<br>**Fire Extinguishing System**<br>• Is a suitable fire extinguisher available?<br>• Have maintenance and check done?<br>• Are automatic extinguishing systems routine controls performed?<br>**Evacuation**<br>• Are escape routes free from barriers?<br>• Evacuation training for family members?<br>• Are exit routes visually marked?<br>• Are emergency call numbers known?<br>**Control and Inspection**<br>• Is routine control of the electrical installation performed?<br>• Is routine chimney cleaning done by authorized units?<br>• Is cleaning and maintenance check of the roof cavities?<br>• Is it known that the roof gap will not be used as a warehouse? | **RESPONSE**<br>**Emergency Call**<br>• In the event of a fire abandon the building close to the ground.<br>• Call emergency numbers as priority.<br>**Leak Prevention**<br>• Close gas valve from main connection.<br>• Make sure that the burning building is abandoned by the occupants.<br>• Report if you trapped in the building.<br>**Check**<br>• Entering the building until the safety of the crime scene.<br>**Control**<br>• Take measures to protect evidence at the scene.<br>• Request temporary accommodation from authorized authorities in need. |
| **RECOVERY**<br>**Insurance Applications**<br>• Did you know about earthquake insurance?<br>• Did you learn about fire insurance?<br>• Have you been informed about accident insurance?<br>• Private (Death, Disability, Personal Accident)<br>• Did you learn about insurance? | **MITIGATION**<br>**Needs Analysis**<br>• Did you analyze your building in terms of opportunities, threats and risks against fires?<br>• Are hazards and risks detected? |

[50] Handout prepared within FireSkill Project and it was distributed in a conference in 2019.

In this handout, the main problems for fire risk management in historic environments were emphasized. Accordingly, the threats to historic areas are described as follows:

- The **electrical systems** in historical buildings are not suitable for the standards and today's daily life requirements
- Insufficient control for **chimney maintenance** in residences where solid fuel is used for heating
- **Vacant buildings** due to financial problems of residents**,**
- Lack of **fire hydrants**
- Lack of **policy documents** for the fire department
- Lack of spatial data in terms of fire safety and suppression capabilities, including detailed street mapping and water supply
- Problems related to traffic such as **car parking** on narrow streets
- **Dense pedestrian flow** in the city center on holidays, weekends, and touristic seasons and **invasion of the streets** by craftsmen products'
- Need for **special fire trucks** due to traditional urban pattern
- The difficulty of **water supply** by tankers due to traditional urban pattern

(Manual for Residential Users prepared within FireSkill Project)

## 4.6.Understanding Fire Vulnerability of the City of Safranbolu WHS

As stated in the previous chapters, Safranbolu is subject to fire risk because more than one traditional building is lost yearly due to fires. In this part of the research, the fire vulnerability of Safranbolu WHS is conducted concerning four categories proposed in the method: The Existence of Ignition Sources Inside and Outside of Traditional Buildings in the City of SWHS, The Existence of Ignition Sources Inside and Outside of Traditional Buildings in the City of SWHS, Fire Combat Within the Building Scale and Fire Combat within the Çeşme Neighborhood.

### 4.6.1. The Existence of Ignition Sources Inside and Outside of Traditional Buildings in the City of SWHS

Different ignition sources exist inside and outside of traditional buildings in Safranbolu. Most traditional buildings are in use, and they have *old electrical systems*.

Historical buildings' electrical systems are incompatible with the standards and do not meet daily life needs. Fires in Safranbolu mainly happened due to chimneys and electrical installations (Gökcü, 2020; Yılmaz, 2018; Personal Interview, 2020). Namely, 13 of 102 fires occurred due to *electrical installations* between 2013 and 2017 in Safranbolu (FireSkills Project Report, 2017). On the other hand, 67% of the FireSkill Project Survey participants stated that their electrical installations were not checked regularly (FireSkills Project Report, 2017).

Furthermore, as was stated before, Çarşı Region was selected to be analyzed due to its mixed land use character since it is the commercial city center of Safranbolu. In addition, traditional buildings in Safranbolu are exposed to increasing tourism demand; however, traditional residential buildings were not constructed according to new adapted uses. Beilicke (1991, p.57) emphasized that potential fire risk increases when original and present use is different.

In Safranbolu, there are many accommodation facilities, residential use, various commercial uses, and public uses. It can be said that all of those functions use different fire ignition sources in traditional buildings. Thanks to being used as residential, accommodation, or commercial, there is always the possibility of different appliances that can start a fire. Therefore, it can be said that various fire ignition sources exist on the site due to their use in daily life.

The dominance of accommodation facilities due to increasing tourism demand can be observed on the site. Accommodation facilities have various electrical devices and kitchen facilities in some plots of accommodation units. One of the current fires happened at Kadıoğlu Konak in Safranbolu; it was assumed that the fire started in the kitchen part of konak. Then it sprawled to Kadıoğlu Konak and the traditional building next to it (Personal Interview, 2020).

Furthermore, some restaurants and bakeries use fire ignition sources. The existence of kitchens in restaurants and active bakery facilities can be evaluated as fire ignition sources in the neighborhood. For example, on holidays, when approximately twenty thousand tourists fill the streets of the bazaar, how to respond to a fire that may arise from LPG cylinders used in restaurants or cafeterias or for any other reasons becomes necessary to fire risk mitigation in Safranbolu (Anonymous, 2018).


Figure 62 Bakeries in Çarşı Region  (photos taken by the author during the site survey conducted in October 2020*)*

In addition, *different types of ignition sources* such as open flames/ chimneys/smoking/candles/grills/grate/hearth can cause fires in traditional buildings in the Çeşme Neighborhood. For example, 7 out of 102 fires happened due to *chimneys* between 2013 and 2017 in Safranbolu (FireSkills Project Report). It was stated in 'Manual for Residential Users' controls for chimney maintenance in residences where solid fuel used for heating was assessed as insufficient in Safranbolu.

*Park, overgrown vegetation, trees, forest, bush, and garbage* close to traditional buildings and environments can cause fires. As was discussed during the site survey, dry grass in the neighborhood causes fires in Safranbolu (Çeşme Neighborhood Mukhtar, Personal Interview, 2020). Due to Safranbolu's natural characteristics, there are various vegetation examples exist. For example, between 2015 and 2020, 31 grass and 14 rubbish fires happened in Çarşı Region (Fire Brigade Archive). Different vegetation samples were investigated during the site surveys (Figure 63).

Figure 63 Some vegetation examples in plots in Hükümet Street in Çeşme Neighborhood (photos taken by the author during the site survey conducted in October 2020)

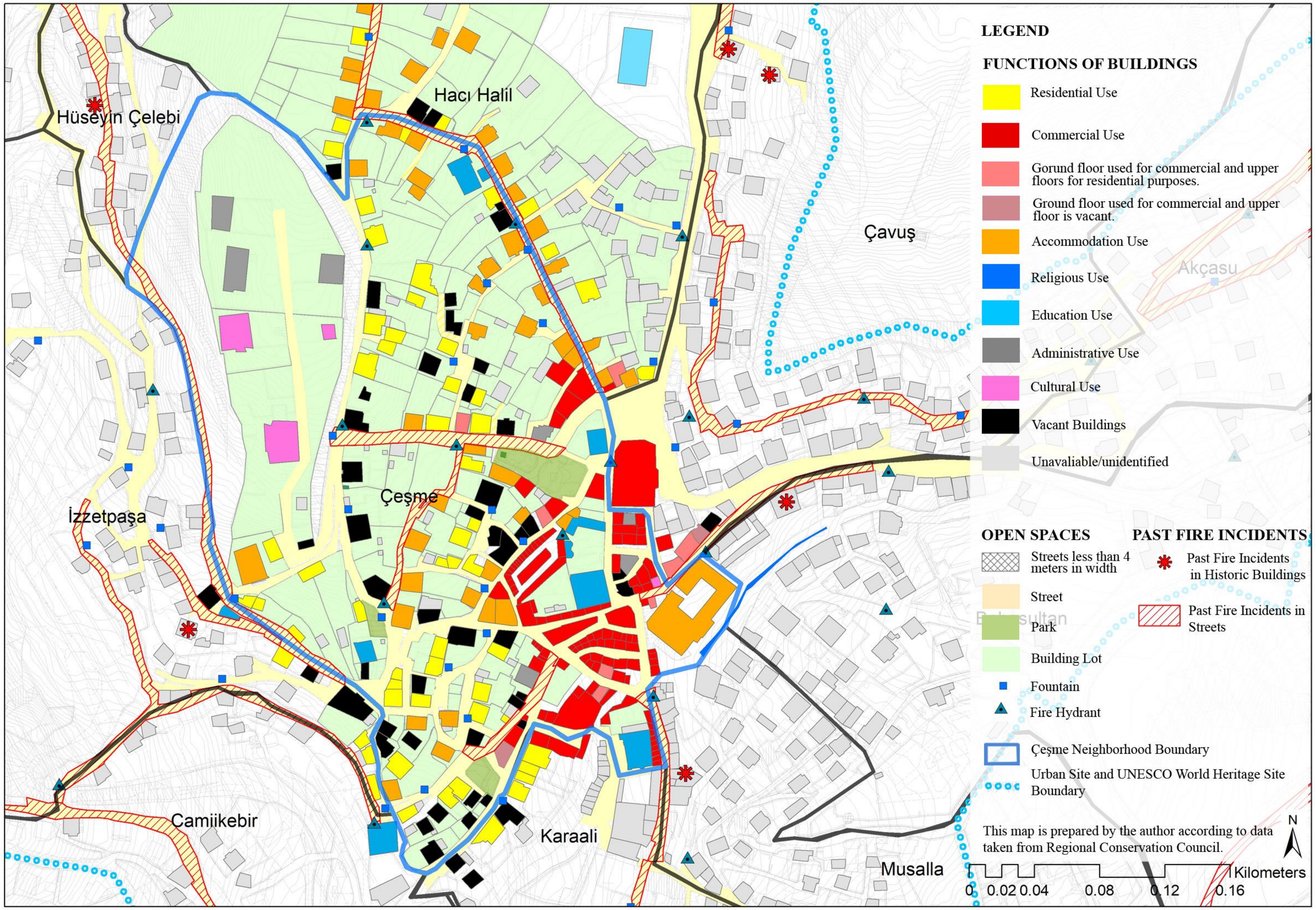



Figure 64 Functions of Buildings

### 4.6.2. The Existence of Flammable Materials Inside and Outside of Traditional Buildings in the City of SWHS

There are different factors related to flammable materials in traditional buildings of Safranbolu. In addition to the goods in the buildings, the structural factors also contribute to the fire load in Safranbolu (Yılmaz, 2018). Namely, traditional buildings with timber frame construction systems automatically include flammable materials. In addition, their roof system also constitutes timber elements. This situation means that in any ignition source, a fire can start, and these buildings can burn. Therefore, traditional buildings that include timber material in their construction system are evaluated as buildings including combustible materials. Furthermore, the flammable character of timber increases with aging and without necessary maintenance implementations.

Most of the traditional buildings in the City of SWHS were constructed with timber frame construction systems. Timber was used in the construction, in the frame, in the building components, and in the coatings of traditional Safranbolu Houses (Gezer, 2013). Stone and mudbrick were also used as building materials and structural systems in traditional buildings of Safranbolu.

Accordingly, there are 13 categories of construction systems that exist in the City of Safranbolu WHS (Table 40). The construction system categories are taken from the 2010 Safranbolu Conservation and Development Plan. Most traditional buildings in Safranbolu WHS are constructed with timber-frame construction systems on the ground or upper floors. As seen in Figure 65, in the Çarşı region, the majority of the traditional houses, the ground floor is stone masonry, and the second floor is a timber skeleton construction system with mud-brick in the orange-colored buildings.

*The existence of flammable materials next to traditional buildings* also creates a fire risk for traditional buildings. Fire events happening in the adjacent plot can easily spread to the next plot due to locating very close to each other in traditional urban patterns. Therefore, combustible materials in adjacent plots were also evaluated as a fire vulnerability parameter as past fire incidents showed many rubbish and grass fires in the City of SWHS. In addition, the past fire incident in Kadıoğlu Konak in 2020 sprawled to the following traditional building.

Table 40 Construction Techniques in the City of SWHS (category taken from Safranbolu Conservation and Development Plan Analysis)

| | |
|---|---|
| **Construction Techniques in the City of SWHS** | Ground floor-stone<br>Upper floor-timber skeleton system and mudbrick filling |
| | Stone Masonry |
| | Mixed |
| | Briquet |
| | Brick |
| | Ground floor-stone<br>Upper floor- timber skeleton system and brick filling |
| | Gorund floor-mudbrick<br>Upper floor- timber skeleton system and mudbrick filling |
| | Ground floor-stone<br>Upper floor- timber skeleton system and stone filling |
| | Mudbrick |
| | Timber skeleton system |
| | Concrete |
| | Ground floor-mudbrick<br>Upper floor- timber skeleton system and brick filling |
| | Ground floor-mudbrick<br>Upper floor- timber skeleton system and stone filling |

*The structural condition of traditional buildings* contributes to the flammability degree of materials in their construction systems. The construction materials can be more flammable with decayed structural systems and materials. Since the older the building is, the more flammable materials such as timber used in the building are. Furthermore, the structural conditions of traditional buildings in the Safranbolu WHS are primarily average and poor (Figure 65, Figure 67). In addition, most of the vacant traditional buildings are in poor condition in the Çeşme Neighborhood in Safranbolu. This situation also affects the fire vulnerability of those buildings.

Also, fires during *building repair or restoration*[51] can be seen in most historic buildings and environments. Due to its dynamic development[52], there have been many building repair implementations on the site. Being in a repair process also contributes to the fire vulnerability of traditional buildings since ignition sources and flammable materials used in repair processes can cause fires in traditional buildings and environments.

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[51] In this research, building repair is considered as interventions where flammable material or ignition sources are used. In addition, the concept of building repair is used to emphasize fires happened during hot works. Accordingly, building repair includes simple repair, maintenance, and restoration that requires hot works and combustible materials.

[52] Dynamic development is used as a concept showing its transformation due to tourism pressure on site. With touristic facilities, traditional houses adapted to other uses by some building repair implementations and sometimes whole restoration project was prepared.

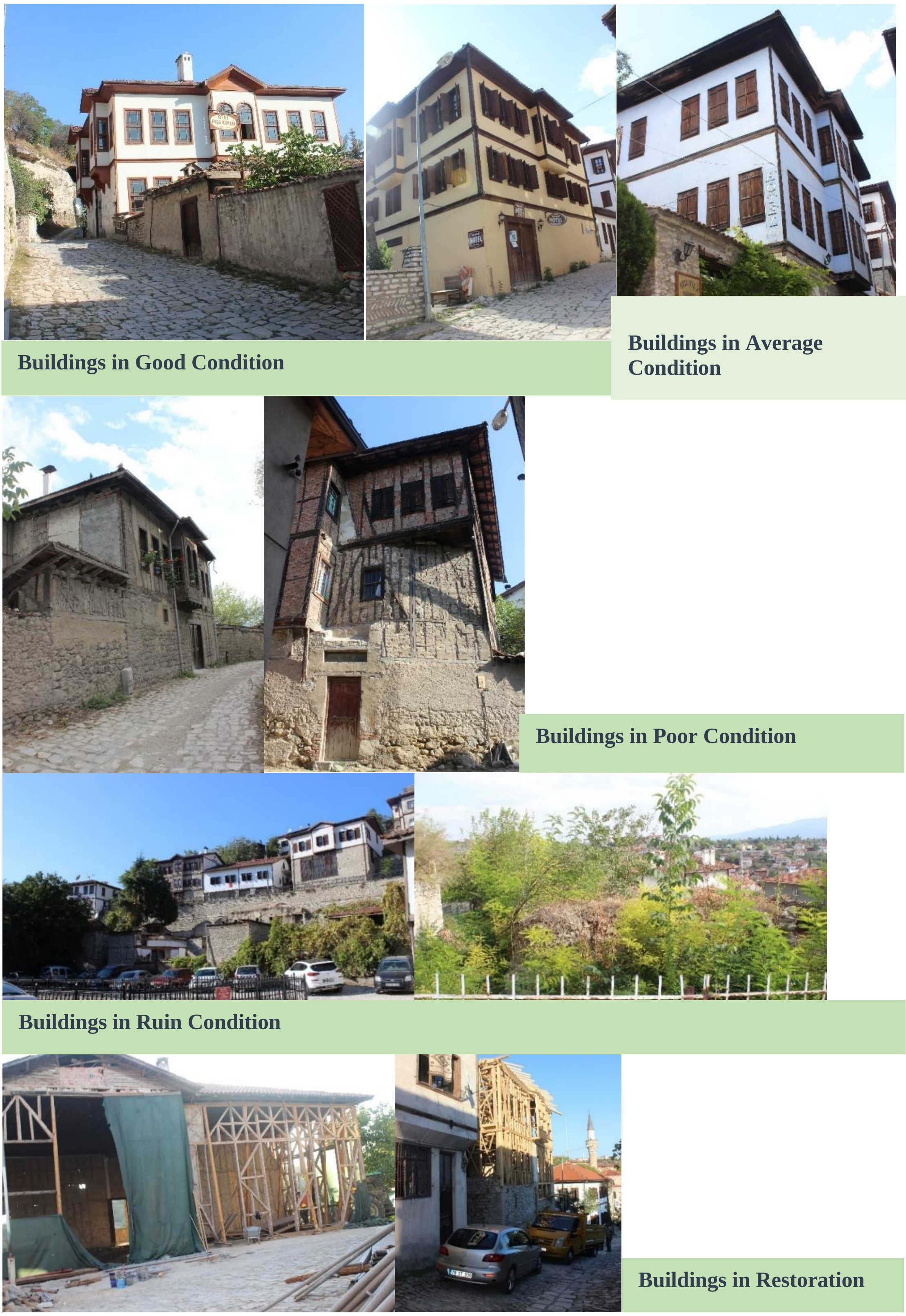



Figure 65 Samples from Building Conditions in the City of Safranbolu WHS (photos taken by the author during the site survey conducted in October 2020)

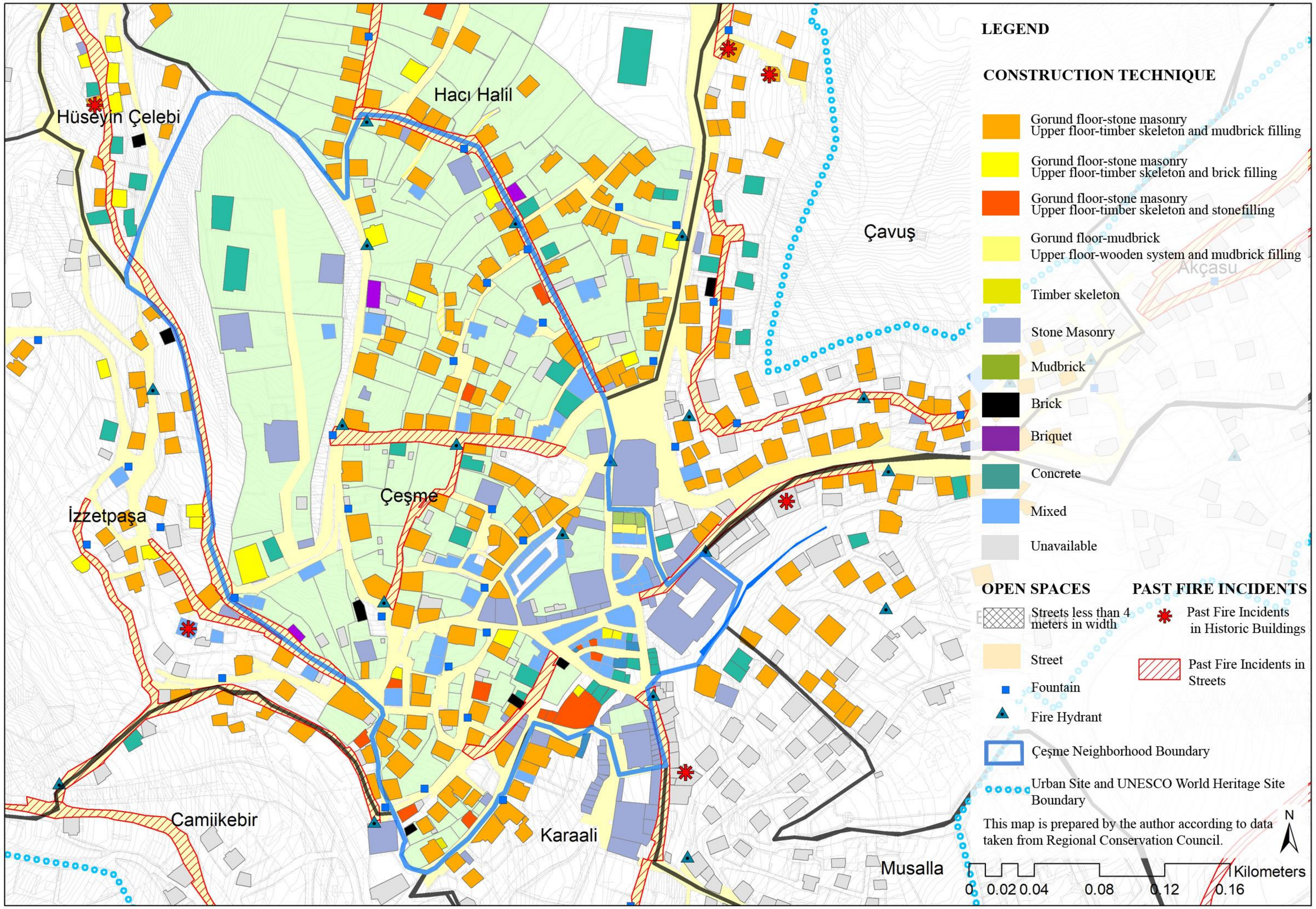



Figure 66 Construction Techniques of Buildings

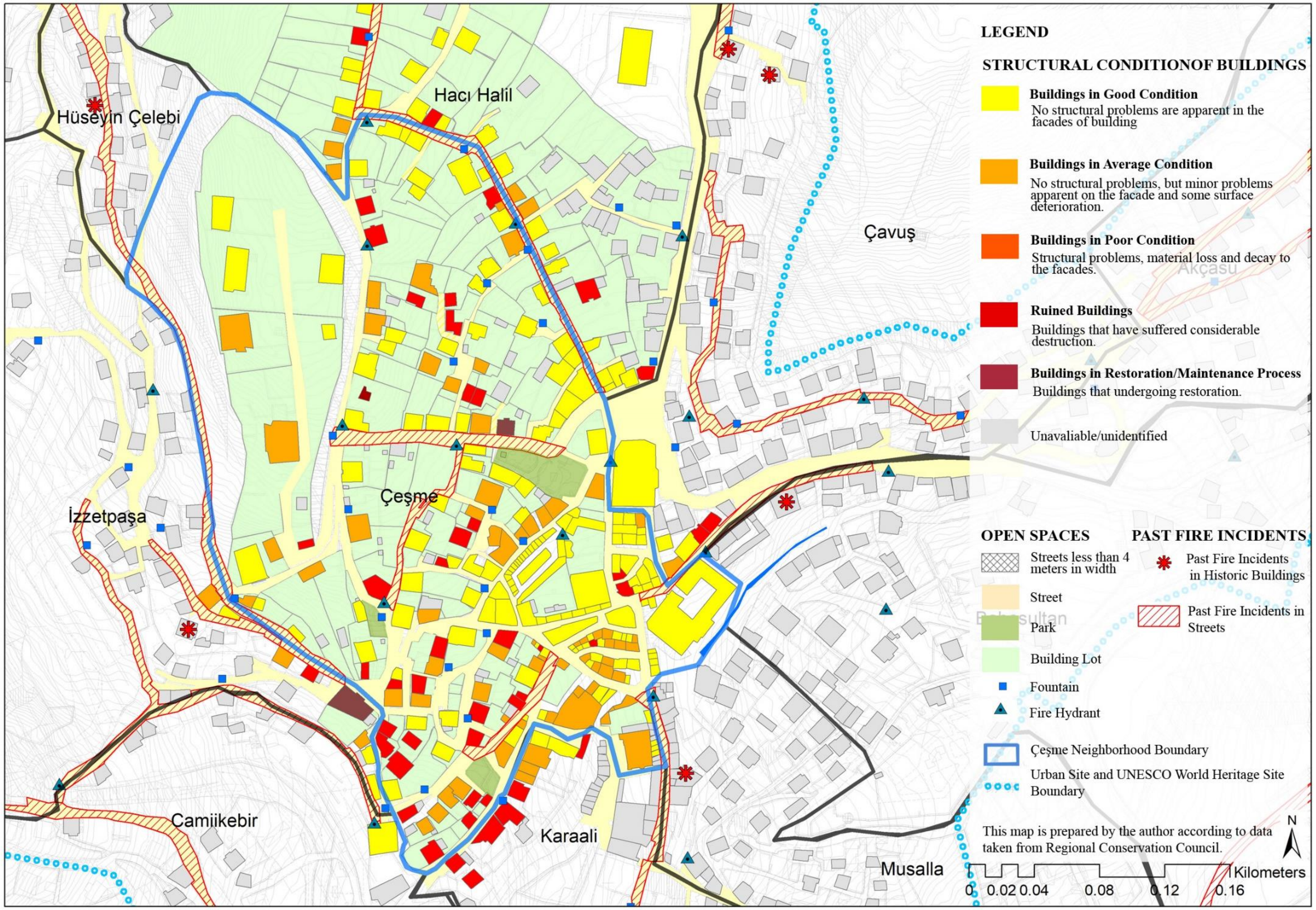



Figure 67 Structural Condition of Buildings in the Çeşme Neighborhood

### 4.6.3. Fire Combat within the Building Scale in the City of SWHS

Various fire combat implementations and factors on the building scale mitigate the fire risk of traditional buildings. The existence or absence of those implementations or characteristics affects the fire vulnerability of historic buildings and environments.

*The existence of vacant buildings* increases the fire vulnerability of heritage places. Many factors in fire combat within a building cannot be satisfied when a building is vacant. There are many vacant buildings in Çarşı Region. The number of vacant buildings has increased significantly in the south of the Çeşme Neighborhood. There is a relation between being vacant and structural conditions. The buildings which stay in poor condition are mostly vacant. On the other hand, some traditional buildings in good condition are vacant (Figure 68).

Figure 68 Vacant Buildings in Kalealtı Street in Çeşme Neighborhood (photos taken by the author during the site survey conducted in October 2020*)*

Mehmet Gökcü, who is the Chief of Safranbolu Fire Brigade, evaluated that the riskiest buildings were vacant ones in Safranbolu (Gökcü, 2020). In addition, the existence of abandoned historic buildings and using those buildings illegally without any fire safety controls cause fires in Safranbolu (Yılmaz, 2018). For example, the news: ‘A historic building burnt due to fire./*Safranbolu'da tarihi konak yandı.’’* [URL 45] stated that a three-storey vacant historic building burnt due to fire on 26 September 2016. 150 years of the historic building became useless after the fire [URL 45].

Figure 69 Historic Building Fire on 26 September 2016 [URL 45]

*The existence of active fire precaution systems* such as sprinkler or alarm systems exists in traditional buildings, which is one of the vital fire combat factors within the building scale. In addition to their existence, their correct design and whether they are operational are also essential and should be considered. Whether the alarm goes automatically to the fire brigade can be evaluated in this category. Active security measures are either non-existent or insufficient due to the high level of costs in Safranbolu. Also, fire detection and warning systems are either absent or inadequate. Traditional buildings in Safranbolu usually have no automatic extinguishing system (Yılmaz, 2018). Traditional buildings, which are used as a workplace, are supposed to have manual fire extinguishing systems. However, residential uses are not required any fire suppression systems. This situation increases the fire vulnerability of traditional buildings in Safranbolu.

### 4.6.4. Fire Combat within the Çeşme Neighborhood

Different factors affect the fire vulnerability of Çeşme Neighborhood in the scope of fire combat within the neighborhood scale. *Accessibility* is one of the critical factors evaluated in fire combat within the neighborhood scale. As stated before, there are standards for fire brigade service accessibility during a fire event.

- The distance of a fire truck to a building facade can be 45 m at most.
- The usual width of the street should be at least 4 m; in dead-end streets should be 8 m,
- The inner radius should be at least 11 m, the outer radius at least 15 m in turns,
- The slope is at most 6 percent,

- Free height should be at least 4 m,
- The load-carrying capacity should be at least 15 tons.

(BYKHY, 2009)

For access of fire fighting vehicles and personnel to traditional buildings, effective firefighting requires vehicles to have access to the outside of the building and firefighters to access the inside of the building (FIRESKILLS, 2017).

There are problems related to accessibility in and to the City of Safranbolu WHS. Accessibility in and to the site is challenging in some parts of Safranbolu. The traditional organic pattern is settled on a high slope. Firefighting became difficult for the passing of fire trucks. The City of SWHS consists of narrow and dead-end streets. The width of some streets is less than 4 meters, allowing fire trucks to pass during response and emergency. The street width is less than 4 meters, the average width for fire trucks defined by the Turkey Fire Regulation of Buildings (BYKY, 2009). In addition, the City of SWHS has a unique topography that shapes its urban pattern. These authentic characteristics of the site increase the fire vulnerability of the site since it produces accessibility problems during response and emergency times (Figure 70).


Figure 70 A Narrow Street in Safranbolu (FIRESKILLS, 2017)

Some streets are less than 4 meters in width in some parts of Safranbolu, and the slope makes accessibility difficult. Due to being a touristic destination, the City of SWHS is crowded with pedestrian and motorized traffic. For example, on holidays, approximately twenty thousand tourists fill the streets of the bazaar in Safranbolu (Anonymous, 2018). Çarşı Region cannot be capable of excessive traffic and population, and accessibility is difficult during firefighting due to rough land characteristics and the existence of narrow streets (Yılmaz, 2018). Gökcü stated that due to narrow streets in Çarşı, car owners should be sensitive about parking (Gökcü, 2020).

For example, Çuhadar Street's width is less than 3 meters. In addition, fire trucks cannot pass through the narrow sections of the street under Hıdırlık, and there is no fire hydrant in this region. The street entering from Hükümet Street to Akçe Street in Çeşme Neighborhood is very narrow; as a result, it is not possible to enter by vehicle to this street. In addition, there is no fire hydrant inside the building block.

Figure 71 Çuhadar Street Width Less than 4-meters and the slope is more than 15 %. (Uluç, 2020)

Figure 72 Gümüş Street and Hükümet Street Junction, the width is less than 4 meters, and the slope is more than 15 %. (Uluç, 2020)

Distance to the fire station is another crucial factor for fire combat. In the standards, it was stated that fire distance should be 1.4 km at maximum. In the City of SWHS, all traditional buildings are located within this range. On the other hand, according to conversations made during the site survey, it was stated that even in 500 m, the fire brigade did not respond to fire in a short time [Personal Interview, 2020]. There can be many other reasons for this situation, such as insufficient staff and firefighting equipment used in historic environments.

Accordingly, for example, the news: ‘’Historic Residential Fire in Safranbolu/*Safranbolu'da tarihi ev yangını’’* [URL 44] stated that fire combat was challenging due to narrow streets and cars parking on the streets during the fire on 15 September 2015. The two-storey historic building was 150 years old and became unusable after the fire [URL 44]. (Figure 73)

Figure 73 Historic Residential Fire on 15 September 2015 [URL 44]

Another news: ‘’Fire in Historic Building in Safranbolu /*Safranbolu'da tarihi konakta yangın’’* [URL 48] stated that it was challenging to intervene against fire due to narrow streets on 25 July 2020 fire. 15o years and three-storey of two historic buildings were damaged due to the fire [URL 48]. (Figure 74)

Figure 74 Historic Residential Fire on 25 July 2020 [URL 48]

Therefore, *the capability of the fire department* is also a significant factor to be analyzed for fire combat within the neighborhood scale. Namely, Safranbolu has some emergency response problems within the neighborhood scale. For example, fire trucks have difficulties during emergencies due to particular characteristics of the site, such as narrow and/or dead-end streets and rugged terrain. The need for special fire trucks compatible with the traditional urban pattern was emphasized in documents prepared for Safranbolu (FireSkill Project Manual for Residential Users). Responding to fires in traditional buildings and environments requires special training and awareness for emergency staff due to the particular characteristics of the traditional urban environment and its components. Seven fire trucks exist in Safranbolu Fire Brigade. According to the analysis conducted, their pressure is sufficient concerning technical standards. However, 4 of 7 fire trucks have insufficient capacity. They should be repaired in case of fire incidents (Safranbolu Municipality, 2020).

In addition, *the existence of water supplies* is another factor that can be evaluated within fire combat on the neighborhood scale. It was stated that the pipes in this region have expired, and the lime rate in Safranbolu's waters is high considering the water network system. It was supposed to be calcification on their walls (Safranbolu Municipality, 2020). This situation affects fire combat for fire brigade services regarding water supplies. In addition, the difficulty of *water supply* by tankers due to the unique character of Safranbolu with the traditional urban pattern was emphasized (FireSkills Project Manual for Residential Users).

Furthermore, many traditional and modern fountains can be evaluated as *water supply sources* for firefighting in the City of SWHS. Many traditional or modern fountains are settled in Safranbolu (Figure 75). However, while some of those fountains are used, some are not. Therefore, further investigations should be conducted to utilize fountains during firefighting. The amount of water and the pressure of water should be evaluated by experts. Fountains in the site were shown in the analysis.

Figure 75 Fountains in the City of SWHS that were investigated during the site survey in 2020

Firefighting staff and equipment are insufficient in Safranbolu. There are problems related to *technical capacity*. The minimum number of personnel required to be present in a shift in the Fire Brigade should be sufficient to respond to a fire, at least eleven people, one of whom is an electrician. However, the current number in Safranbolu is six people, which seems insufficient during fire response (Safranbolu Municipality, 2020).

There are seven fire trucks in Safranbolu Fire Brigade, and only three are sufficient in terms of water supply capacity as stated in Fire Regulation (Safranbolu Municipality, 2020). In addition, the lack of policy documents for fire brigade staff was also emphasized (FireSkills Project Manual for Residential Users). It is also essential to let the firefighting team know the site characteristics such as topography, accessibility, population density, and building plans. The better knowing the neighborhoods and buildings, the better they combat a fire.

Yılmaz (2018) asserted that there was no field study including mapping, water supply, and firefighting area according to building characteristics in Safranbolu with the support of all parties on fire safety. Suitable fire trucks for various settlement attributes are absent (Yılmaz, 2018). The news: ‘’Fire in Historic Building in Safranbolu *(Safranbolu'da tarihi konakta yangın)* [URL 43]’’ stated that there was insufficient technical capacity in Safranbolu to combat the fire on 3 May 2010. This historic building was 474 years old, used as a hotel, and restored [URL 43]. (Figure 76)

Figure 76 Historic Building Fire on 3 May 2010 [URL 43]

The presence of a *fire hydrant* in the streets is another essential factor for fire combat within the neighborhood scale**.** The number of fire hydrants on the site is insufficient as well. There are 44 fire hydrants in Çarşı Region. A study was conducted to test all fire hydrants' performance in the City of SWHS. The flow rates of 7 of the 44 existing fire hydrants were evaluated as appropriate, and the pressures of 4 were assessed as proper (Safranbolu Municipality, 2020). Considering 44 fire hydrants, having 7 and 4 appropriate for each issue is problematic. Most of the fire hydrants on the site have technical problems.

Approximately 88% of fire hydrants are below the standards specified in the regulation because the pipes in this region have expired, and the lime rate in Safranbolu’s waters is high; it was assumed that there is calcification in their walls (Safranbolu Municipality, 2020). Furthermore, most of those fire hydrants stay in poor condition. Moreover, the number of fire hydrants is insufficient considering the density of historic buildings on the site. This issue was also emphasized in different documents prepared for the Safranbolu (FireSkills Project Handout; Yılmaz, 2018).

*The level of preparedness within the neighborhood scale* is another crucial factor for fire combat. As was discussed in the previous part of the thesis, within FireSkill International Project, a survey[53] was conducted on historic building users' in the City of SWHS. In this part of the thesis, the results of this survey were discussed since the level of preparedness of users for fire risk management of cultural heritage is a critical factor, which was assessed within fire combat on a building scale and neighborhood scale (FireSkills Project Report):

- The success rate of 50% on average for the participants' level of knowledge on risk assessment is not sufficient.
- The level of knowledge about the maintenance requirements and safety of historical buildings was evaluated. They are sensitive to the fire safety of historic buildings.
- The success rate for the participants' level of understanding of fire risk assessment was around 50%. The participants' level of knowledge on risk assessment was assessed as insufficient.
- The participants' level of knowledge of fire risk management was around 15%, which was assessed at a very low level. These results suggest a need for specific training for fire risk management.
- The perspectives and knowledge levels of the participants about the precautions and measures for protecting historical buildings from the fire were evaluated. The participants did not generally respond to the questions at the desired level.

[53] The questions of this survey in FireSkill Project can be found in Appendix K.

- The rate of participants' perspectives on fire safety was around 30%. The success rate of participants on basic principles of fire at the introductory level is approximately 40%.
- 62% of the respondents stated that their buildings did not pass fire inspection.
- The success rate of participants in fire extinguishing is around 50%. Of the participants' levels of awareness, 67% know the escape points from their building in case of a fire. 74% answered that family members do not know what to do. Although the level of personal knowledge of the participants about evacuation is relatively high, the level of appropriate behavior of other family members regarding evacuation is deficient.
- Although the emergency numbers are known by 85%, 15% of the participants do not know the emergency number.
- 71% of the participants stated that there was no fire alarm system in the buildings they use; 60% claimed that the fire extinguishers in their buildings were not checked regularly.
- 81% of the participants did not conduct fire drills with the Fire Brigade in their buildings, and 67% stated that their electrical installations were not checked regularly.
- The level of participants in fire prevention measures was around 30%. In the data obtained from the risk management department, the correct answer percentages are very low. The success rate is around 15%. These results suggest a need for specific training in risk management. The accuracy rate of the answers regarding fire prevention measures is about 30%.
- Although the personal knowledge level of the participants about the evacuation behavior in fire incidents was evaluated as sufficient, the level of knowledge of the individuals who lived in the same building during the evacuation was quite insufficient. The knowledge levels of the participants in cooperation with emergency organizations, expected behavior, and exercises are low (FireSkill Project Report).

According to the results of these surveys, it should be stated that their users' awareness of fire risk reduction in traditional buildings is limited. At this point, the level of preparedness at the building and neighborhood level can be assessed as low. The participants did not generally respond to the questions at the desired level about the precautions and measures for protecting historical buildings from fire. 71% of the participants stated that their buildings had no fire alarm system. However, since these data are not gathered within the building scale, they are not evaluated in the FVA of the Çeşme Neighborhood. For each traditional building, the level of preparedness should be assessed.

### 4.7.Application of the Proposed Methodology to the Case of SWHS

Necessary data were obtained through literature review, site survey, and interviews to apply the proposed methodology to the case area, as was discussed in the methodology section of the thesis. Those data were inserted into GIS, and a database related to the fire vulnerability of Safranbolu was prepared. Furthermore, the fire inventory of Safranbolu Fire Brigade Analysis between 2015 and 2020 was used. Past fires from Fire Brigade Archive and fires investigated during site surveys were inserted into the base map. Burnt building investigated during site survey shown as a dot data. Past fire incidents, derived from Fire Brigade Archive, where building information is not clear, were shown on the streets.

In addition, as was discussed in the methodology part of the thesis, the proposed methodology is applied to Çeşme Neighborhood in the Çarşı Region of the City of Safranbolu WHS. Accordingly, data related to fire ignition sources, combustible materials, fire combat within the building scale, and fire combat within the neighborhood scale were evaluated for the fire vulnerability of the Çeşme Neighborhood. The data of each category, including the ignition sources, combustion materials, fire combat within the building, and fire combat within the neighborhood, was inserted into the Geographical Information System, and indicators in accordance with increasing or decreasing fire vulnerability were assessed both in the building and neighborhood scale for fire vulnerability of Çeşme Neighborhood.

Different *ignition sources inside and outside buildings affected Safranbolu's fire vulnerability*. Ignition sources in building or adjacent plot, the existence of old electrical installation system, ignition sources using open flames, and building in restoration/maintenance that needs heat applications or flammable materials are assessed for each traditional building in Safranbolu. Due to hosting accommodation facilities, residential use, various commercial uses, and public uses, different fire ignition sources exist in traditional buildings in Çeşme Neighborhood. Thanks to being used as residential, accommodation, or commercial, there is always the possibility of different appliances that can start a fire.

Indicators related to the existence of combustible materials are also evaluated. Different *combustible materials inside and outside of traditional buildings* affected the fire vulnerability of Safranbolu. Flammable materials in the building or adjacent plot, green areas such as parks, vegetation, tree, and forest are assessed. Safranbolu, due to its unique natural characteristics, includes various landscape elements. In addition, bush and rubbish near a building are considered a source of flammable materials. Past fire incidents in Safranbolu showed that bush and rubbish fires are critical. The structural condition of the building and the existence of other flammable stuff were assessed. Since most of the traditional building in Safranbolu was constructed with timber skeleton systems, they automatically included flammable materials inside.

Fire combat within the building is elaborated. Those indicators are the vacancy situation of the building, the existence of active fire protection systems, and controlling whether designed right and works properly and an alarm goes automatically to the fire brigade[54]. While assessing *fire combat within the building scale***,** insufficient detection suppression systems and an insufficient level of preparedness were figured out. According to a survey conducted by FireSkills Project, 71% of the participants stated that there was no fire alarm system in the buildings they use. This response rate is critical for historic buildings with ignition sources and combustible materials. For

[54] In addition, the level of awareness/preparedness of occupiers for fire safety should also be assessed. Within thesis time, owners of each traditional can not be assessed; therefore, this parameter is not evaluated within this research. However, in further investigation, owners' level of awareness or preparedness should also be assessed.

working units such as commercial and accommodation facilities, it is required to have manual fire suppression systems. On the other hand, having manual suppression systems is not an obligation for residential uses. This situation is also a critical issue for the fire vulnerability of traditional buildings in Safranbolu.

*Vacant buildings in Çeşme Neighborhood* constitute a significant part with a very high fire vulnerability degree. Especially in the south part of the Çeşme Neighborhood, traditional buildings remain vacant and in poor condition. Kalealtı Street, Yokuşbaşı Street and Eski Camii Street there are dominancy of vacant buildings. In addition to being in poor condition and not having proper detection, alert, and alarm systems, this category of traditional buildings has a very high fire vulnerability degree.

*Fire combat within the Çeşme Neighborhood scale* is assessed to evaluate traditional buildings' fire vulnerability. Parameters for neighborhood-scale fire vulnerability are building accessibility in terms of street width and slope, the existence of a fire hydrant next to a building in 50 m, and distance to the fire station. In addition, the adequacy of the technical capacity of the fire department, the level of awareness/preparedness of the fire brigade, and the water supplies nearby that can be used during firefighting are assessed.

Accordingly, some streets in the Çeşme Neighborhood are *not accessible* during a fire incident. There are streets less than 4 meters. Those streets in Çeşme Neighborhood are Müftü Street, Karaüzüm Street, Arasta Arkası Street, Cebeci Street, Kundurucalılar Street, Street passing from Hükümet Street through Mescit Street. In addition, *the dead-end streets in the historic environment* also increased the fire vulnerability of traditional buildings. For example, traditional buildings in dead-end streets past Hükümet street have *very high* fire vulnerability degrees. In addition to not being accessible during a fire incident, there are no fire hydrants within 50 m in this region.

Analysis conducted by the Municipality showed the insufficiency of *fire hydrants* in the neighborhood and technical capacity. Most fire hydrants have technical problems and are in poor condition. 88 % of fire hydrants are under technical standards (Safranbolu Municipality, 2020). Moreover, the number of fire hydrants is insufficient considering the density of historic buildings on the site. There are nine fire hydrants in Çeşme Neighborhood. These fire hydrants have technical problems, 9 have insufficient flow, and 8 of 9 have inadequate pressure. However, the one with sufficient pressure has difficulty opening and water leaking.

At south part of Çeşme Neighborhood, especially Kapıcıoğlu Street and Debbah Pazarı, Eski Cami, Eski Hamam Street, Yokuşbaşı Street there are sub-areas that fire hydrants do not service during a fire incident. Past fire incidents in Kapıcıoğlu and Debbah Pazarı Street also confirm this situation.

There are many fountains in the City of SWHS. Fountains are shown in all analysis maps. While some of them are in use, some are not. Since a detailed investigation is not made, they are not evaluated in fire vulnerability assessment. On the other hand, after detailed investigations, these local values can also be used during fire extinguishing by users of traditional buildings.

Following the existence or absence of these parameters, the fire vulnerability degree of traditional buildings was assessed. Five levels, including *very low, low, medium, high, and very high,* are classified for the level of fire vulnerability degree of traditional buildings.

The spatial analysis for fire vulnerability assessment showed that traditional buildings in the Çeşme Neighborhood are vulnerable to fires at different levels (Table 41). There are different factors affecting these results. Accordingly, the south part of the neighborhood has a medium and high level of vulnerability. In this part of the neighborhood, there are many vacant buildings, some of which are in poor condition. In addition, very highly vulnerable traditional buildings mainly exist in areas having accessibility problems in terms of street width and slope.

The first building group is assessed with a *very low fire vulnerability degree.* 3 % (7/233) of traditional buildings in the Çeşme Neighborhood have a very low-level fire vulnerability. In this category, buildings with stone masonry systems and public uses are evaluated. In this category, buildings are in good condition, and there are no dangerous ignition sources. Therefore, they are assessed as very low fire vulnerability degrees.

The second building group is evaluated in the *low fire vulnerability degree*. In this category, there are different types of traditional buildings. 36 % (86/233) of traditional buildings in the Çeşme Neighborhood have a low-level fire vulnerability. Residential buildings with stone masonry construction systems are evaluated in this category since they have ignition sources in buildings; however, there are no flammable materials in their construction system. Therefore, they are assessed as having a low fire vulnerability degree.

The third category of the building is assessed in *medium fire vulnerability degree.* 35 % (83/233) of traditional buildings in the Çeşme Neighborhood have a medium-level fire vulnerability. In this category, buildings have ignition sources and combustible materials. Most buildings in the commercial city center and accommodation units are evaluated in this category since they are not vacant and are supposed to have manual fire extinguishing systems. In addition, accommodation units are required to have a smoke detector and gas detector.

The fourth category is evaluated in *high fire vulnerability degree*. Within this category, traditional buildings are used as residential, and they do not have fire combat tools within the buildings despite having ignition sources and combustible materials. 10 % (24/233) of traditional buildings in the Çeşme Neighborhood have a high-level fire vulnerability.

There are traditional buildings with *very high fire vulnerability degrees.* 14 % (33/233) of traditional buildings in the Çeşme Neighborhood have a very high-level fire vulnerability. This analysis showed that vacant buildings have a very high vulnerability in terms of being unable to provide fire combat within the building. In addition, most of the vacant traditional buildings in Safranbolu stay in poor condition. This situation also increases the fire vulnerability of those buildings since the flammability of materials increases with decayed structural systems and materials. In addition, residential buildings are included in this category since they have ignition sources and combustible materials, and there are no fire combat tools within the building and neighborhood scale.

In conclusion, this simplified method showed traditional buildings that urgent mitigation policies and interventions should be applied. It is a preliminary assessment tool presenting highly vulnerable traditional buildings and areas. In the south of the Çeşme Neighborhood, where vacant and decayed traditional buildings are located, traditional buildings need urgent fire risk mitigation actions both on a building and neighborhood scale

Table 41 Fire Vulnerability Levels and Their Distribution in the Çeşme Neighborhood (prepared by the author)

| Fire Vulnerability Category | Explanation | Percentage | Samples |
|---|---|---|---|
| **Very Low** | No major ignition sources<br>No combustible materials in the construction system<br>Stone Masonry<br>Concrete<br>Public Use (Administrative) | 3 %<br>(7/233) |  |
| **Low** | Ignition source<br>No combustible materials in the construction system<br>Commercial Use (giftshops) | 36 %<br>(86/233) |  |
| **Medium** | Existence of Ignition source and Combustible materials<br>Fire extinguishers partially exist.<br>Accommodation and commercial uses | 35 %<br>(83/233) |  |
| **High** | Existence of Ignition source and Combustible materials<br>Partial fire extinguishers<br>No fire hydrant service<br>Accommodation and residential uses | 10 %<br>(24/233) |  |
| **Very High** | Ignition source<br>Combustible material<br>Fire extinguishers partially exist.<br>No fire hydrant service<br>Vacant buildings,<br>Residential uses | 14 %<br>(33/233) |  |

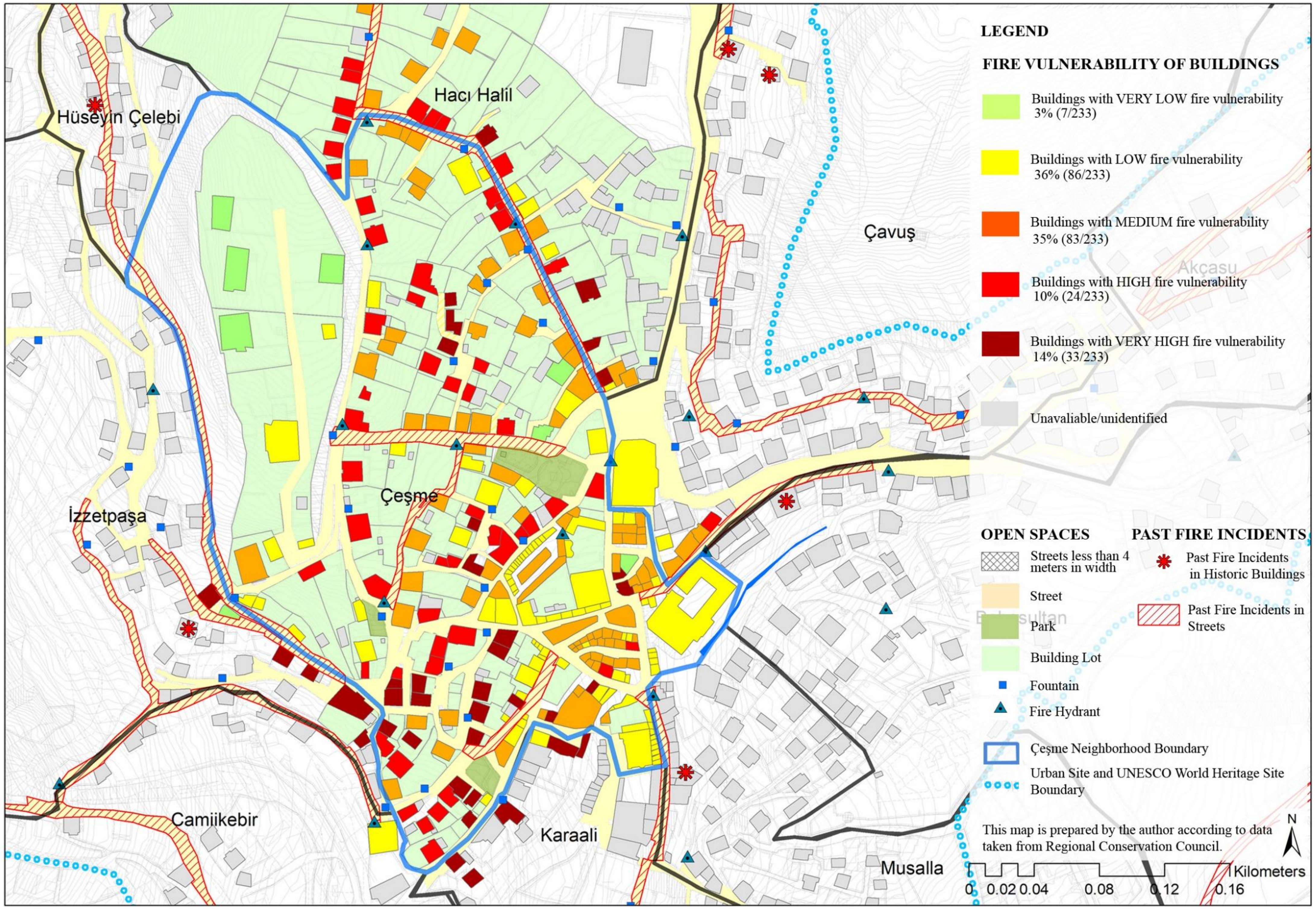



Figure 77 Fire Vulnerability Level of Buildings in the Çeşme Neighborhood

# CHAPTER 5

# CONCLUSION

Fire has been one of the most devastating hazards that historic buildings and environments encounter throughout history. The most recent and well-known examples are Notre Dame Cathedral and Brasil Museum Fire. Likewise, two or three historical buildings were lost yearly due to such fires in Safranbolu (Personal Interview, 2019). In addition to its impacts on the physical environment, fires also affect social and economic life in cities. In addition, if a fire in a traditional building sprawl to a neighborhood, the effects of fires on an urban scale can be more destructive.

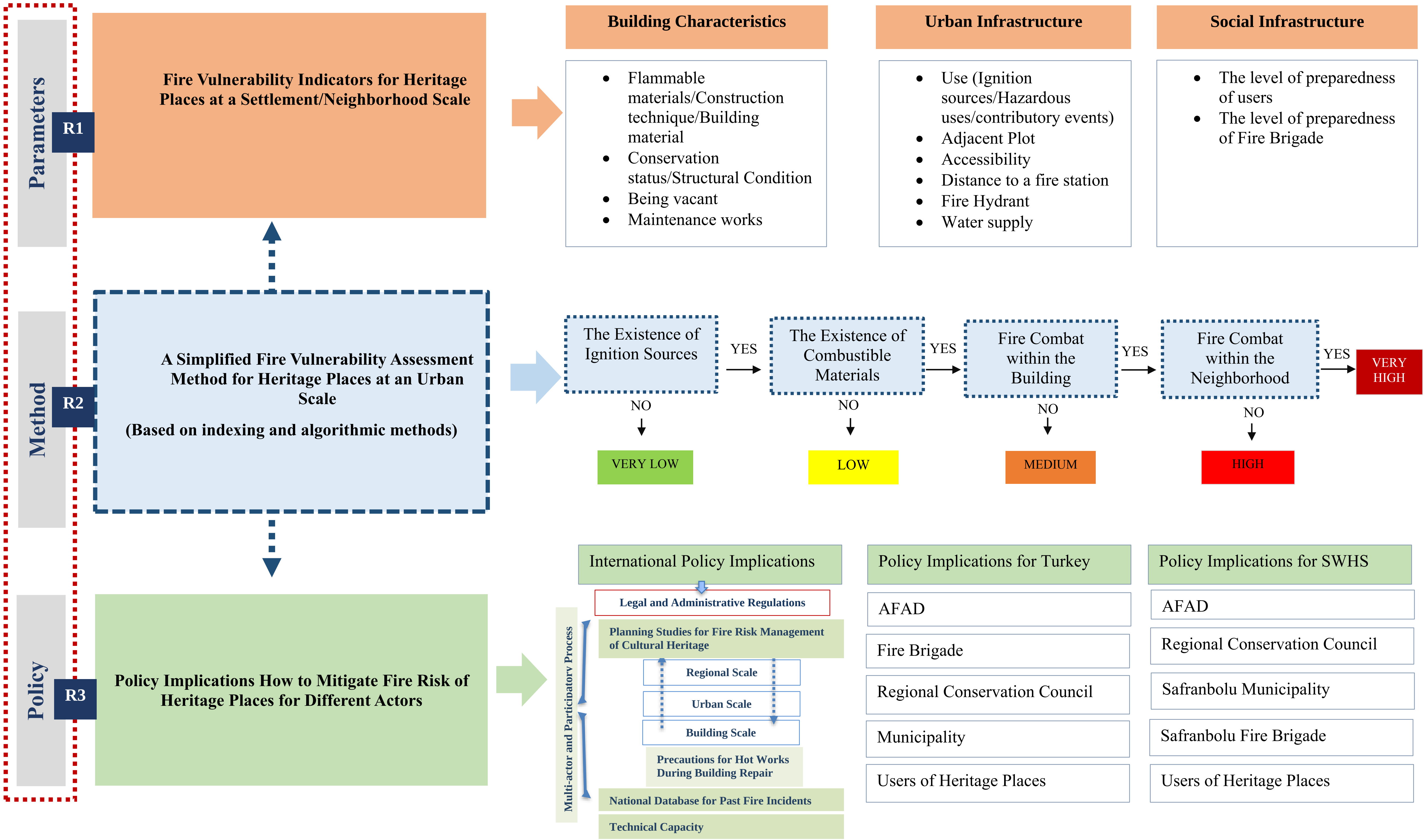
Every building might face a fire in its entire life. Its probability is higher than the other hazards (Torero, 2019). However, contrary to other disasters, fires can be prevented. So why cultural heritage could not be conserved against fires should be the primary concern for different actors. There are several quantitative methods for fire risk assessment in the related literature, but they require excessive human and financial support. Also, the combination of complex parameters may cause higher errors in fire risk calculation (De Smet, 1999, cited in Santana et al., 2007). In addition, the majority of methods focused on single building assessments. Most of the fire risk assessment and fire vulnerability assessment indicators are based on buildings' interior and exterior characteristics. In this sense, the integration of urban infrastructure into those methods is limited. Therefore, they do not apply to historic environments at larger scales. Accordingly, this thesis aimed to assess the fire vulnerability of historic buildings at an urban scale by focusing on the City of Safranbolu WHS.

The method of the thesis was mainly based on a qualitative approach. It classifies fire vulnerability by confirming the existence or absence of those indicators inside and outside traditional buildings. Accordingly, four categories of indicator sets are defined, including ignition sources, combustible materials, fire combat within the building, and fire combat within the neighborhood. Those indicator sets are related to building characteristics, urban fabric, and infrastructure. With the help of this new simplified method, it is easy to identify Highly Vulnerable Areas, buildings, and the required interventions in historic settlements. A large number of cultural heritage assets can be assessed by this method when resources are limited, and it can be used as a screening tool to evaluate the fire vulnerability of traditional buildings and environments.

All stakeholders responsible for the sustainability of heritage places like municipalities, Fire Brigades, site managers, and different users of heritage places can benefit from this method since it requires less human and financial sources within a shorter time.

This new method proposed and applied in this thesis can be used for other heritage places. The fire risk can be mitigated, and every required precaution should be taken to prevent fires. This thesis has contributed to the parameters of fire vulnerability assessment for cultural heritage. In addition, it tests the proposed simplified qualitative fire vulnerability method at an urban scale in the City of Safranbolu WHS. Lastly, this research provides policy implications on how to mitigate the fire risk of heritage places for different actors (Table 42).

Table 42 Contributions of the research regarding parameters, method of FVA of CH, and policy of FRR for CH (prepared by the author)



## 5.1.Planning, Conservation, and Fire Risk Management

The role of planning and planner in fire risk management of cultural heritage is critical. In different planning scales, the conservation of cultural heritage is considered in different aspects. Planners are enrolled in regional, urban, and building scale interventions in addition to other responsible actors. Each decision taken on a regional, urban, and site scale should consider fire risk mitigation of cultural heritage. However, regulations, policies, principles, and interventions to mitigate fire risk are limited or absent.

In the upper scale plan, as was discussed before, *accessibility* and *land use decisions* can affect fire risk mitigation of traditional buildings and environments. Accessibility to cultural heritage sites in case of emergency is essential. Upper-scale plans should consider the accessibility of cultural heritage sites. In addition, hazardous land use should be far away from cultural heritage. The location of the fire station should be assessed in land use by considering where cultural heritage sites are located. Accordingly, the fire station should be located within 1.4 km of the cultural heritage site in case of any fire incident.

*A conservation and development plan* is prepared for cultural heritage. Following Article 17 of Law No. 2863, conservation plans are mandatory to be prepared in conservation areas; there is an article about the planner's responsibility. It was stated that the project owner of the conservation plans is the city and regional planner. In this sense, the role of planning and planners in urban conservation planning and fire risk mitigation of cultural heritage is crucial.

## 5.2.Policy Implications about How to Mitigate Fire Risk of Heritage Places

Although fire is preventable, unlike other types of hazards that can turn into disasters, it is a risk that threatens historical structures and environments with high vulnerability and has severe consequences. In addition to being a primary disaster, fire is a secondary disaster that can occur after disasters such as earthquakes, landslides, and volcanic eruptions increase the risk of fire for cultural heritage. To reduce the risk of fire threatening cultural heritage, the existence of legal and administrative documents supporting integrated policies gains importance. This risk may become even more complex for cultural heritage located in urban areas. Different land uses in urban areas, which can sometimes be considered dangerous, accessibility problems, and technical capacity inadequacies can also increase this risk. Fire risk management covers the prevention of fires, detection of fires, and suppression of fires. This situation in the fire risk management process necessitates different policies. At first, legal and administrative documents are needed to support integrated policies that can reduce such risks to cultural heritage in urban areas. At this point, international and national-level policies addressing these measures are essential.

- **Enhancing legal and administrative regulations on fire risk management in terms of cultural heritage**

The first is the necessity of developing legal and administrative regulations on fire risk management in terms of cultural heritage. Although it is thought that legal and administrative regulations alone will not be sufficient, the lack or inadequacy of such documents in guiding policies will undoubtedly increase the existing risks. The "Regulation on the Protection of Buildings from Fire (BYKHY)" is a legal document that explains precautions that can be taken against fire risk in Turkey. This document also has a separate section on cultural heritage fire risk. However, there is a need for more detailed and explanatory legally binding regulations because of the diversity of cultural heritage. In addition, various factors that may cause fire at different planning scales exist for cultural heritage. In this sense, comprehensive regulations in line with the Turkish Cultural Heritage Conservation and Disaster Risk Management legislation are necessary under the leadership of international policies.

- **Assessing the fire risk reduction of cultural properties at different planning scales**

Another policy is to evaluate the fire risk reduction related to cultural properties at different planning scales. Regarding cultural heritage, risk can be reduced if fire risk management is the subject of planning and design studies at different scales and is handled in an integrated and mutually supportive manner. Site selection and accessibility decisions for uses containing flammable and explosive materials on a *regional scale* are planning decisions that can contribute to fire risk management. In addition, it is necessary to consider fire risk reduction in planning studies on *the site scale.* Site-scale policies cover site and building use decisions, accessibility, fire brigade site selection, fire hydrant placement, and preparation of fire risk management plans. The precautions on the building scale can be summarized as early warning systems, sprinkler systems, fire cabinets, fire hydrants, control of electrical installations, showing the necessary sensitivity to flammable materials, and creating fire compartments. Active and passive measures can be taken to prevent fire and reduce risks at the building scale. Passive measures include the arrangements made for the structure. Active measures include fire extinguishing systems and detection and warning systems. Another policy specifies the explanatory principles for the heat treatments applied during building repair and adds them to the contract texts. The examples from the past also show that if adequate precautions are not taken during the restoration and this process is not controlled, fires can break out, and historical buildings can be severely damaged.

- **Enhancing multi-actor and participatory fire risk management process**

Another policy is to provide *a multi-actor process* that can take part in fire risk management regarding cultural heritage. Various actors are responsible for protecting cultural heritage and disaster risk management during fire risk management of cultural heritage. It is essential to ensure the active participation of responsible actors in central and local governments and historical building users in the process. Fire risk reduction is possible through this multi-actor and dynamic participation process.

Another issue related to cultural heritage fire risk management is *increasing and developing technical capacity*. Due to the unique traditional textures of historical buildings, intervention in these structures requires differentiation from intervention in fires that occur in existing structures. Accordingly, drills should be organized by informing the technical personnel responding to the fire in historical buildings about the responsibilities before, during, and after a fire.

- **Establishing a national database on fires encountered by historic buildings and environments**

Another important policy is preparing a national database on fires encountered by historic buildings and environments. These databases should include information on past fires, enable the contributions of all relevant institutions, and should be updated at regular intervals. In addition to the essential characteristics of the heritage structure, this database should include details such as materials and fire-related information. The absence of such a database in Turkey makes it difficult to assess the magnitude of the fire risk that cultural heritage faces. Huang et al. (2009) emphasized that databases on past fires should be handled to show the differences in the natural environment and economic factors in different regions where fires occurred. The connection of the fires with the natural environment and economic development should not be ignored as well.

As seen in this research, fire has been one of the critical threats affecting cultural heritage. However, many historic buildings in many countries still face a severe fire risk and are damaged or destroyed. This situation shows that the current national and international policies are insufficient or limited. The lack of explanatory and legally binding regulations on managing the fire risk for cultural heritage draws attention. When the example of England is examined, it is noteworthy that there are various regulations especially prepared by 'Historic England' against the fire risk faced by historic buildings and environments. However, these regulations are handled independently of the planning studies and are not legally binding. Although the existence of such regulatory documents is essential, being not binding may leave the fire risk management to the initiative of the users. On the other hand, it can be said that what kind of measures to be taken for fire safety of cultural heritage at a site scale is insufficient. Regulatory documents have been limited to building-scale policies.

On the other hand, in the case of Turkey, there is a need for legal and administrative regulations explaining the management of the fire risk faced by the cultural heritage. Considering the diversity of cultural heritage, the precautions that can be taken may differ accordingly. The subject is only dealt with in the "Regulation on Protection of Buildings from Fire," which shows many required steps for Turkey. Adopting the policies in this study is vital to avoid losing historic buildings and environments due to fire, a preventable threat. The policy framework presented by this study constitutes a base for other countries at risk of fire in terms of cultural heritage.

## 5.3.Fire Vulnerability Assessment Indicators and Method for Heritage Places on an Urban Scale and Using Fire Vulnerability Assessment Method as a Fire Risk Mitigation Tool

The FRA method is proposed to assess the fire vulnerability of heritage places at the settlement scale in this study. FRA of CH has based on four categories of indicator sets, including (i) The existence of ignition sources, (ii) The existence of flammable materials, (iii) Fire Combat within the Building, and (iv) Fire Combat within the Neighborhood (Figure 78). Each indicator set includes related indicators/parameters discussed in the literature. Ensuring each indicator inside and outside the building specifies the degree of fire vulnerability of a heritage building.

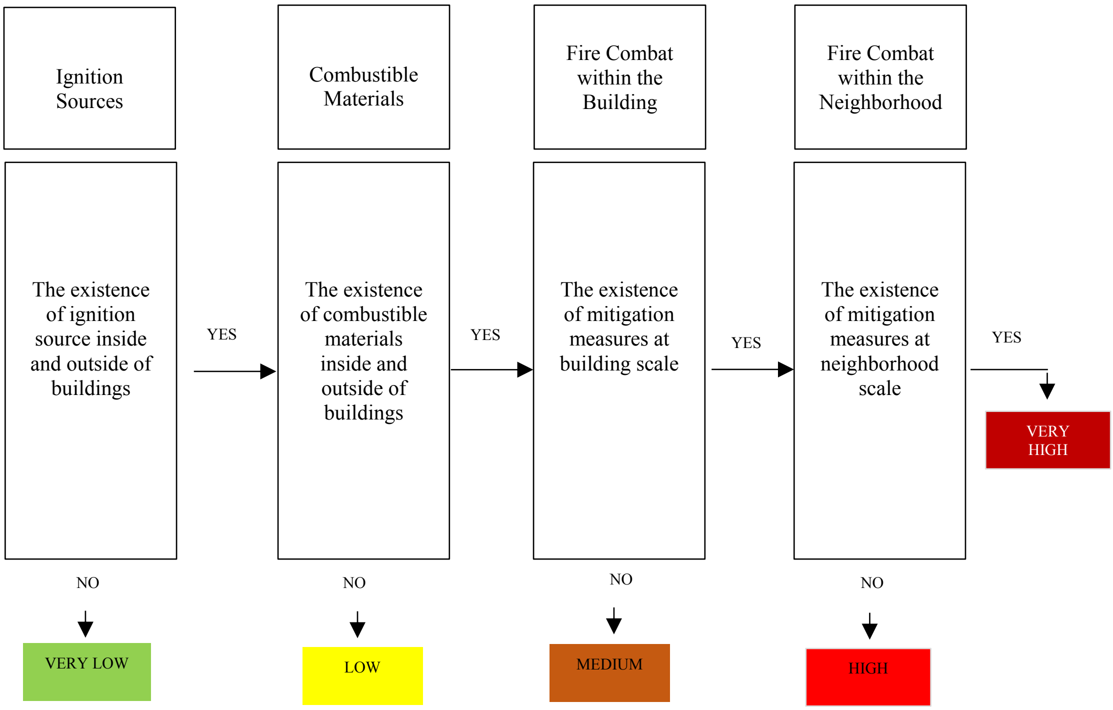



Figure 78 Fire Vulnerability Assessment Method for Cultural Heritage (prepared by the author)

This method can assess the fire vulnerability of traditional buildings and provide policies and interventions to mitigate the existing fire risk. With the method of FVA of CH, site managers, fire brigade, and Provincial AFAD Directorate may understand the level of fire vulnerability.

In addition, the policies required for reducing the fire risk of heritage buildings can be understood. In this way, the level of fire vulnerability could be mitigated, and areas that need further analyses can be identified. The simplified method developed within this study can also be used as a fire risk mitigation tool for cultural heritage. Four categories of indicator sets that include ignition sources, flammable materials, fire combat within the building scale, and fire combat within the neighborhood scale could be evaluated to decide what policies or interventions contribute to mitigating cultural heritage fire risk.

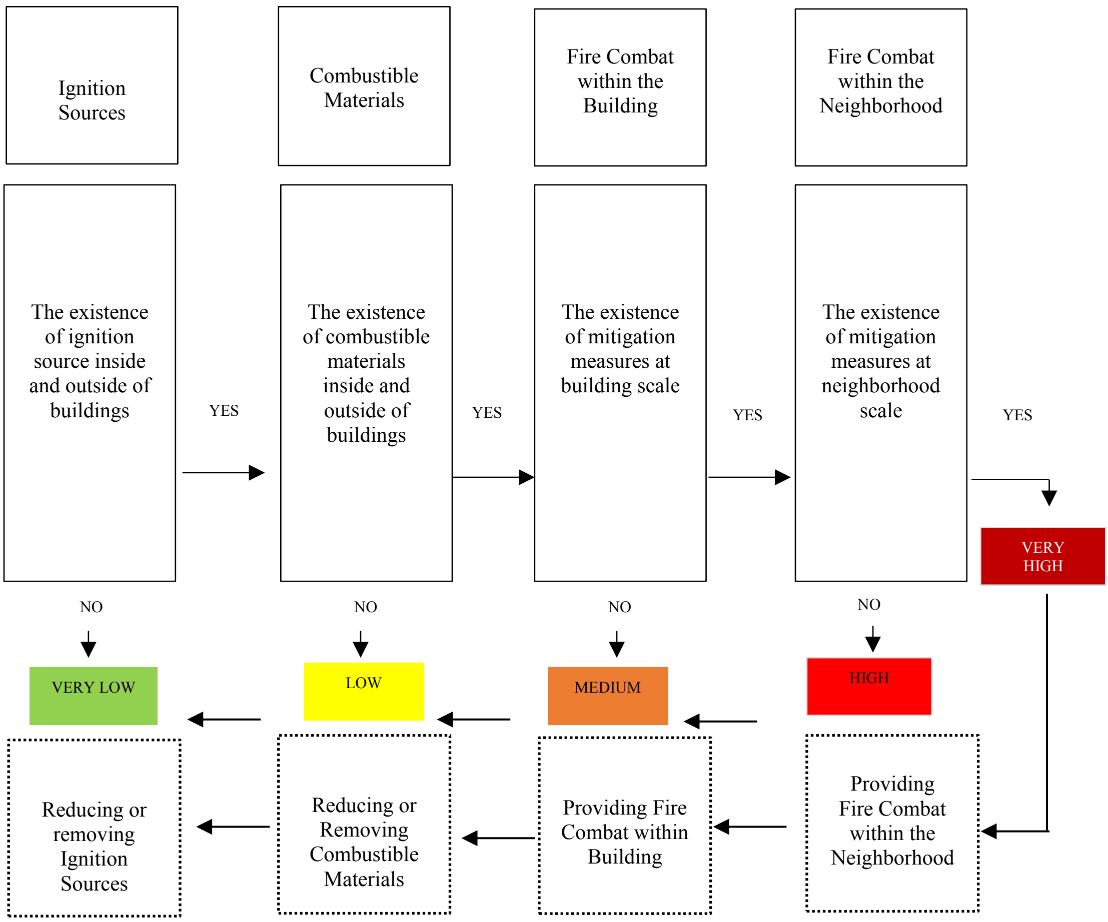



Figure 79 Using Fire Vulnerability Assessment Method as a Fire Risk Mitigation Tool (prepared by the author)

If a traditional building is assessed within a very high vulnerability degree category. In that case, the indicators in this category are elaborated on whether they are existed or absent, and necessary precautions can be taken concerning providing fire combat within the neighborhood, fire combat within the building, excluding or reducing combustible materials, and ignition sources. If each category is evaluated on a checklist, it can be easier to find appropriate building and neighborhood scales interventions.

If one of the indicators of fire combat within the building is not achieved by the existence or absence of one or more indicators. In that case, fire risk mitigation could be provided within the building scale by mitigating or preventing the risk that indicator brings. For example, if a building does not have active fire precaution systems such as sprinklers, suppression, alarm, and early detection systems, fire risk mitigation within the building scale can be achieved by implementing such measurements. In addition, if there are problems regarding indicators related to combustible materials, the fire risk can be mitigated by removing or reducing combustible materials.

Briefly, each indicator or parameter in four categories could be evaluated as a policy or intervention for cultural heritage fire risk mitigation. If the insufficiencies in each category are solved, fire risk can be mitigated concordantly. For example, if there are problems related to ignition sources inside and outside of heritage buildings, fire risk mitigation could be provided by preventing problems led by ignition sources.

## 5.4.Policy Recommendations for Different Actors enrolled in Fire Risk Management of Heritage Places

The thesis discusses fire vulnerability assessment of cultural heritage at the settlement scale. As discussed in the previous part of the thesis, most cultural heritage fire vulnerability assessment is based on building scale. Methods applied on an urban scale are also limited. Their urban-scale implementation is complex due to time and costs limitations. Accordingly, it is crucial to assess the fire vulnerability of cultural heritage on a larger scale with a more straightforward method that different actors could easily apply.

Namely, in this thesis, the fire vulnerability of heritage places is related to various factors. In this study, factors are classified as (i) The existence of ignition sources, (ii) The existence of flammable materials, (iii) the Fire Combat within the Building Scale, and (iv) the Fire Combat within the Neighborhood Scale. Following those indicators, different policies arise for various stakeholders responsible for the conservation of cultural heritage, including municipalities, fire brigades, site managers, and occupiers, to mitigate the fire risk of cultural heritage.

### 5.4.1. Policies for Users

26 of 102 fires happened due to negligence in Safranbolu between 2013 and 2017 (FireSkill Project Report, 2017); however, most fires can be prevented via good housekeeping (Haire, 2014). CFPA-E (2013) states that simple and low-cost actions can be applied for the fire safety of historic buildings. Those actions include good housekeeping such as regular cleaning, proper storage and disposal of litter, controlling electrical equipment, cutting the grass in the close surrounding of the building, recording incidents, and maintenance. Those actions could be taken by owners/occupiers of the historic buildings.

Some policies are related to the existence of ignition sources, flammable materials, and fire combat within the building that occupiers of traditional buildings can follow to prevent or mitigate fire risk.

Occupiers of traditional buildings can check *the existence of ignition sources* inside and outside their properties. When the reasons for fire in heritage buildings are analyzed, the most seen reason is a malfunction of electrical installations and heating equipment. Since many heritage buildings are not constructed in accordance with current electrical systems and equipment, using too much electrical equipment or having an old electricity wiring system results in fires. Combustible materials can be ignited via open fires, smoking materials, candles, and heating equipment due to contacting directly and thermal radiation (CFPA-E, 2013). They regularly should be controlled.

The use of electric equipment is a significant issue in historic buildings. Users should carefully use and control equipments in historic buildings[55]. Information should be given on using stoves, boilers, and ovens correctly. Accordingly, at this point, the awareness of owners/occupiers should be increased regarding using electrical equipment, and regular control of the wiring system should be enhanced.

In addition, they also can control *the existence of combustible materials* both inside and outside of traditional buildings. With the age of the building, the materials in the building might change, which can reduce the fire performance of heritage buildings. Therefore, regular repair and maintenance works should be conducted. Cutting the branches of the trees in the close vicinity of traditional houses that come into contact with the building, cleaning the leaves gathered on the roof of buildings. Regular environmental cleaning of houses, cleaning grass and leaves. Filters in kitchen hoods should be cleaned frequently. There should not be significant amounts of flammable liquid gas in the warehouses inside the houses. There should be no easily flammable plastic or foam materials close to the burning equipment in the warehouses inside the house. There should not be excessive flammable gas and oil in the kitchens. Roofs should not involve combustible or hazardous materials.

In addition, there are some interventions for *fire combat within the building* that owners can apply. Active fire safety equipment such as fire suppression and early detection systems should be implemented. Conservation experts should be approved for proper fire suppression and early detection systems.

### 5.4.2. Policies for AFAD and Provincial AFAD Directorates

As stated, the Turkey Disaster Response Plan (TAMP) aims to define the roles and responsibilities of the service groups and coordination units that will participate in the emergency response and determine the basic principles of response planning before,

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[55] See Appendix N for Precautions for electrical equipments that occupiers of traditional buildings can follow.

during, and after the disaster. TAMP includes ministries, institutions and organizations, private organizations, NGOs, and natural persons who will respond to disasters and emergencies of any type and scale that may occur in Turkey [URL 39]. In this plan, the role of different actors in disaster risk reduction of cultural heritage should be enhanced.

In addition to TAMP, Provincial Disaster Risk Plans are prepared for each city in Turkey. The Provincial Disaster Risk Reduction Plan (IRAP) is a plan that reveals the disaster profile of the province and the possible effects of disasters, shows the actions to be taken, and defines the responsibilities of different actors enrolled in disaster risk management of cities. Provincial AFAD Directorates are the primary actors preparing Province Disaster Risk Mitigation Plans.

It is produced with the institutions in the provinces and all other relevant stakeholders. Since provinces have different dynamics and disaster risks, each local will reveal its priority hazards, risks, and risk reduction actions by all stakeholders in that locality and implementation [URL 40].

Within this plan, cultural heritage fire risk management should also be integrated considering the scope of those plans since an integrated disaster risk management process can mitigate current risks.

### 5.4.3. Policies for Fire Brigades for Fire Risk Management of Cultural Heritage

There are different policies that the fire brigade can apply during a fire event happening in historic buildings and environments. First, fire brigades should know how to combat a fire that historic buildings and environments face during firefighting. They also should know that a high amount of water use can damage cultural properties and their contents. Accordingly, fire drills should be organized for fire brigade services. The equipment compatible with historic environments should be provided as well. If a building includes important contents, the fire brigade should evacuate them.

For effective rescue and firefighting, streets should provide *accessibility* to fire brigade services during emergency and response situations. Accessibility of streets and the suitability of fire tracks to existing transportation networks should be controlled.

Fire Brigades should control *water supplies* that will be used in firefighting. If there is no sufficient water supply, alternative water supplies such as a swimming pool, lake, and underground cistern should be provided (CFPA-E, 2013).

Electric transformers and panels in the neighborhood should be cleaned of combustible materials. Regular cleaning should be enhanced. In addition, the electrical system in traditional buildings must comply with "Electric Heavy Load Installation Regulation (Elektrikli Ağır Yük Kurulumu Yönetmeliği), Indoor Electrical Installation Regulation (İç Mekan Elektrik Tesisatı Yönetmeliği ), Grounding Regulation in Electrical Installations (Elektrik Tesislerinde Topraklama Yönetmeliği). Fire Brigade, with other local actors, should regularly check whether laws and regulations are followed or not.

### 5.4.4. Policies for Actors who are Responsible for the Conservation of Cultural Heritage

Site managers or institutions responsible for cultural heritage conservation also have some responsibilities for fire risk management of cultural heritage. Accordingly, the first responsibility occurs in preparing disaster risk management plans. Every heritage place should have a *Disaster Risk Management Plan.* As a part of these plans, *Fire Risk Management Plan* should also be prepared. Since fires can follow earthquakes and landslides, FRM Plan should be prepared with an integrated approach by considering other hazards creating fires.

In addition, due to tourism pressure on cultural heritage, land-use changes in those places become inevitable. In this regard, in case of a change to the original function of a traditional building, improving building fire safety is needed due to being constructed without fire safety codes (Mydin, Arminda, and Sani, 2014).

**Policies that can be implemented during Building Repair[56] that needs heat applications or flammable materials**

As was discussed in the previous part, hot works during building repair and restoration may result in fires. The measures to be taken against fires during building repair must be added to the contracts. In the case of building repair or other kinds of interventions, the approval of the Regional Conservation Board and KUDEB should be taken, and experts should control the process.

Fire safety requirements should be involved in contracts for maintenance and restoration works. Various activities during restoration or maintenance may need heat or produce heat, or flammable materials are used. If the use of heat is obligatory, permission[57] for these kinds of applications should be taken, and experts should monitor the process. Measurements could be the provision of the fire brigade, removing combustible materials, and control at the end of the working day (Kidd, 2010b, p.7).

Kidd (2010b, p.10) describes hot work as any construction process or activity which uses or produces heat. Accordingly, some hot works using heat are defined as:

- Blowlamps (including hot-air equipment) as used for plumbing, paint removal
- Welding or cutting equipment
- Grinding or cutting equipment that can create sparks or large quantities of heat
- Direct application of heat or flames as used in brazing copper piping or lead work
- LP gas when used for tar and bitumen spreading or installing waterproof membranes on roofs and elsewhere.

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[56] Building repair includes construction works, restoration, renovation that can use heat implementations or flammable materials.
[57] A Sample of Permission Document proposed by Historic England can be found in Appendix M.

Flammable insulation materials should never be used to provide heat and sound insulation between floors and walls inside the building. Fire retardant coatings can be used for walls, wooden, and metal parts (Yıldırım Esen, 2022).

Ferreira (2019) stated that a fire management strategy should be applied during restoration works. For example, fire detection systems and separation of work areas for hot uses and combustible material with temporary fire safety systems can be implemented to mitigate fire risk derived from restoration works (Ferreira, 2019). Roofs should not have flammable and hazardous materials and should be checked. In addition, they should be retrofitted with fireproof materials (Yıldırım Esen, 2022).

## 5.5. Fire Risk Management Policies for Turkey and the Case of the City of Safranbolu WHS

In Safranbolu, as in most cultural heritage sites, fires occurred due to electrical installation, chimneys, and other reasons. Also, there are many vacant traditional buildings in the City of SWHS. They have narrow streets with traffic problems that also affect the fire vulnerability of the City of SWHS. There are various policies for different actors responsible for fire risk management and conservation of the City of SWHS. It can be said that local actors are aware of the fire risk of the City of SWHS. However, interventions and current policies are insufficient to manage fire risk since fires continue to happen on the site.

### 5.5.1. Policies for Karabük Provincial AFAD Directorate

There are different policies that Karabük Provincial AFAD Directorate can apply. Provincial Disaster Risk Mitigation Plan is a critical document that fire risk management of cultural heritage can be considered. Actions in IRAP are assessed considering the fire risk of the City of SWHS. In Karabük IRAP (2022), several actions were emphasized in different periods. Those are [URL 41]:

A1-H1-8: Periodic training on evacuation, prevention, and extinguishing will be provided in workplaces and social centers. (Responsible Actor: Karabük Provincial AFAD Directorate)

A1-H3-2: The insurance rate would be increased by increasing the security measures to reduce the fire risk in historic buildings. The action period was defined as 2021-2025. (Responsible Actor: Governor's Office/District Governor's Office, Supportive Actors: Provincial/District Municipalities/Regional Conservation Council, 2021-2025)

A1-H5-3: Controlling fire hydrant infrastructure within the boundaries of the municipality (Responsible Actor: Provincial/District Municipalities, 2021-2025)

A1-H7-2: It will be ensured that training and studies are carried out to prevent vehicle parking violations that will complicate the fire response. (Responsible Actor: Provincial Police Department / Provincial Gendarmerie Command, 2021-2023)

Karabük IRAP shows that various actors are responsible for fire risk mitigation. A collaboration between AFAD, Fire Brigade, Safranbolu Municipality, Provincial Police Department, Provincial Gendarmerie Command and Regional Conservation Council is crucial for cultural heritage fire risk mitigation. On the other hand, in relation to this plan, the site-specific fire risk management of Safranbolu should be developed and implemented with participation and collaboration of various actors.

### 5.5.2. Policies for Safranbolu Municipality

There are many policies that Safranbolu Municipality can apply for the fire safety of the City of SWHS. First, some policies related to *the existence of ignition sources* inside and outside traditional buildings on the site exist. Unsuitable electrical installations of the existing historical buildings should be replaced, and electrical installations should be controlled regularly with collaborating Fire Brigade Services.

Parallel to this, as discussed before, users of traditional buildings should be informed about the uses of electrical devices[58].

Also, some policies related to the *existence of combustible materials* inside and outside traditional buildings on the site exist. Additions made with flammable materials to traditional buildings used for accommodation and restaurant services should be removed. Flammable materials used for shading should never be used on streets and courtyards of traditional buildings (Safranbolu Municipality, 2020).

In addition, it was seen that there are many grass fires in the Çarşı Region of Safranbolu. As grass fire can spread to traditional buildings, grass should be cleaned regularly. Especially in the summer, special attention should be paid to clearing grass in the historic environment. Between 2015 and 2020, in Çarşı Region in Safranbolu Fire Brigade Archive, 31 grass fires happened, and 1 of these fires occurred in Çeşme Neighborhood.

*Vacant traditional buildings* should be identified by a commission consisting of municipal officials and the mukhtar, and their owners should be warned. In addition, written information should be given to the Electricity Energy Authority to cut off the electrical power of the vacant buildings. Combustible materials around empty buildings should be removed as well.

In addition, some significant policies for fire combat within the neighborhood existed. Firstly, there are *accessibility* problems on the site. Accordingly, in the Çarşı region, some streets that commercial uses are mainly invaded by tables, chairs, and crafts products. This situation should be controlled to allow fire trucks to pass through easily during an emergency response. *The problem of parking* in front of fire hydrants and on narrow streets should not be permitted. The barriers at the entrances and exits of the traffic-free areas in the Çarşı Region prevent the fire response. These should be

[58] See Appendix N. Precautions for electrical equipment that occupiers of traditional buildings can follow.

solved and allow Fire Brigade access. In case of any maintenance works on the roads by the municipality, the fire department should be informed daily.

In addition, as stated before, many local and foreign tourists visit the City of SWHS; this situation creates extra pedestrian traffic, especially on holidays. Dense pedestrian traffic can prevent access of fire emergency staff to buildings in fire. Therefore, this situation also should be taken into account. Information panels should be located on streets where dense pedestrian mobility exists to increase people's awareness of what to do during a fire.

*Awareness of different actors* enrolled in cultural heritage fire risk management is critical. Therefore, as was discussed in the Report of Safranbolu Municipality, awareness campaigns should be organized with the support of the Safranbolu Municipality.

- A fire safety campaign should be started on the whole Safranbolu scale.
- Safranbolu fire safety week should be held once a year.
- Multiple activities should be carried out with the participation of all public institutions, municipalities, and non-governmental organizations.
- One week a year in schools, all students should be informed about fire safety awareness.

(Safranbolu Municipality, 2020).

These awareness activities should also include users of traditional buildings, such as residents, retailers, and local and foreign tourists. Fires can happen anytime, and these users can be subject to a fire incident. Therefore, the preparedness of various users for fire risk mitigation of Safranbolu WHS is critical.

The water network system for fires in the historical bazaar should be independent of the drinking water lines and be arranged to function independently. For example, even in the event of a water cut in the city drinking water network, water tanks, electric generators, and pumps are placed in the appropriate parts of the bazaar. The number and volume should be organized according to fire probability calculations (Safranbolu Municipality, 2020).

### 5.5.3. Policies for Actors Responsible for Conservation of Safranbolu WHS

Institutions responsible for cultural heritage conservation can collaborate with fire brigade services to develop emergency requirements. They can control the building repair process. In Law No. 2863, as building repair is under the control of KUDEB and Regional Conservation Councils in Turkey, these processes should be inspected regarding fire risk. Any intervention and hot works such as welding, cutting, and grinding should be avoided as much as possible. If hot works are unavoidable, the working process should be under control.

Site managers should also check accessibility to the site and within site for firefighting. Accessibility of the site should be elaborated within site management and fire risk management plan contrary to being an individual plan or analysis.

Heritage experts should assess the convenience of fire detection and suppression systems. For the scale and needs of the site, proper tools should be applied. Sprinklers, one of the automatic fire suppression systems, can be used in heritage buildings. In addition, contrary to sprinklers, other mechanical fire suppression systems use gas or less water in amount. Those kinds of sprinkler systems can be used in smaller spaces or places with significant cultural properties. Heritage experts should decide what sprinkler systems are appropriate for heritage and heritage places.

Regional Conservation Board has proposed that one fire cabinet be installed on each floor of a traditional building to protect them against the possibility of fire. According to the Safranbolu Municipality Commission to Protect Heritage Places from Natural Disasters Report (2020), it was claimed that there is no need to build a fire cabinet for each floor because one fire cabinet is found sufficient. It is proposed that in the restoration works, it is necessary to use the new generation fire extinguishers, together with one fire cabinet. For each 30 $m^2$, 6 kg manual and sprinkler with chemical powder fire extinguisher are proposed between the roofs. It should be recommended to place one piece of 500 gr aerosol fire extinguisher with aerosol gas, one piece of panel type fire extinguisher next to the electrical panel, or close to the fuse box. This system is evaluated as more economical and aesthetic than one fire cabinet system for each floor currently being applied (Safranbolu Municipality, 2020).

Being a popular site, an obligation to conserve the site may contribute to preserving and developing the City of SWHS. On the other hand, being a UNESCO site may bring over-tourism facilities. In parallel to this, traditional buildings can be adapted to new functions without taking necessary precautions for fire safety. Therefore, when traditional buildings are adapted to new functions, the suitability of building characteristics and conditions should be checked. In addition, over-visiting can also increase vulnerability. Therefore, the tourism capacity of the site should be defined as well.

### 5.5.4. Policies for Safranbolu Fire Brigade

There are different policies that Safranbolu Fire Brigade can apply. However, there should be *policy documents* explaining the responsibilities of the fire brigade before, during, and after fire incidents. These documents should include information about the water network system, chimney cleaning team, fire drills, and technical capacity.

Fire brigade services should have fire trucks compatible with the site's narrow streets to combat fire efficiently and effectively. Accordingly, a five or seven-ton single axle water tanker and a new ladder vehicle suitable for the narrow streets of the historical bazaar should be provided. One double cabin pioneer vehicle must be purchased (Safranbolu Municipality, 2020). If there is a water pump behind this pickup truck, a possible fire in the Historical Bazaar, such as container, vehicle, and stubble fires, will be reached more quickly and effectively.

A *fire network of* approximately 15 kilometers should be established in the historical bazaar, 124 fire hydrants above ground, and 83 fire cabinets should be installed (Safranbolu Municipality, 2020). The fire network system built in the historical bazaar should be independent of the drinking water lines. It should be arranged so that it can function independently even in the event of a water cut in the city drinking water network by placing water tanks, electric generators, and pumps in the appropriate parts of the bazaar (Safranbolu Municipality, 2020).

In Fire Brigade, there should also be a *chimney cleaning* team. Statistics showed 7 of 102 fires happened due to chimneys in Safranbolu between 2013 and 2017 (FireSkill Project Report, 2017). In addition, there should be a specialist to provide regular training in the neighborhoods for emergency response, and precautions can be taken before fires. Furthermore, an expert should be available for periodic maintenance of fire emergency vehicles and minor repairs of fire hydrants.

Firefighters should be prepared for intervention by continuous *training*. Some policies for Fire Brigade in a fire drill to be carried out were reported in the Report of Safranbolu Municipality Commission to Conserve Heritage Places from Natural Disasters (2020);

- Does the switchboard operator who receives the fire alarm professionally report the correct address to other employees on time?
- Does it give information to the Police Department, the Energy Agency, the Natural Gas Company, the Ambulance, Water Sewerage Officers, the Forestry Operations Organization, Karabük Fire Brigade Directorate, Kardemir Incorporated Company, and the Safranbolu Military service?
- Do the firefighters who receive the fire report act professionally and consciously?
- Do firefighters wear their protective clothing in a short time?
- Does a firefighter take their place in the fire truck in a short time?
- Are the materials in the fire truck fully loaded?
- Is the exercise recorded with a camera?
- Is it possible to reach the location of the fire from the appropriate road on time without interruption?
- Is there a plan for the intervention during the transportation to the fireplace?
- When the fire chief arrives at the incident location, does he quick reconnaissance of the fireplace and its surroundings?
- Is the fire being handled correctly?

All these exercises should be checked by taking notes on the control forms, and the results should be shared with firefighters. When firefighters know the places, they respond to the fire better. At this point, training becomes essential for fire brigade services. Unique characteristics of heritage places should be shown to fire brigade services.

There are seven fire trucks in Safranbolu. Their pressure is sufficient according to technical standards. On the other hand, 4 of 7 fire trucks have insufficient capacity. (Safranbolu Municipality, 2020). Their maintenance should be provided regularly. In addition, the Fire Brigade's technical capacity should also be improved. Small fire trucks should also be equipped, especially for fire incidents on narrow streets.

### 5.5.5. Policies for Users living in the City of SWHS

There are different policies that owners or users of traditional buildings can implement. First, there are some policies related to the *existence of ignition sources* inside and outside of traditional buildings. 67% of the FireSkill Project Survey participants stated that their electrical installations were not checked regularly (FireSkill Project Report). Accordingly, renewing the electrical installation and cables is necessary to handle the electrical load due to different activities. The principles for electrical devices should be followed as defined in Appendix N. Open fires, fireplaces, stoves, and smoking materials can also cause fires in traditional buildings. They should not be used as much as possible. If they are used, they should be located in proper locations of rooms, and they should not be surrounded by combustible materials.

Second, the *existence of combustible materials* inside and outside of traditional buildings should be checked by owners. For example, some policies can be applied to roofs. The lower parts of the roof eaves should not be covered with wood. Especially in summer, the temperature rises due to the roof tiles heating, and the electrical cables between the roof heat up and cause a fire. The roofs of traditional buildings should not be used as a storage area, and it should be noted that flammable materials should not be stored (Safranbolu Municipality, 2020). In addition, the lower parts of the roof eaves should be left open as it was constructed. Especially in summer seasons, the fresh air from these parts of a building causes the temperature to decrease in the roof space, thus preventing the electrical cables between the roof from overheating and causing a fire. It also ensures that the upper floors of the building stay cooler (Safranbolu Municipality, 2020).

Third, owners or occupiers can follow some significant *fire combat policies within the building scale*. Proper fire detection and suppression systems should be installed in traditional buildings. The Regional Conservation Council or KUDEB should monitor the suitability of fire detection and suppression systems for traditional buildings. In addition, necessary repairs should be conducted on time to keep the traditional building in good structural condition. As discussed, principles should be followed if heat or combustible materials are needed during these repairs. A Sample of Permission Document proposed by Historic England can be found in Appendix M. These principles can also be adapted to traditional buildings in Safranbolu.

Lastly, some significant policies for *fire combat within the neighborhood scale* exist. Users of traditional buildings should know what to do during a fire incident, whether in their own house or one of the buildings in the neighborhood. Since a fire incident can easily sprawl to other buildings in a historic environment, a user of traditional buildings should know how to cope with fire risk. Furthermore, they should be informed about how to use fire hydrants and fountains in case of fire incidents. A fire drill should be conducted at a neighborhood scale with the participation of different local actors to mitigate existing fire risk.

## 5.6.Limitation of the Study

The findings of this study have to be seen in the light of some limitations observed. The first limitation is the available data. Although most of the data were gathered through site surveys, some data, including construction techniques and materials and past fire incidents used in fire vulnerability assessment, are derived from Safranbolu's conservation and development plan.

In addition, the second limitation concerns that limited studies focus on simplified fire vulnerability assessment methods for an urban scale. Most studies use quantitative methods, which are not easy to apply to an urban scale cultural heritage. Therefore, a new methodology was developed by analyzing other studies focusing on risk assessment.

## 5.7.Further Studies

Based on the devastating impacts of fires on heritage places and the possibility of preventing fires, this thesis aims to assess the fire vulnerability of heritage places on a settlement scale with a simplified method that different stakeholders can easily apply. Within this context, the contributions of this thesis are determined as follows:

- The thesis defines fire vulnerability assessment parameters/indicators for cultural heritage on an urban scale.
- The thesis assesses the fire vulnerability of CH by a simplified method. The proposed method can be used for fire risk mitigation and meeting indicators/parameters criteria.
- The thesis develops policy implications for fire risk mitigation that can be applied nationally and internationally.
- The thesis contributes to the WHS management process concerning how to assess fire vulnerability and mitigate the fire risk of WHS.
- The thesis shows how to use GIS spatial analysis tools that provide superposing of different spatial data for fire vulnerability assessment of CH.

As discussed in previous chapters, the City of SWHS was selected among 5 UNESCO WHSs at an urban scale in Turkey. Other 4 UNESCO WHS at urban scale and urban heritage places in Turkey can be studied in further research since many urban sites have been constructed with timber frame construction systems. In addition, they have the same problems related to fire risk management.

On the other hand, the Çeşme Neighborhood in the Çarşı Region in the City of SWHS is selected to be studied in this thesis, other three sites of UNESCO World Heritage Sites such as Kıranköy and Bağlar, and the remaining neighborhoods could be studied in further studies.

In this study, due to focusing on urban sites with screening in more manageable or more simple ways, fire vulnerability assessment indicators are considered equally important. However, the impacts of each parameter through fire vulnerability could differ. In further studies, indicators defined in this study could be weighted, and fire vulnerability could be assessed according to the defined weights of indicators.

Furthermore, different actors are enrolled in fire risk management of cultural heritage. The awareness level of those actors might also affect fire risk management of cultural heritage. These actors are central and local administrative decision-makers, residents in heritage places, and local and foreign visitors. Further studies could also consider the awareness of those different actors in the fire risk management process.

This study focused on combustible materials within construction systems of traditional buildings. Therefore, timber frame construction systems are evaluated as increasing the fire vulnerability of buildings. On the other hand, other traditional construction systems may also be affected by fires. For example, stonemasonry buildings in a fire are distressed when heat increases.

The socio-economic development of communities may also affect fire risk management. In further studies, the impacts of the socio-economic level of communities on the assessment of fire risk could be considered. Fire vulnerability assessment degree of Çeşme Neighborhood can be compared with the total population of other neighborhoods, and disabled people as Granda and Ferreira (2019b) conducted their study. This situation shows that different sociodemographic characteristics impact cultural heritage fire vulnerability assessment.

This thesis focused on urban heritage places. Rural heritage places with different spatial characteristics, architecture, and infrastructure, also face critical fire risk. The socio-economic development level of residents and land-use diversity in rural heritage places may differ from urban heritage places. Therefore, the impacts of fire incidents on rural heritage and the required fire risk mitigation measurements can also be studied in further studies.

The policy framework for fire risk mitigation presented by this study constitutes a base for other countries where cultural heritage is subject to fire risk. As a result of the local pilot applications in the City of SWHS, considering the basic framework that this study proposed, deficiencies can also be assessed in further studies.

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[URL 25] https://historicengland.org.uk/images-books/publications/fire-safety-for-traditional-church-buildings/fire-safety-traditional-church-buildings/ (17.02.2021)

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[URL 49] https://www.haberler.com/safranbolu-da-tarihi-konakta-cikan-yanginda-maddi-14028871-haberi/ (30.04.2021)

# APPENDICES

## Appendix A. Important international attempts regarding conservation of CH and DRM (prepared by the author according to different data)

| Year | Institution | Name | Content |
|---|---|---|---|
| 1899 | | The Hague Convention | Laws and customs of war<br>Article 28&47-prohibit pillaging<br>Article 56- prohibits the destruction |
| 1907 | | The Hague Convention | Regulations concerning the Laws and Customs of War on Land |
| The 1950s | UNESCO | organizing and supporting international conferences and workshops on the risk management of cultural heritage; publishing regulatory & guidance documents | |
| 1954 | UNESCO | The Hague Convention | Regulations concerning the Laws&Customs of War on Land |
| The 1960s | ICCROM | organizing training programs, international conferences, and workshops and supporting them | |
| 1964 | ICOMOS | Venice Charter | Conservation and rehabilitation of historical center |
| 1972 | UNESCO | Convention concerning Protection of World Cultural and Natural Heritage | Threats such as disasters, fires, earthquakes, ground slides, volcanic eruptions, changes in the water level, floods, and tidal waves, large projects, rapid urbanization, tourism development projects, changes in land and property use, armed conflicts |
| 1975 | EC | Amsterdam Declaration | Integrated conservation, Threats defined as new development areas around historic sites, no attention to today's risks |
| The 1990s | Civil Wars in Yugoslavia<br>The Gulf War<br>Natural disasters | | Destructive effects on cultural heritage<br>So the emphasis on how to protect cultural heritage from that kinds of events (Jigyasu, 2013)<br>Conservation strategies focused on PREVENTION rather than intervention (Stovel, 1998) |
| The 1990s | | | United Nations General Assembly declared the 1990s as the "International Decade for Disaster Risk Reduction." (Lattig, 2012: 1) |
| 1992 | ICOMOS | IATF | Inter-Agency Task Force to Rescue Cultural Heritage including ICCROM, UNESCO, ICOMOS, ICOM<br>- focused on preparedness, the recognition of cultural heritage as a priority in disaster response, coordinated international response to disasters, training of professionals, and searching for new tools through testing of experiences<br>-'finance,''emergency intervention,' 'documentation,' 'education' and 'guidance,' 'sensitivity,' and coordination between institutions and organizations (Jigyasu, 2013: 37) |
| Attitudinal Shift in Conservation Era<br>The concept of Disaster Management<br>-conservation paradigm focused on prevention & risk preparedness (Stovel, 1998 in Jigyasu, 2013)<br>-integration between cultural heritage protection and disaster management (Jigyasu, 2013: 37) | | | |

| Year | Institution | Name | Content |
|---|---|---|---|
| 1994 | UNDP | The Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and Its Plan of Action | Important guidance on the reduction of disaster risk and its impacts |
| 1995 | Kobe Earthquake | | Focusing on searching for possible systems how to protect cultural heritage from disasters |
| 1996 | ICOMOS | International Committee for Blue Shield (ICBS) | increasing awareness, education, intervention |
| 1998 | Blue Shield | Radenci Declaration, Blue Shield Seminar on the Protection of Cultural Heritage in Emergencies and Exceptional Situations | ‘’…to avoid loss or damage to cultural heritage in the event of emergencies by improving prevention, preparedness, response, and recovery measures by developing, implementing, and monitoring strategies which assess and reduce risk, improve response capacity, ensure the co-operation of all relevant parties in local, national and international emergency management. |
| 1999 | UNISDR | providing disaster mitigation activities within the UN, coordination and synergy between regional organizations, socio-economic and humanitarian activities | |
| 1999 | UNESCO | Heritage Emergency Fund | financing subsidiary activities and projects of member states |
| 1999 | ICOMOS | Heritage@Risk Program | The ICOMOS National Committees, ICOMOS global professional committees, and the global professional network present brief reports on case studies |
| 2003 | UNESCO | Convention for the Safeguarding of the Intangible Cultural Heritage | It aims to preserve intangible cultural heritage such as traditional knowledge, practices, and community skills to reduce disaster risks. (Jigyasu, 2013: 36) |
| 2004 | Blue Shield | Torino Declaration, Resolutions of 1st Blue Shield International Meeting | considering the importance of risk preparedness, response, and recovery, recommend that cultural heritage professionals and others integrate these stages into their programs |
| 2005 | ICOMOS/ICORP | Kyoto Declaration on the Protection of Cultural Properties, Historic Areas, and their Settings from Loss in Disasters | emphasizing the importance of establishing a relationship between heritage property management, the community context, and municipal emergency preparedness measures (Lattig, 2012: 10) |

| Year | Institution | Name | Content |
|---|---|---|---|
| 2005 | UNISDR | Hyogo Framework for Action | -The role of cultural heritage emphasized in Priorities for Action<br>3 (i)(a)…The information should incorporate relevant traditional and indigenous knowledge and cultural heritage and be tailored to different target audiences, considering cultural and social factors.<br>4 (i) (b) Implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction, including structural and non-structural measures, such as integrated flood management and appropriate management of fragile ecosystems<br>-Landmark Event (Jigyasu, 2013)<br>The gaps and challenges<br>(a) Governance: organizational, legal, and policy frameworks;<br>(b) Risk identification, assessment, monitoring, and early warning;<br>(c) Knowledge management and education;<br>(d) Reducing underlying risk factors;<br>(e) Preparedness for effective response and recovery. (Hyogo Framework for Action, 2005: 2) |
| 2006 | UNESCO WHC ICCROM | Workshop on Integrating traditional Knowledge Systems and Concern for Cultural and Natural Heritage into Risk Management Strategies | -highlighted the role that cultural heritage (especially intangible cultural heritage) plays in risk reduction and recovery processes<br>-Traditional knowledge for disaster risk reduction |
| 2006 | Prince Claus Fund | Culture is a basic need: Responding to Cultural Emergencies | -Culture as a basic need in every humanitarian crisis<br>-the need to expand the cultural heritage response to include the protection of intangible aspects such as traditions, customs, and indigenous knowledge systems to provide hope and a sense of continuity to the affected communities<br>-the need to directly involve the local communities in cultural relief and recovery (Tandon, 2013: 18) |
| 2007 | UNESCO | Strategy for Reducing Risks from Disasters at World Heritage Properties | 5 key aims according to 5 main priorities for action identified by Hyogo Framework but adapted to reflect the specific concerns and characteristics of World Heritage<br>a) Strengthen support within relevant global, regional, national, and local institutions for reducing risks at World Heritage properties;<br>b) Use knowledge, innovation, and education to build a culture of disaster prevention at WHP;<br>c) Identify, assess and monitor disaster risks at WHP;<br>d) Reduce underlying risk factors at World Heritage properties;<br>e) Strengthen disaster preparedness at World Heritage properties for effective response at all levels |

| Year | Institution | Name | Content |
|---|---|---|---|
| 2007 | ICOMOS | New Delhi Resolution Impact of Climate Change on Cultural Heritage | |
| 2007 | | Protecting the cultural heritage from natural disasters | |
| 2010 | | International Conference on Disaster Management and Cultural Heritage | ‘’cultural heritage should be promoted because of its intrinsic historical or artistic value, and spiritual, psycho-social support and the sense of belonging it provides to communities during the disaster recovery phase (Tandon, 2013:20).’’ |
| 2012 | ICOMOS/ICORP | International Symposium on Cultural Heritage in Times of Risk: Challenges and Opportunities | ‘’Risk preparedness, disaster response, and recovery strategies should address cultural heritage in parallel with practical humanitarian needs, as disaster recovery is a wider and long-term social process. (Jigyasu, 2013: 38)’’ |
| 2012 | UNISDR | International Conference on Building Cities' Resilience to Disasters: Protecting Cultural Heritage and Adapting to Climate Change | ‘’linked a city’s resilience against disasters with urban planning, cultural heritage protection, and adaptation to climate change, thus paving the way for strengthening cooperation between provincial governments, municipalities, town planners, emergency responders, and heritage agencies (Tandon, 2013: 5)’ |
| 2015 | Sendai Framework | UNISDR | Culture as a dimension of DRR (Sabbioni et al, 2016) |

# Appendix B. Factors and related secondary factors affecting UNESCO WHS

| | Threat Group | Secondary Factors | | Threat Group | Secondary Factors |
|---|---|---|---|---|---|
| **1** | **Buildings and Development** | Housing | **11** | **Sudden ecological or geological events** | Volcanic eruption |
| | | Commercial Development | | | Earthquake |
| | | Industrial Areas | | | Tsunami/tidal wave |
| | | Major Visitor accommodation and associated infrastructure | | | Avalanche/landslide |
| | | Interpretative and visitation facilities | | | Erosion and siltation/deposition |
| **2** | **Transportation Infrastructure** | Ground Transport Infrastructure | | | Fire (wildfires) |
| | | Air Transport Infrastructure | 12 | **Invasive/alien or hyper-abundant species** | Translocated species |
| | | Effects arising from Transport Infrastructure | | | Invasive/alien terrestrial species |
| | | Underground Transport Infrastructure | | | Invasive/alien freshwater species |
| **3** | **Utilities or Service Infrastructure** | Water Infrastructure | | | Invasive/alien marine species |
| | | Renewable Energy Facilities | | | Hyper-abundant species |
| | | Localised Utilities | | | Modified genetic material |
| | | Major Linear Utilities | 13 | **Management and Institutional Factors** | Management System/Management Plan |
| **4** | **Pollution** | Pollution of marine waters | | | Legal Framework |
| | | Groundwater pollution | | | Low-impact research/monitoring activities |
| | | Surface water pollution | | | Governance |
| | | Air pollution | | | High-impact research/monitoring activities |
| | | Solid Waste | | | Management Activities |
| | | The input of Excess Energy | | | Financial Resources |
| **5** | **Biological Resource Use/modification** | Fishing/collecting aquatic resources | | | Human Resources |
| | | Aquaculture | **14** | **Others** | |
| | | Land conversion | | | |
| | | Livestock farming/grazing of domesticated animals | | | |
| | | Crop production | | | |
| | | Commercial wild plant collection | | | |
| | | Subsistence wild plant collection | | | |
| | | Commercial Hunting | | | |
| | | Subsistence hunting | | | |
| | | Forestry/wood production | | | |
| **6** | **Physical Resource Extraction** | Physical Resource Extraction | | | |
| | | Mining | | | |
| | | Quarrying | | | |
| | | Oil and Gas | | | |
| | | Water extraction | | | |
| **7** | **Local conditions affecting the physical fabric** | Wind | | | |
| | | Relative Humidity | | | |
| | | Temperature | | | |
| | | Radiation/Light | | | |
| | | Dust | | | |
| | | Water (Rain/water table) | | | |
| | | Pests | | | |
| | | Micro-organisms | | | |
| **8** | **Social/Cultural uses of heritage** | Ritual/spiritual/religious and associative uses | | | |
| | | Society's valuing of heritage | | | |
| | | Indigenous hunting, gathering, and collecting | | | |
| | | Changes in traditional ways of life and knowledge system | | | |
| | | Identity, social cohesion, changes in local population and community | | | |
| | | Impacts of tourism/visitor/recreation | | | |
| **9** | **Other human activities** | Illegal Activities | | | |
| | | Deliberative destruction of heritage | | | |
| | | Military training | | | |
| | | War | | | |
| | | Terrorism | | | |
| | | Civil Unrest | | | |
| **10** | **Climate change and severe weather events** | Storms | | | |
| | | Flooding | | | |
| | | Drought | | | |
| | | Desertification | | | |
| | | Changes to oceanic waters | | | |
| | | Temperature change | | | |
| | | Other climate change impacts | | | |

## Appendix C. International Projects Dealing with Risk Assessment for Cultural Heritage (prepared by the author)

| Project | Duration | Focus | Aim | Website |
|---|---|---|---|---|
| HERACLES- H2020 Heritage Resilience against Climate Events on | 2016-2019 | Climate Change | -designing and promoting responsive systems to provide the resilience of cultural heritage against climate change impacts | http://www.heracles-project.eu/ |
| STORM- Safeguarding cultural heritage through technical | 2016-2019 | Climate change and natural hazards | -providing decision-making tools for climate change and natural hazards in the context of prevention, intervention, policies, planning, and processes | http://www.storm-project.eu/ |
| Noah' s ARK | 2004-2007 | Climate change | -investigating the meteorological parameters and changes to cultural heritage and impacts of climate change<br>-developing mitigation and adaptation strategies<br>-providing electronic information sources and tools for heritage managers in order to evaluate threats, simulate future scenarios, model the impacts of different adaptation strategies<br>-preparing recommendations for policymakers and legislators | http://noahsark.isac.cnr.it/ (no access) |
| Climate for Culture | 2009-2014 | Climate Change | -examining the potential effects of climate change on European cultural heritage, especially on historic buildings and their interiors | https://www.climateforculture.eu/ |
| CHIC- European Cultural Heritage Identity Card | 2009-2012 | Natural deterioration and human impacts | -Systematic data collection and storage<br>-Indicators for risk assessment | http://www.euchic.eu/ |
| Risk Map of Cultural Heritage (Italy) | 1992-1995 | -static-structural danger<br>- environmental air danger<br>- human danger | Developing systems and methods for maintenance and restoration programs for architectural, archaeological, and historic properties | http://www.aec2000.eu/riskmap/english.htm |

| Project | Duration | Focus | Aim | Website |
|---|---|---|---|---|
| PROTHEGO- Protection of European Cultural Heritage from Geo-Hazards | 2015-2018 | Seismic, landslide, volcanic, subsidence, flood | -analyzing geohazards UNESCO WHS face<br>- Using Interferometric Synthetic Aperture Radar (InSAR) technology for ground stability data | http://www.prothego.eu/ |
| PROteCH2save | 2017-2020 | Climate change and hydrometeorological and climatic extremes events such as flood, heavy rain, fire due to drought, and sea flood | -improving public and private sectors' capacities to mitigate climate change and natural hazards' effects on cultural heritage | https://www.interreg-central.eu/Content.Node/ProteCHt2save.html |
| PROCULTHER Protecting Cultural Heritage from Consequences of Disasters | 2019-2021 | Scope defined as disasters | -developing and improving technical and operational capacities for the safeguard of cultural heritage at disaster risk at territorial levels | https://www.procult her.eu/prochulter-at-a-glance/ |
| Fire-TECH | | | -evaluating fire risk that heritage places are exposed to | |
| FireSkill (Fire Protection Practice and Competence-Based Training in Historical Building) | 2017-2019 | Fires in Safranbolu (TR), Frederikssund (DK), Marche (IT) and Ljubljana (SI) | -increasing public awareness about the conservation of cultural heritage against fires staffs working in public institutions, students, academicians, technical staff, and local people | http://www.fireskills.org/ |

## Appendix D. Visited Central Institutions and Data gathered and their formats (prepared by the author)

| Visited Institution | Visit Date | Data obtained |
|---|---|---|
| AFAD | 11.06.2018<br>21.06.2018<br>26.06.2018 | • Landslide Susceptibility Map of 17 sites and their surroundings<br>• Past earthquakes occurred in 17 provinces where UNESCO World Heritage Site is located.<br>• Location, depth, and magnitude of the epicenters of the earthquakes<br>• Location of active fault lines<br>• Disaster events (avalanche, rock fall, flood) occurred within a 50 km radius from the center of 17 World Heritage Sites between 1950 and 2008 |
| Ministry of Culture and Tourism World Heritage Site Unit | 09.04.2018<br>22.06.2018 | • Basemaps of 17 UNESCO World Heritage Sites in Turkey (pdf, netcad format)<br>• Interview: Ministry of Culture and Tourism and Risk Management for Conservation of Cultural Heritage |
| DSİ Director of Flood Plant | 03.09.2018<br>03.10.2018 | • Interview: DSİ and Flood Management at Cultural Heritage Sites |
| Ministry of Forest and Water Affairs | 30.07.2018 | • Interview: Ministry of Forest and Water Affairs and Flood Management at Cultural Heritage Sites<br>• Border of Basins in Turkey (kmz format) |
| MTA | 16.11.2018<br>12.12.2018 | • Soil Structure of Turkey for 17 provinces where UNESCO World Heritage Sites are located. |

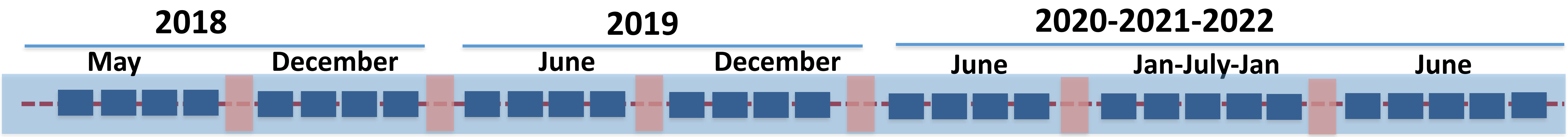
## Appendix E. Data Obtained from Local Institutions (prepared by the author)

<table>
<tr><th>Taken from</th><th colspan="2">Name of Data</th><th>Produced By</th><th>Data type</th></tr>
<tr><td rowspan="2">Provincial AFAD Directorate</td><td colspan="2">Rockfall Prequations Area</td><td rowspan="2">AFAD</td><td>Word document</td></tr>
<tr><td colspan="2">FireSkills Project Report</td><td>Pdf</td></tr>
<tr><td rowspan="3">Safranbolu Municipality</td><td colspan="2">Old Plans of Safranbolu</td><td>-</td><td>Jpeg</td></tr>
<tr><td colspan="2">Current Conservation Plan</td><td>Private Planning Office</td><td>Netcad</td></tr>
<tr><td colspan="2">Current Conservation Plan Report</td><td>Private Planning Office</td><td>Word document</td></tr>
<tr><td rowspan="17">Regional Conservation Council</td><td rowspan="17">The analysis made in Conservation Plan</td><td>Borders of the site</td><td rowspan="15">Private Planning Office</td><td rowspan="17">Jpeg</td></tr>
<tr><td>Slope</td></tr>
<tr><td>Geological Condition</td></tr>
<tr><td>Soil Structure</td></tr>
<tr><td>Registration Status</td></tr>
<tr><td>Solid-void analysis</td></tr>
<tr><td>Ownership</td></tr>
<tr><td>Lot Size</td></tr>
<tr><td>Landuse</td></tr>
<tr><td>Building Height</td></tr>
<tr><td>Construction System</td></tr>
<tr><td>Building Condition</td></tr>
<tr><td>Roof form</td></tr>
<tr><td>Roof material</td></tr>
<tr><td>Additions to building</td></tr>
<tr><td>Building category (new/traditional)</td><td rowspan="2"></td></tr>
<tr><td>Threshold Analysis</td></tr>
<tr><td rowspan="3">Fire brigade Directorate</td><td colspan="2">The location of hydrants</td><td>Fire brigade Directorate</td><td>Ncz</td></tr>
<tr><td colspan="2">Electricity infrastructure</td><td>Fire brigade Directorate</td><td>Ncz</td></tr>
<tr><td colspan="2">Gas Infrastructure</td><td>Fire brigade Directorate</td><td>Ncz</td></tr>
</table>

## Appendix F. Thesis Development Process and Different Inputs and Outputs contribute to the Thesis (prepared by the author)

| | Work Packages Done | Proposal 2018 | TİK1 2018 | TİK2 2019 | TİK3 2019 | TİK 4 2020 | TİK 5 2020 | Input & Output |
|---|---|---|---|---|---|---|---|---|
| DRM & DRA for CH | **Presentation at a Meeting:** Kültürel Miras Alanlarının Karşılaştığı Riskleri Diyalog(suzluk) Üzerinden Tanımlamak, Geçmiş \| Bugün \| Gelecek Arasındaki Diyalog, 26-27-28 October 2017, TED University, Published Extended Abstract Book (p. 47-54) | | | | | | | |
| | Problem definition (DRM&CH) | | | | | | | |
| | What kinds of threats are identified in the State of Conservation System, and periodic reports exist for UNESCO WHS in Turkey? | | | | | | | |
| | What is the legal framework regarding DRM and conservation of heritage places in Turkey? | | | | | | | |
| | How could DRM for CH evolve in time? | | | | | | | |
| | **Scientific Research Project:** Türkiye'deki UNESCO Dünya Miras Alanları'nın Karşılaştığı Doğal ve İnsan Kaynaklı Tehlikelerin Mekansallaştırılması. 2018 – 2021 METU Scentific Research Project Fund (YÖP-202-2018-2853) | | | | | | | |
| | **Presentation at a Meeting:** Türkiye'deki UNESCO Dünya Miras Alanları'nı Koruma Sürecinde Afet Yönetiminin İncelenmesi. Disaster Risk Management of Turkey 20th Round Table Meeting, METU, TURKEY, 16 March 2018 | | | | | | | |
| | Evaluating 17 UNESCO WHSs in Turkey in terms of DRM | | | | | | | |
| | Systematic literature review (RA+CH/RM+CH) | | | | | | | |
| | Data Collection (Part 1: Central Institutions/Interviews) | | | | | | | |
| | Evaluation of some methods used for DRM for CH (ABC/HIA/AHP) | | | | | | | |
| FVA | International Regulations regarding FVA (NFPA, CFPA-E) | | | | | | | |
| | Regulations regarding FVA in Turkey | | | | | | | |
| | Fire Vulnerability Assessment Parameters and Methods | | | | | | | |
| Safranbolu WHS | General Information about Safranbolu | | | | | | | |
| | Analysis for Safranbolu (Past Events/Earthquakes/Landslide Susceptibility Map) | | | | | | | |
| | Data Collection (Part 2: Local Institutions/Safranbolu) | | | | | | | |
| | Literature Review for Safranbolu | | | | | | | |
| | **Presentation at an International Conference:** 'The Comparison of Different Institutional Frameworks Regarding Risk Management for Conservation of Cultural Heritage: the Case of Britain, Japan and Turkey UNESCO World Heritage Sites', in *Proceedings of International Disaster and Resilience Congress - From Risk to Resilience*, 26-28 June 2019, Eskişehir, TURKEY | | | | | | | |
| | **Article 1:** The Comparison of Institutional Frameworks Regarding Risk Management for Conservation of Cultural Heritage by Focusing on UNESCO World Heritage Sites: The Cases of the UK, Japan and Turkey, Resilience, 2019, 3(2), p.347-367. | | | | | | | |
| | **Presentation at an International Conference:** *''Investigating the City of Safranbolu World Heritage Site with its Natural Threats''* Karabük, Proceeding Book (Editor: Dr. İnan Keskin) (p. 429-434) | | | | | | | |
| | Evaluation of Vulnerability Factors | | | | | | | |
| | What are the factors affecting World Heritage Sites? | | | | | | | |
| | Site Survey (12-17 October 2020) | | | | | | | |
| | Preparing base map and combining different data gathered | | | | | | | |
| | Current Approaches about Fire Risk Assessment of Cultural Heritage: The Case of the City of Safranbolu World Heritage Site (in Turkish)<br>*Emre Madran izinde EDEP YAHU Buluşmaları 8, Risk at Cultural Properties, Current Situation and Interventions on 26 September 2021, (Webinar)* **(Invited Speaker)** | | | | | | | |
| | **Article 2: Publication in TÜBA-KED Journal (Volume 24, December 2021):** Assessing the Policies on Fire Risk Management of Cultural Heritage: Cases of the England and Turkey (in Turkish) | | | | | | | |
| | Spatial Analysis regarding Fire Vulnerability Assessment in GIS | | | | | | | |

**Appendix G. Development Process of the Thesis and Feedback was given by the Thesis Committee (prepared by the author)**




| | Proposal<br>**May 2018** | TİK 1<br>**December 2018** | TİK 2<br>**June 2019** | TİK 3<br>**December 2019** | TİK 4<br>**June 2020** | TİK 5- 6-7<br>**Jan 2021 /July 2021/Jan 2022** | FINAL<br>**24 June 2022** |
|---|---|---|---|---|---|---|---|
| **CRITICS** | • Reviewing the Management Plan of UNESCO WHS about how Risk Assessment and Management were taken into account<br>• Why select UNESCO World Heritage Sites?<br>• Focusing on one case concerning one hazard/risk or multi-hazard/risk | • The hypothesis and research question of this dissertation should be straightforward.<br>• The selection of the case study<br>• Different methods used in the literature for DRM should be assessed.<br>• What kind of method that the City of Safranbolu WHS needs? | • Updating hypothesis and research questions<br>• Analyzing different methods used<br>• Whether to study risk assessment or risk management should be decided.<br>• What scale will the study be conducted?<br>• The emphasis on integrating Planning, Conservation, and Risk Management can be made. | • Gaps in the literature<br>• Revising research questions and hypothesis<br>• Planning History of Safranbolu | • Methodology<br>• Site Survey Planning<br>• Justifying why to study this topic:<br>-the significant gaps in the literature have been evaluated again<br>-the need for an integrated study for identification of different natural hazards for a WHS at an urban scale<br>-the need to integrate Disaster Risk Management (DRM) into management plans<br>• the need for a method to assess vulnerabilities and risks that WHS at an urban scale face. | • Analyzing results of the site survey<br>• Testing proposed methodology on the site<br>• Getting missing data of Safranbolu from related institutions<br>• Constituting spatial database including fire vulnerability indicators in GIS<br>• Conducting spatial analysis in GIS to assess fire vulnerability of Safranbolu WHS<br>• Preparing and publishing articles about the thesis | • Presentation of whole thesis process and outputs of the study |
| | The issues mentioned above were carried out after the proposal. | After this TİK, the City of Safranbolu WHS was selected to be studied as a case. | General analyses about Safranbolu WHS were conducted regarding past events and the current landslide susceptibility map. | It was decided that the study would focus on **Fire Vulnerability Assessment**. | The site Survey was carried out in October 2020.<br>Different methods were analyzed, and a method was proposed. | | |

## Appendix H. Fire Suppression Systems that can be used during Firefighting

### Fire pumps

These pumps provide pressurized water to the aqueous extinguishing systems, expressed in terms of nominal flow rate and pressure value. (BYKY, 2009, Fire Pumps, Article 93, Item 1)

### Fixed piping and fire cabinets

The purpose of the installation is to provide reliable and sufficient water for firefighting inside the building. For this, water intake systems and fire cabinets are installed. (BYKY, 2009, Fixed piping and fire cabinets, Article 94, Item 1)

| Fire Suppression Systems |
|---|
| **Water Suppression System** |
| Fire Pumps<br>Hydrant Systems<br>Sprinkler Systems |
| **Fixed Automatic Extinguishing and Prevention Systems with Foam, Gas, and Dry Powder**<br>An appropriate type of extinguishing system is established in the volumes where the quenching effect of water is not considered sufficient, or substances that can react with water are found, stored, and produced. |
| **Portable Extinguishers**<br>The type and number of portable extinguishers are determined according to the situation and risks in the spaces. |

(BYKY, 2009, Fire Suppression Systems)

**Appendix I. Different Fire Suppression Tools applied in Historic Environments**

Shirakawa-go, a UNESCO World Heritage Site in central Japan
(https://english.kyodonews.net/news/2019/11/cb28b8b3c101-fire-near-world-heritage-site-in-central-japan-causes-scare.html)

Fire suppression shovels and sand buckets at Shwe-nandaw Kyaung in Mandalay, Myanmar (https://www.wmf.org/fire)

## Appendix J. Past Fire Incidents in Safranbolu gathered from Internet News

| # | Date of incident | News Title | Content of News |
|---|---|---|---|
| 1 | 3 May 2010 | Fire in Historic Building in Safranbolu/*Safranbolu'da tarihi konakta yangın* [URL 43] | 474 years konak/Used as hotel/restored Insufficient technical capacity |
| | |  | |
| 2 | 15 September 2015 | Historic Building House Fire in Safranbolu/*Safranbolu'da tarihi ev yangını* [URL 44] | 150 years/2 storey/ after fire unusable/narrow streets and cars parking on the streets so challenging to intervene |
| | |  | |
| 3 | 26 September 2016 | A historic building burnt due to fire./*Safranbolu'da tarihi konak yandı. [*URL 45] | 150 years/three storey/empty/fires frequency in winter/after fire unusable (Address: Akçasu Neighborhood Ulukavak Street, "Emeksizler Evi") |
| | |  | |
| 4 | 7 October 2017 | Fire in Historic Building in Safranbolu/*Safranboluda Tarihi Konakta Yangın* [URL 46] | 150 years/2 storey/ after fire unusable (Address: Hüseyin Çelebi Neighborhood Taşminare Street) |

| # | Date of incident | News Title | Content of News |
|---|---|---|---|
| 5 | 5 November 2018 | Fire in Historic Building /*Tarihi Konakta Yangın* [URL 47] | 150 years/ after the fire, the traditional building became unusable. (Address: Karaali Neighborhood Street Bayram Akın) |
| |  | | |
| 6 | 25 July 2020 | Fire in Historic Building in Safranbolu /*Safranbolu'da tarihi konakta yangın* [URL 48] | 150 years/3 storey/2 konaks were damaged/ narrow streets so difficult to intervene |
| |  | | |
| 7 | 30 March 2021 | Financial loss occurred in the historical building fire in Safranbolu, two people were injured./ *Safranbolu'da tarihi konakta çıkan yangında maddi hasar oluştu, iki kişi yaralandı* [URL 49] | 130 years/3storey/ (Address: İzzetpaşa Neighborhood Akseki Street) |
| |  | | |

## Appendix K. Past Fire Incidents in Safranbolu (Safranbolu Fire Brigade Archive)

| **Konaks** | **Date** | **Location** | **Reason of fire** |
|---|---|---|---|
| Maltalı Hacı Kamil House | 1280(1864) | Eski Mosque | |
| Karagözler House | (1943) | | |
| Fuat Sarıoğlu (shop) | (1945) | Demircilerbaşı | |
| Kör Hakkı House | (1947) | Çeşme Neighborhood | Neglience |
| Nuhoğlu Emin Alpaslan | (1949) | Akçasu -Uzunkır | Lightning S trike |
| Dedeoğlu House | | Bağlar-Aslanlar | |
| Petirler House | | Bağlar-Müftüpınarı | |
| Küçük Mehmetler House | (1952-1957) | Akçasu-Sütçü Bahçesi | |
| Dolmacılar House | (1960) | Bağlar-Köyiçi | Bakery Fire |
| Berber Cemal House | (1962) | Misakımilli-Okul Street | |
| Şevket Çanga House | (21.06.1968) | Misakımilli | |
| Baraka Dükkanlar | (1973) | Misakımilli | |
| Kavuşturucu House | (1973) | Kalealtı-Taş Minare | |
| Hükümet Konak | (1976) | Çeşme Neighborhood | |
| Hacı Cemaller House | (2003) | Kalealtı | |
| Hacıbey Yılmaz House | (20.10.2003) | Bağlar-Kavaklar | |
| Hacı Memişler Konak | (01.01.2003) | | |
| Saraçlar House | (30.06.2004) | Pazar Yeri | |
| Zalifre Otel | (19.04.2010) | | |
| Kardelen Otel | (..11.2011) | | |
| Emeksizler House | (25.09.2016) | Akçasu-Ulukavak Street | |
| Değirmencioğlu Konak | (07.10.2017) | -Gümüş -Dibanoz | |
| Balabanlar House | (18.04.2017) | Kalealtı Dua Taşı Yanı | |
| Hasan Tok House | (02.02.2018) | Akçasu -Kaçak Street | |
| Hamdi Şengül House | (2013) | Bağlar-Kavaklar | Neglience |
| Tevfik Beyler House | (2015) | Akçasu Neighborhood | Electricity |
| Ağabeyler Aşçı Hasan House | (2016) | Aş.Çarşı | Electricity |
| Hacıbey Mehmet Karademir | (2017) | Musalla Neighborhood | Electricity |
| Kırbıyıklar House | | Dışkale altı | |
| İsmail Baş House | | Bağlar-Aktan Street | Unknown |
| Konaklar Saniye | | Gümüş-Kilci Mosque Altı | Unknown |
| Sarı Aliye Hanım House | | Akçasu-Kaçak Street | Unknown |
| Next to Canip Saka House | | Kayadibi Street | Unknown |

| **Konaks** | **Date** | **Location** | **Reason of fire** |
|---|---|---|---|
| Karahasanlar House | | Hükümet Street | Unknown |
| Selmanlar House | | Bağlar Eriklik | Unknown |
| Ayıcının Yavuz House | | Misakımilli-Eralp Street | Unknown |
| Çöllü House | | Misakımilli-Utku Street | Unknown |
| Macunlar House | | Misakımmilli-Okul Street | Unknown |
| Çakırlar Cinema | | Misakımilli (Not registered building) | Unknown |
| Kürt Hayrettin Katrak House | | Misakımilli (Not registered building) | Unknown |
| Aş. Tabakhane Mosque | | Camikebir Neighborhood | Unknown |
| Çiçekler House | | | |
| Saraç Mustafa House | | Köyiçi | |
| Hacı Cemaller House | 2003 | Kalealtı | |
| Hacıbey Yılmaz House | 20.10.2003 | Bağlar-Kavaklar | |
| Hacı Memişler Konak | 1.01.2003 | Çeşme Neighborhood | |
| Saraçlar House | 30.06.2004 | Pazar Yeri | Elektricity |
| Zalifre Otel | 19.04.2010 | Barış Neighborhood | |
| Kardelen Otel | …11.2011 | Atatürk Neighborhood | |
| Emeksizler House | 25.09.2016 | Akçasu Ulukavak Street | |
| Değirmencioğlu Konak | 7.10.2017 | Gümüş -Dibanoz | |
| Balabanlar House | 18.04.2017 | Next to Kalealtı Dua Taşı | |
| Sezai Özdemir | 2017 | Sağlık Street | |
| Hasan Tok House | 2.02.2018 | Akçasu -Kaçak Street | Chimney |
| Sarı Aliye Hanım House | 2018 | Akçasu-Kaçak Street | Unknown |
| Kadıoğlu Otel | 25.07.2020 | Çavuş Neighborhood | |
| Ali-Orhan Demirci House | 25.07.2020 | Çavuş Neighborhood | |

## Appendix L. Survey conducted within "FireSkill" "Fire Protection Practices and Competence-Based Training in Historical Buildings (Protecting People and Cultural Heritage)" (2017-1-TR01-KA202-045607)

| | | |
|---|---|---|
| Cinsiyet | □ Erkek | □ Kadın |
| Yaş | □ 20 ve altı<br>□ 31-40<br>□ 51-60 | □ 21-30<br>□ 41-50<br>□ 61 ve üstü |
| Sektör | □ Kamu<br>□ Sivil Toplum Kuruluşu<br>□ Eğitim Kurumu | □ Özel<br>□ Diğer |
| Eğitim Durumu | □ İlkokul<br>□ Ortaokul<br>□ Lise | □ Ön lisans<br>□ Lisans<br>□ Yüksek lisans/Doktora |
| Meslek | □ Yönetici<br>□ Arama ve Kurtarma Takımı Üyesi<br>□ Teknik Personel<br>□ Akademisyen | □ Mühendis<br>□ İşçi<br>□ Öğrenci<br>□ Diğer<br>……………………….. |

**SURVEY QUESTIONS**

| **RİSK ve DEĞERLENDİRMESİ** | |
|---|---|
| Soru | Cevap |
| **1. Tarihi binaların demirbaşlarının ve iç dekorasyonlarının korunmasına yönelik prosedürler nelerdir? (Veya aşağıdaki koruma tekniklerinden hangisini sıklıkla kullanıyorsunuz?** | |
| a) Ateşe dayanıklı malzemeler ile aşamalı değiştirme. | |
| b) Risk altındaki dekoratif alanların bölünmesi. | |
| c) Müstakil yangın söndürme sistemlerinin kullanımı. | |
| **2. Sizce tarihi binaların korunmasını sağlamak için tarihi binaların çevre değerlendirmesi nasıl yapılır?** | |
| a) Risk altında kullanılan varlıkların tanımlanması. | |
| b) Tehlikeli hizmet ağlarının tanımlanması. | |
| c) Özellikle savunmasız binaların mevcudiyetinin tanımlanması. | |
| **3. Sizce, tarihi binaları yangından koruyan ana tasarım öğeleri hangileridir?** | |
| a) Yanmaz malzemeler | |
| b) Yangın söndürme sistemleri | |
| c) Muhafazalı alanlar ile binaların bölümlere ayrılması | |
| **4. Sizce insanları koruyan ana tasarım öğeleri hangileridir?** | |
| a) Kaçış rotalarının tanımlanması ve doğru iletişim | |
| b) İyi tanımlanmış korunan alanlarda parselleme | |
| c) Acil durum araçlarının erişilebilirliği | |

| **TARİHİ BİNALARIN BAKIM GÜVENLİĞİ** | |
|---|---|
| Soru | Cevap |
| **5. Kullanıcıların (bina sahibi, kiracı, vb.), tarihi binaların yangınla mücadele planları konusunda hangi şekilde bilgilendirilmesi gerektiğini düşünüyorsunuz?** | |
| a) Sınıf eğitimi | |
| b) Uygulamalı çalışmalar | |

| | |
|---|---|
| c) Sanal laboratuvarlar | |
| d) Kişisel donanım (uygulama, bilgilendirici materyaller, vb.,. ...) | |
| **6. Tarihi bir binanın restorasyonunda, geleneksel yapı malzemelerine ve tekniklerine uymak sizce ne kadar önemlidir? (1: En Kötü; 5: En iyi)** | |
| 1) | |
| 2) | |
| 3) | |
| 4) | |
| 5) | |
| **7. Yangından korunma seçenekleri binanın tarihi bütünlüğünü ne ölçüde etkileyebilir? (1: En Kötü; 5: En iyi)** | |
| 1) | |
| 2) | |
| 3) | |
| 4) | |
| 5) | |
| **8. Tarihi binaların restorasyonu amacıyla kullanılan yenilikçi tekniklerden hangisinin, binanın bütünlüğü üzerinde belirgin bir etkisi yoktur?** | |
| a) Dış cepheler ve dışsal biçimlendirme | |
| b) İç mekân mobilyaları | |
| c) Dekoratif detaylar | |
| d) Kaplama | |
| e) Malzemeler (Sıvalar, renkler, vb.) | |

| **RİSK YÖNETİMİ** | |
|---|---|
| Soru | Cevap |
| **9. Tarihi binalarda yangın güvenliğinden kim sorumludur (Ayrıca yangın risk değerlendirmesinden)?** | |
| | |
| **10. Bir binanın yangın güvenliği hangi faktörlere bağlıdır? Binanın kendisine mi bağlıdır?** | |
| | |
| **11. İnşaat çalışmaları neden daha yüksek yangın tehlikesi olarak değerlendirilir?** | |
| | |
| **12. İtfaiyecilerin hızlı ve verimli bir şekilde müdahale etmelerini sağlamak için neler yapılabilir?** | |
| | |
| **YANGIN ÖNLEME TEDBİRLERİ** | |
| Soru | Cevap |
| **13. Tarihi bir binanın uygun şekilde yangın koruma önlemleri nelerdir?** | |
| | |
| **14. Boş durumda bulunan tarihi binaların yangından korunması için ne yapılabilir?** | |
| | |

| | |
|---|---|
| **15. Tarihi tescilli yapılarda yangın riskini artıran en önemli etmen/etmenler sizce aşağıdakilerden hangisi/hangileridir? (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz).** | |
| a) Binalardaki elektrik tesisatının eski olması | |
| b) Binaların ahşap olması | |
| c) Yangın önlemlerinin yeterli olmaması | |
| d) Binaların dar sokaklarda yapılmış olması | |
| **16. Tarihi tescilli yapılarda yangınların önlenmesinde en önemli faktör/faktörler sizce nelerdir? (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz).** | |
| a) Yapılarda yangın sistemlerinin yapılması | |
| b) Ahşap yapılarda ahşap kısımların ateşe dayanıklı sıvı madde ile kaplanması | |
| c) Yapılara yeterli düzeyde yangın tüpü konulması | |
| d) Bina sahiplerinin yangın önleme ve yangına müdahale konusunda eğitilmesi | |

| **EŞYALARIN KORUNMASI** | |
|---|---|
| Soru | Cevap |
| **17. Yaşadığınız yerde yangın olması durumunda öncelikli olarak kurtarılmasını düşündüğünüz bir değer var mı?** | |
| a) Evet | |
| b) Hayır | |
| c) Fikrim yok | |
| **18. Böyle değerlere sahipseniz bunlar için belirlediğiniz bir öncelik sıralaması var mı?** | |
| a) Evet | |
| b) Hayır | |
| c) Fikrim yok | |
| d) Uygulanamaz | |
| **19. Taşınamaz nitelikte ise yerinde korunabilmesi için herhangi bir koruma tedbiri alınmış mıdır?** | |
| a) Evet | |
| b) Hayır | |
| c) Fikrim yok | |
| d) Uygulanamaz | |
| **20. Taşınamayacak nitelikte değere sahip eşyalar için varsa alınan yangından koruma tedbirleri nelerdir?** | |
| | |
| **YANGIN TEMEL PRENSİPLERİ** | |
| Soru | Cevap |
| **21. Bir odada yangın fark kederseniz ne yaparsınız? (Lütfen uygun olan seçenek/ seçenekleri işaretleyiniz);** | |
| a) Kapıyı açık bırak ve yardım için kaçarım | |
| b) Kapıyı açık bırakırım çünkü dumanı dışarı atar | |
| c) Odanın kapısını yangınla birlikte kapatır ve yardım isterim | |
| **22. Bir binadaki yangının yayılmasında en önemli faktör nedir? (Lütfen uygun olan seçenek/ seçenekleri işaretleyiniz);** | |
| a) Yanabilecek pek çok malzeme | |
| b) Yangın yüzünden parlamalar | |
| c) Kapıları açın, böylece duman binaya yayılabilir | |
| d) Eski kapılar | |
| **23. Bir yangın eğitimine katıldınız mı?** | |
| a) Evet | |
| b) Hayır | |

| | |
|---|---|
| **24. Şayet binanız yetkililer tarafından denetleniyorsa, bu işlem hangi sıklıkla yapılıyor? (Lütfen uygun olan seçenek/ seçenekleri işaretleyiniz);** | |
| a) Her yıl | |
| b) 2-3 yıl | |
| c) 3-5 yıl | |
| d) Denetlenmedi | |

| **YANGIN SÖNDÜRME** | |
|---|---|
| Soru | Cevap |
| **25. A sınıfı yangın denildiğinde ne anlıyorsunuz?** | |
| a) Katı madde yangını | |
| b) Yanıcı Sıvı yangını | |
| c) Yanıcı gaz yangını | |
| d) Fikrim yok | |
| **26. Yanmanın gerçekleşmesi için gerekli unsurlar nelerdir?** | |
| a) Isı | |
| b) Yakıt | |
| c) Oksijen | |
| d) Kimyasal Reaksiyon | |
| e) Hepsi | |
| f) Bir fikrim yok | |
| **27. Yangında insanların ölümüne neden olan en önemli unsur hangisidir?** | |
| a) Alev | |
| b) Yüksek ısı | |
| c) Duman | |
| d) Binanın çökmesi | |
| **28. Bir yangında elektrik enerjisi varsa söndürürken neye dikkat etmelisiniz?** | |
| | |
| **TAHLİYE** | |
| Soru | Cevap |
| **29. Oturmuş olduğunuz binada herhangi bir yangın esnasında kaçış noktalarını biliyor musunuz? (Lütfen uygun seçeneği işaretleyiniz).** | |
| a) Evet | |
| b) Hayır | |
| **30. Bulunduğunuz bölgede herhangi bir yangın esnasında itfaiye ve ambulans araçlarının gelmesini zorlaştıran etmenler nelerdir? (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz);** | |
| a) Sokakların dar olması | |
| b) Özel araçların uygunsuz olarak park edilmesi | |
| c) Yolların yapısının bozuk olması | |
| d) Herhangi bir etmen bulunmamaktadır | |
| **31. Yangın ihbarı için aşağıdaki numaralardan hangisini ararsınız? (Lütfen uygun seçeneği işaretleyiniz);** | |
| a) 110 | |
| b) 120 | |
| c) 130 | |
| d) 140 | |
| **32. Yangın nedenleri ve yangın anında yapılması gerekenler konusunda çocuklarınızın bilgi düzeyi sizce yeterli midir? (Lütfen uygun seçeneği işaretleyiniz);** | |
| a) Evet | |
| b) Hayır | |

| ACİL DURUM ORGANİZASYONLARI İLE İŞBİRLİĞİ | |
|---|---|
| Soru | Cevap |
| **33. Binanızda yangın alarm sistemi var mıdır?** | |
| a) Evet | |
| b) Hayır | |
| **34. Binanızda yerel yangın birimleri ile yangın tatbikatı yaptınız mı?** | |
| a) Evet | |
| b) Hayır | |
| **35. Şayet binanızda yangın söndürücü varsa, düzenli şekilde kontrol edilir mi?** | |
| a) Evet | |
| b) Hayır | |
| **36. Yangınları önlemek için elektrik tesisatınız düzenli bir şekilde kontrol ediliyor mu?** | |
| a) Evet | |
| b) Hayır | |

| TARİHİ BİNALAR İLE İLGİLİ KANUNLAR VE MEVZUAT | |
|---|---|
| Soru | Cevap |
| **37. UNESCO'ya göre "Etik ve Somut Olmayan Kültürel Miras"ın korunmasında (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz);** | |
| a) Topluluklar, gruplar ve bireyler birincil role sahiptir. | |
| b) Topluluklar, gruplar ve bireyler ikincil role sahiptir. | |
| c) Topluluklar, gruplar ve bireylerin söz hakkı yoktur. | |
| d) Tüm kararlar sadece ülkeler tarafından alınır. | |
| **38. "Dünya Kültür ve Tabiat Varlıklarını Koruma Sözleşmesi"ne göre (1972 tarihli), bu sözleşmenin amaçları için "kültürel miras" olarak kabul edilecektir …….. (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz)<br>I- Anıtlar (Tarih, sanat ya da bilim açısından olağanüstü evrensel değere sahipler),<br>II- Yapı grupları (Tarih, sanat ya da bilim açısından olağanüstü evrensel değere sahipler),<br>III- Siteler (Tarih, sanat ya da bilim açısından olağanüstü evrensel değere sahipler).** | |
| a) I | |
| b) II | |
| c) III | |
| d) I-II | |
| e) I-II-III | |
| **39. Somut olmayan kültürel mirasın temel prensipleri " (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz)** | |
| a) Yeri doldurulamaz evrensel bir miras olarak görülmeli. | |
| b) Her üye devletin koşullarına uygun olarak düşünülmeli. | |
| c) Bütünlük içerisinde tutarlı olarak düşünülmelidir. | |
| d) Her türlü hasara karşı aktif olarak korunmamalı. | |
| **40. UNESCO tarafından tanımlanan tarihi kentsel peyzaj için zorluklar ve fırsatlar aşağıdaki gibi yer almıştır (Lütfen uygun seçenek ve/veya seçenekleri işaretleyiniz).** | |
| a) Kentleşme ve küreselleşme. | |
| b) Kalkınma. | |
| c) Çevre. | |

## Appendix M. Permission for Hot Works Sample[59]

**EXAMPLE 1**

**Method Statement for single permit – lead roof repairs**

1. The hot works will be under supervision of the responsible person or their duly authorised agent, who will ensure this method statement is followed and that the user has signed Parts III and V of the hot works permit.
2. The hot works will stop at least 2 hours before the end of the normal working day or building closing time.
3. The responsible person or their duly authorised agent must inspect at the end of each working day and at the completion of the hot works the work area, and all roof spaces/floors within 3 metres directly below and adjacent to the working area after a period of at least 2 hours to ensure all has been made safe.
4. The work area will never be left unattended during the hours of 8.00 and 16.00.
5. No hot works will be allowed to be undertaken overnight (18.00 to 8.00).
6. An appropriate fire extinguisher and a fire blanket are to be kept within the working area with the operatives undertaking the hot works suitably trained to use the fire extinguisher and fire blanket. The person responsible for monitoring the hot work will also be trained in the use of fire extinguishers and fire blankets.
7. All combustible materials should be kept at least 3 metres away from the hot works.
8. At the end of the hot work activities each day, all hot surfaces must be cool before the operatives leave the work area. Any burning embers must be thoroughly extinguished. All gas cylinders/canisters and waste materials must be removed from the work area overnight.



[59] Hot work permission samples were taken Fire Safety: Hot Works and Historic Buildings published by Historic England. [URL 26].

**EXAMPLE 1**

## Authority to carry out hot work – Single permit

| | | |
|---|---|---|
| AUTHORITY | Type of work *Repair of lead roof* | |
| | Valid for the period to subject to conditions of the PTW Hot Work Policy | |
| | PART I: To be prepared by the 'Responsible Person' in conjunction with the contractor | |
| | Why alternative methods cannot be used | |
| | *The hot work is required for the repair of lead roof*<br>*No suitable alternative available* | |
| | Exact location of hot works | |
| | *North Wing roof* | |
| | Person carrying out the works | |
| | *Specialist lead roofing contractor trained with regards to the fire procedures only* | |
| | Risks associated with the work | |
| | *The use of naked flame*<br>*Potential of hot embers*<br>*Direct and indirect heat transfer to combustible materials*<br>*Use of flammable liquids (gas)*<br>*Access and restricted space for inspection of area during and post completion of the hot works* | |
| | How risks will be managed | |
| | *A Method Statement and Risk Assessment has been written regarding the hot works and will be reviewed at regular intervals.*<br>*All roof spaces/floors within 3 metres directly below and adjacent to the working area will be cleared of all loose combustible and flammable materials.*<br>*All combustible items, on ceilings and walls to be moved away clear of any metal likely to conduct heat. This may require the removal of roof insulation which will need to be reinstated once the works are complete. Where this is not possible then temporary fire-resistant materials to protect the working and adjacent areas may be required.*<br>*The responsible person or the duly appointed representative will inspect the working area at regular intervals.* | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| ACCEPTANCE | PART II: To be completed by the 'Responsible Person' on site before works commence | |
| | I am satisfied that there is no practical alternative to hot working in this case and, having examined the location, permission is granted to: | |
| | Name of Staff Member | |
| | Address | |
| | To undertake (type of work) | *Lead roof repairs* |
| | Location | *North wing roof* |
| | Between the stated times and subject to the conditions of this Authority | Start Time:<br>Finish Time: |
| | Signed | |
| | Name (printed) | |
| | Date | |

## EXAMPLE 1

### Authority to carry out hot work – Single permit

| | | |
|---|---|---|
| AUDITING | PART III: To be completed by the contractor | |
| | I certify that the work will be carried out in accordance with the requirements of this Authority, including all precautions listed overleaf. | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| | PART IV: To be completed by 'Responsible Person' on site | |
| | I have examined the work in progress and am satisfied that it is being carried out in accordance with the requirements of this Authority. | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| UPON COMPLETION | PART V: To be signed by the contractor on completion | |
| | The hot work has been completed and all sources of ignition removed. The work area and all adjacent areas to which sparks and heat might have spread, were thoroughly inspected on completion of the work, and again two hours later in order to ascertain that no smouldering fires had started. | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| | PART VI: To be signed by the 'Responsible Person' on completion | |
| | I have examined the area and am satisfied that there are no signs of fire. | |
| | Signed | |
| | Name (printed) | |
| | Date | |

**EXAMPLE 2**

**Method Statement for annual permit – use of the kitchen fireplace**

1. Any use of the fireplace must be under supervision of a staff member, who will ensure this method statement is followed and that the user has signed Parts III and V of the hot works permit.
2. If the fireplace is used at night, a security guard will be employed to monitor the fire and ensure that this method statement is followed.
3. The fire must never be left unattended by the persons using it and the general public will not be allowed within 1 metre of it.
4. A water fire extinguisher and a fire blanket must be kept in close proximity to the fireplace. These are concealed at events but the position known to all staff, security and re-enactors using the kitchen. The person responsible for monitoring the fire should be trained in the use of fire extinguishers.
5. The hastener and the fire basket provided must always be used, and the iron fire basket must remain in the centre of the hearth.
6. Turf and/or a fire plate must be placed under the fire basket to prevent any damage to the historic hearth.
7. All combustible materials should be kept at least 3 metres away from hearth.
8. Persons attending the fire should be appropriately dressed for the tasks. Clothing should be made of natural fibres which are typically difficult to ignite or melt, and costumes must not have any trailing material.
9. At the end of the activities, all hot or burning embers must be thoroughly extinguished, placed into the fire-proof metal box, removed from the house and safely disposed of.
10. After the removal of all embers from the house, both the chimney and fireplace must be examined by the persons using the fireplace and the staff member, to make sure that there are no sparks or smouldering particles.
11. A senior member of staff (or the Duty Manager) must inspect the fireplace, after a period of at least 2 hours following the removal of the embers, to ensure all has been made safe.

**EXAMPLE 2**

## Authority to carry out hot work – Annual permit

### AUTHORITY

Permit to use: *Kitchen fireplace*

Valid for the period            to            subject to conditions of the PTW Hot Work Policy

**PART I: To be prepared by the 'Responsible Person'**

**Why alternative methods cannot be used**

*Lighting the fire is part of the interpretation of the kitchen for visitors. There is no alternative to recreating the experience. The fire needs to be burning for the duration of the visitor day 10:00–17:00, therefore lit between 08:00–18:00.*

**Exact location of hot works**

*Old Kitchen, Country House*

**Person carrying out the works**

*Only staff members specifically trained with regards to the fire procedures.*

**Risks associated with the work**

*Chimney fire.*
*When removing embers each day, there is the possibility embers might escape and ignite flammable materials in the room.*

**How risks will be managed**

*A Method Statement and Risk Assessment has been written regarding the fire and will be reviewed at regular intervals.*
*All floors will be swept clean of all combustible materials.*
*Flammable liquids have been removed to an approved location.*
*All combustible items, on ceilings and walls have been moved away clear of any metal likely to conduct heat.*
*A member of staff will be present at all times.*
*Where possible, flammable materials will be removed on the visitor route between the entrance/exit door and the fireplace.*
*The embers will be carried outside in a metal box.*
*The chimney has been lined.*
*The chimney is swept each year (chimney sweep must be HETAS (https://www.hetas.co.uk/) registered.*
*Safety reports kept on site at the Estate Office.*

| | |
|---|---|
| Signed | |
| Name (printed) | |
| Date | |

### ACCEPTANCE

**PART II: To be completed by the 'Responsible Person' on site before works commence**

I am satisfied that there is no practical alternative to hot working in this case and, having examined the location, permission is granted to:

| | |
|---|---|
| Name of Staff Member | |
| Address | |
| Specific equipment or facility | *Kitchen fire, as part of interpretation demonstration for visitors* |
| Location | *Old Kitchen, Country House* |
| Between the stated times and subject to the conditions of this Authority | Start Time:<br>Finish Time: |
| Signed | |
| Name (printed) | |
| Date | |

**EXAMPLE 2**

## Authority to carry out hot work – Annual permit

| | | |
|---|---|---|
| AUDITING | PART III: To be completed by the person carrying out the work | |
| | I certify that the work will be carried out in accordance with the requirements of this Authority, including all precautions listed overleaf. | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| | PART IV: To be completed by 'Responsible Person' on site | |
| | I have examined the work in progress and am satisfied that it is being carried out in accordance with the requirements of this Authority. | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| UPON COMPLETION | PART V: To be signed by the person carrying out the work on completion | |
| | The hot work has been completed and all sources of ignition removed. The work area and all adjacent areas to which sparks and heat might have spread, were thoroughly inspected on completion of the work, and again two hours later in order to ascertain that no smouldering fires had started. | |
| | Signed | |
| | Name (printed) | |
| | Date | |
| | PART VI: To be signed by the 'Responsible Person' on completion | |
| | I have examined the area and am satisfied that there are no signs of fire. | |
| | Signed | |
| | Name (printed) | |
| | Date | |

## Appendix N. Precautions for electrical equipments that owners/occupiers of traditional buildings can follow

| Precautions for Electrical Equipments[60] | Check |
|---|---|
| Technical space, such as an electrical signal box or distribution box, is not used as a storage facility. | |
| The cables are intact and not pinched, and the areas surrounding heat radiating equipment are clean and clear. | |
| Lids and doors to distribution boxes, controller cabinets, and switch bays are closed. | |
| That distribution boxes and other electrical installations are not exposed to humidity. | |
| Electrical heating equipment such as electric radiators, coffee makers, and sauna heating units are not covered or placed in an unsuitable environment. | |
| Hot plates are cleared of all combustible materials, and knobs cannot accidentally be turned on. | |
| Hot plates not in use are disconnected. | |

[60] These policies are derived from CFPA-E (2013). Managing Fire Safety in Historical Buildings.

## CURRICULUM VITAE

Surname, Name: Uluç Keçik, Aynur
Email:

### EDUCATION

| Degree | Institution | Year of Graduation |
|---|---|---|
| **PhD** | METU City and Regional Planning | 2022 |
| **MS** | METU Restoration and Conservation of Historic Sites and Monuments | 2014 |
| **BS** | Anadolu University Business Administration (Distant Learning) | 2014 |
| **BS** | METU City and Regional Planning | 2011 |

### PROFESSIONAL EXPERIENCE

| Year | Institution | Affiliation |
|---|---|---|
| **March 2016 – Present** | Middle East Technical University (METU) | Research Assistant |
| **February 2015 – October 2015** | Süleyman Demirel University | Research Assistant |

### PUBLICATIONS

**Thesis**

2022 Fire Vulnerability Assessment for Heritage Places: A Case of the City of Safranbolu World Heritage Site Unpublished Ph.D. Thesis, METU, Ankara, Supervisor: Assoc. Prof. Dr. Meltem Şenol Balaban Co-Supervisor: Assist. Prof. Dr. Sibel Yıldırım Esen.

2014 A Framework for Sustainable Urban Mobility in Historic Urban Landscapes: A Proposal for Antalya Kaleiçi, Unpublished Master Thesis, METU, Ankara, Supervisor: Assist. Prof. Dr. Güliz Bilgin Altınöz.

**Article in Journal**

2019 **Uluç, A.** and Şenol-Balaban, M. The Comparison of Institutional Frameworks Regarding Risk Management for Conservation of Cultural Heritage by Focusing on UNESCO World Heritage Sites: The Cases of the UK, Japan and Turkey. Resilience, 3 (2), 247-267. DOI: 10.32569/resilience.618752

2021 **Uluç, A.** and Şenol-Balaban, M., Yıldırım-Esen, S. "Assessing the Policies on Fire Risk Management of Cultural Heritage: Cases of the England and Turkey" *(in Turkish). TÜBAKED.*

**National Book Chapter**

2021 Kurtuluş, B. and **Uluç, A**. Spatial Characteristics of Housing in Susuz Beğiş Village in Korkuteli (in Turkish), in *Ömür Bakırer Anı Kitabı*, METU Faculty of Architecture Press (Editors: Ali Uzay Peker and Neriman Şahin Güçhan)

**International Book Chapter**

2022 **Uluç, A**. The Repair, Maintenance, and Restoration of Traditional Housing and the Related Legal Framework: Antalya Kaleiçi, in *Housing in Turkey: Policy, Planning, and Practice*, Routledge (Editors: Burcu Özdemir-Sarı, Esma Aksoy-Khurami, and Nil Uzun)

**Oral Presentation and Full Paper in Conference and/or Symposium**

2016 **Uluç A.** and Bilgin-Altınöz G. Planning and Conservation of Cultural Heritage Education *(in Turkish)* *8 Kasım Dünya Şehircilik Günü, 8. Türkiye Şehircilik Kongresi*, METU, Ankara, Turkey. Conference Proceeding Book (p.719-740).

2015 **Uluç A.** and Bilgin-Altınöz G. Addressing Transportation and Historic Urban Landscape Dilemma within Sustainable Urban Mobility Perspective: A Case of Antalya Citadel Area *(in Turkish)*, *ROTRASA 2015: Sürdürülebilir Ulaşım için Yol ve Trafik Güvenliği Ulusal Kongresi Bildiri Kitabı*, (2016), (p.224-234).

**Oral Presentation and Abstract in Conference and/or Symposium**

2019 **Uluç, A.** and Şenol-Balaban, M. Investigating the City of Safranbolu World Heritage Site with its Natural Threats. *International Science and Engineering Applications, Symposium on Hazards (ISESH2019),* 25-27 Eylül 2019, Karabük, Proceeding Book (Editor: Dr. İnan Keskin) (p. 429-434).

2017 **Uluç, A.** and Şenol-Balaban M. Identification of Risks that Cultural Heritage Sites face concerning (no)dialog in different stakeholders *(In Turkish)*, *Geçmiş | Bugün | Gelecek Arasındaki Diyalog*, 26-27-28 October 2017, TED University, Published Extended Abstract Book (p. 47-54)

2017 **Uluç, A.** and Bilgin-Altınöz, G. Reading Dialog via Public Open Spaces: The Case of Antalya Kaleiçi *(In Turkish)*. *Geçmiş | Bugün | Gelecek Arasındaki Diyalog*, 26-27-28 October 2017, TED University, Published Extended Abstract Book (p. 123- 130).

**Oral Presentation in Conference and/or Symposium**

2022 **Uluç, A.,** Şenol-Balaban, M., and Yıldırım-Esen, S. (Invited Speaker). Fire Risk Management of Cultural Heritage: Recent Policies and Interventions *Short Training Course on Disaster Risk Management / Natural Hazards for Cultural Heritage, 22 February 2022, organized as part of the project "CRAFT: Developing a Novel Climate Change Risk Assessment Framework for Cultural Heritage in Turkey." (Webinar)*

2021 **Uluç, A.** (Invited Speaker). Current Approaches about Fire Risk Assessment of Cultural Heritage: The Case of the City of Safranbolu World Heritage Site *Emre Madran izinde EDEP YAHU Buluşmaları 8, Risk at Cultural Properties, Current Situation and Interventions on 26 September 2021 (Webinar)*

2021 Şenol-Balaban M. and **Uluç, A**. Assessing Different Threats faced by 17 UNESCO World Heritage Sites in Turkey *(in Turkish). Disaster Risk Management of Turkey, 24$^{th}$ Round Table Meeting,* 26 February 2021, METU, Ankara, Turkey.

2021 Şenol-Balaban M. and **Uluç, A.,** Özgür, B. Local Disaster Rik Mitigation Plans defined in Sendai Framework: Provincial Disaster Risk Mitigation Plans initiated by Kahramanmaraş Case *(in Turkish). Disaster Risk Management of Turkey, 24$^{th}$ Round Table Meeting*, 26 February 2021, METU, Ankara, Turkey.

2019 **Uluç, A.,** Bouakaze-Khan, D. and Şenol-Balaban, M. The Comparison of Different Institutional Frameworks regarding Risk Management for Conservation of Cultural Heritage: The Case of Britain, Japan and Turkey UNESCO World Heritage Sites. *International Disaster and Resilience Congress (IDRC2019)*, 26-28 June 2019, Eskişehir, Turkey.

2019 Şenol-Balaban M. and **Uluç, A**. Revealing different natural threats that 17 UNESCO World Heritage Sites in Turkey are subject to using GIS and Risk Mitigation Studies *(In Turkish)*, *Disaster Risk Management of Turkey, 21th Round Table Meeting*, METU, Turkey, 22 February 2019.

2019 Şenol-Balaban M. and **Uluç, A**. A Comparison between the City of Safranbolu and Bursa-Cumalıkızık UNESCO World Heritage Sites regarding Different Natural Threats by Geographical Information System (GIS) *(In Turkish). Disaster Risk Management of Turkey, 21st Round Table Meeting*, METU, Turkey, 22 February 2019 (Poster Presentation)

2018 Kumtepe, E., **Uluç, A.** and Aydın N. Analysis of Physical, Social and Social Transformation of Urban Cultural Heritage Sites with respect to Tripadvisor: The Case of Ankara Hamamönü *(In Turkish)*, *Uluslararası*

*Kentleşme ve Çevre Sorunları Sempozyumu Değişim/Dönüşüm/Özgünlük.* 28-29-30 June 2019, Eskişehir, Turkey.

2018 Aydın N. and **Uluç, A.** The Comparison of Different City and Regional Planning Education Systems. Focusing on Studio Education. Paper presented at *the Association of European Schools of Planning (AESOP) Annual Congress, Making Spaces for Hope*, 10-14 July 2018, Gothenburg, Sweden. Published Abstract Book p.646.

2018 **Uluç, A.** and Aydın, N. How a Campus can be Disabled Friendly: The Case of METU, Ankara, paper presented at *the Association of European Schools of Planning (AESOP) Annual Congress, Making Spaces for Hope,* 10-14 July 2018, Gothenburg, Sweden. Published Abstract Book (p.642).

2018 **Uluç, A**. Analyzing Disaster Management during Conservation of UNESCO World Heritage Sites in Turkey *(In Turkish). Disaster Risk Management of Turkey, 20th Round Table Meeting*, METU, Ankara, Turkey. 16 March 2018.

2017 **Uluç, A.** and Özbilen B. An Emphasis on the Pedestrian Accessibility Measures of Ankara City Center, presented at *the Association of European Schools of Planning (AESOP) 30th Annual Congress*, AESOP 10-14 July 2017, Lisbon, Portugal, Published Abstract Book (p. 522).

2016 **Uluç, A**. Parking Pricing as a Tool for Sustainable Urban Transport: Comparison of Belgrade and Istanbul Examples, *Sürdürülebilir Şehircilik Kongresi ve Sergisi 1: Kuramdan Pratiğe Sürdürülebilirlik*, 20-21 April 2016, Eskişehir, Turkey.

2012 Lotfata, A. and **Uluç, A**. Socio-Spatial Resilience Strategic Planning Through Understanding Strategic Perspectives on Tehran and Bath, *the Association of European Schools of Planning (AESOP)*, METU, Ankara, Turkey (Poster Presentation).

**Projects Involved**

2018 As a Researcher (May 2018 – May 2021)
Project title: Spatialization of Different Natural and Man-made threats that UNESCO World Heritage Sites in Turkey face (in Turkish) [Project Code: YÖP-202-2018- 2853] Coordinator: Dr. Meltem Şenol-Balaban

2019 As a Researcher (February 2019 – October 2019)
Project title: Implementation Project: With Ministry of Interior, Disaster and Emergency Management Authority, “Updating Guidelines for Provincial Risk Reduction Plan Preparation by Pilot Implementation Project” (in Turkish) Coordinator: Dr. Meltem Şenol-Balaban

## SELECTED WORKSHOPS & SUMMER SCHOOLS ATTENDED

2021 16-20 August 2021, Lulea Technic of University, Kiruna, Sweden, *Ph.D. summer school Urban Arctic (Sustainable urban development in resource-extraction territories: The Arctic as a case study)*

2020 European Commission's Joint Research Centre (JRC), Florence, Italy, 13-15 January 2020, *Evidence4policy Disaster Risk Management*

2018 Danube University, Krems, Austria, 23 January 2018 *Safeguarding Cultural Heritage from Natural and Man-made Disasters*

2015 12-24 July 2015 "KNOW the PAST to BUILD THE FUTURE: LAND and PRODUCTS - Survey for Planning: New Technologies and Land Protection", Milano, Pisa, Alberobello, Locorotondo, Matera, Laterza, Bari, Grottaglie, Castellana Grotte, Noci, Italy.

## ACHIEVEMENTS

**2011 June** graduated with a 3rd rank degree in the City and Regional Department, METU, Ankara, Turkey
**Dean's Honor List (GPA above 3.0/4.0)**, METU June 2011
**2010-2011 Spring** High Honor Certificate, METU
**2010-2011 Autumn** High Honor Certificate, METU, Ankara, Turkey
**2009-2010 Spring** High Honor Certificate, METU, Ankara, Turkey
**2009-2010 Autumn** Honor Certificate, METU, Ankara, Turkey
**2008-2009 Spring** High Honor Certificate, METU, Ankara, Turkey
**2002-2005** graduated with 3rd rank degree from Muratpaşa High School, Antalya, Turkey

## RESEARCH INTERESTS

Urban conservation planning, disaster risk management of cultural heritage, urban mobility in historic landscapes

## LANGUAGES

Turkish (native language), English (advanced), German (beginner), Italian (beginner), Swedish (beginner)