EARTHQUAKE RISK PERCEPTION, COMMUNICATION AND MITIGATION STRATEGIES ACROSS EUROPE

Piero Farabollini, Francesca Romana Lugeri, Silvia Mugnano
Editors

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CONTENTS

1. Urban Seismic Risk Reduction and Mitigation Strategies in Turkey

Ahmet Anıl Dindar[1], Cüneyt Tüzün[2], Aybige Akinci[3]

Abstract

Since the early ages of humankind, safety and security has been a critical issue against the forces of nature. However, history has always proven the power of nature over humankind in certain regions on Earth for centuries. Indeed, this is a never-ending war between Earth and its inhabitants, namely us, human beings. Humankind's organization (cities, roads, lifelines etc.) in the nature has never been perfect within the view of environmental pollution and excessive consumption of the resources. Particularly, the quality of civil engineering design and practice is strongly affected from the social and economic background of the country. The societies in rapid development claim excessive demands in terms of housing and transportation. Such demands may create vulnerable urban areas if the economic and social conditions are not in balance or harmony. Thus, nature should not be blamed as the scapegoat in the regions where disasters claim human and economic losses. In fact, the reason for the losses is nothing else than humankind itself. A rational question arises then about how to overcome human and economic loss due to natural disasters. The idea of determining the most vulnerable items in urban areas and reconstructing with the most reliable equivalents may seem very challenging. Even though the macroeconomic implications are very complex, reconstructing the items in densely populated areas is the most effective mitigation action against disasters in the short term. Having learnt lessons from the major earthquake disasters in the heart of the industry and mostly dense urban areas, Turkish government has drawn a long strategic road map in the risk perception and the disaster mitigation strategy for almost all the community services and the infrastructure. The development of awareness against disasters has become part of formal education at all ages. The National Disaster Management system was reorganized from scratch and

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the capabilities improved by providing additional financial and human resources. All school and hospital buildings in İstanbul were assessed in terms of seismic safety. Those found inadequate were demolished and then reconstructed. In addition, a law on urban renewal of the seismic risk areas was enacted in 2012 allowing the licensed engineering offices to assess the seismic risk of residential buildings at the request of the house owners. If the assessment report is approved by the local municipality, the building is set to demolish within 60 days following the legal notice to the property owners. Disagreeing owners have the right to get the assessment re-evaluated by the independent peer reviewers. In the case of demolition, the house owners are eligible to receive 12 months of rental support from the government. During the time period 2012 to 2019, more than 120 000 buildings were assessed and 74% of them were demolished, the majority of the latter were in İstanbul area where a major earthquake is expected within the following decades. This chapter is intended to explain one of the most comprehensive and challenging disaster mitigation strategies being applied in Turkey based on experience since the 1999 earthquakes.

Keywords: buildings, disasters, mitigation strategies, Turkey, urban seismic risk reduction,

1. Introduction

Because of the real earthquake threat in Turkey, due to the country's geological and tectonic structure characteristics, the need for seismic hazard studies has become progressively more important for engineering applications, mitigation and reduction of earthquake risk particularly after the two recent earthquakes; İzmit-August 17, 1999, M7.4 and Düzce -November 12, 1999, M7.2 (Erdik et al., 1999). According to statistical results, natural disasters in Turkey from 1900 to 2011 are dominated by earthquakes, and earthquakes are a synonym with the concept of disaster in Turkey (Sonmez Saner, T. 2015; Ergunay, 2007). The United Nations Development Program (2004) and the Global Assessment Report on Disaster Risk Reduction (2009) reported that Turkey ranks high among countries according to mortality risk and significant losses of property due to earthquakes. For example, 1939 Erzincan, M7.9 and 1999 İzmit M7.4 earthquakes caused almost 32,000 and 17,000 fatalities and left more than half a million people homeless. Economic losses caused by larger earthquakes have often exceeded $5 billion (US$) and

have reached $23 billion and $10 billion for the 1939 Erzincan and 1999 İzmit earthquakes, respectively.

These major earthquakes have also revealed that buildings are quite vulnerable in the country. A majority of the population is living in earthquake-prone areas where there are also the industrial facilities producing 75% of the nation's economic income (e.g. Marmara and western Anatolian region). The rapid migration from rural to urbanized areas since the 1950s in Turkey caused severe circumstances in terms of vulnerability in every aspect of life. Only 25% of the entire population was living in urban areas in 1950, but this ratio reached 75% in 2017. The new residents of the metropolitan cities demanded to a house in very large numbers. Due to the steadily increasing population, with improper land-use planning, inappropriate construction techniques and inadequate infrastructure systems, associated with existing high hazard level, many major cities in Turkey (e.g. İstanbul, Bursa) have become some of the most risky cities in Europe and the Mediterranean region (Ansal et al., 2010).

The constant and persistent risk of being hit by a devastating earthquake has become a crucial social and financial issue for the Turkish government. The earthquakes of 1999 generated a strong national determination in Turkey to devise new and effective methods of tackling disasters. A number of risk assessment studies have been carried out in Turkey both at national and local levels since 1999. These studies that related to settlement level risks are the Earthquake Master Plan of İstanbul (EMPI) imposed by the Metropolitan Municipality of İstanbul and carried out by four universities in 2003 (ITU, METU, BU and Yıldız Tech. Un.). EMPI developed a comprehensive framework for the determination of urban risks and methods of reducing them. One of the important national projects was the İstanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP) Project initiated by the Turkish Government, financed by a World Bank loan and carried out by the İstanbul Special Provincial Administration (ISMEP, 2010; www.ipkb.gov.tr). Its objective was to transform densely-populated İstanbul (hosting over 14.6 million people is approximately one-fifth of Turkey's population) into a city resilient to a major earthquake by strengthening the emergency management capacity, enhancing emergency preparedness, activating the seismic risk mitigation actions for priority public buildings and the enforcement of Building Codes. However, all those efforts have not been specified in a particular policy or action plan. In 2009 the Disaster and Emergency Management Presidency of Turkey (AFAD) was also established effective emergency management and civil protection issues on a nationwide scale.

As a part of the Declaration of the National Earthquake Strategy Plan for Turkey (NESAP-2023) between 2012 and 2023, the government decided to implement a very strict policy for action through a law called "Transformation of Areas under the Disaster Risks (No: 6306)" legislated in May 2012. This policy calls for the demolition of risky and illegal buildings and the renewal of those based on some rules and procedures. The cost of urban transformation is roughly estimated to be at $500 billion and the timeframe for completion is, ambitiously, 20 years (Güneş, 2015). By now it has been in use almost in every town in Turkey, however, numerous discussions and allegations have made by academic and non-governmental organizations due to the application procedures This paper deals with the rationale of Law No: 6306, its scope, its procedures, and explains the current situation in its application. Having been enforced for 7 years, there have been many lessons learned from the application of the law and its social and economic effect on society.

2. Seismotectonic Setting and Seismic Activity in Turkey

Turkey is located on the Alpine-Himalayan Seismic Belt which is one of the most seismically active regions in the world. Recently, the compiled historical catalog lists or identifies 2247 events for the time period from 2000 BC to 1900 AD with 212 earthquakes with an intensity (I_o) of nine (IX) greater during the last 4000 years (Soysal et al., 1981; Ambraseys 2009; Albini et al., 2013) Figure 1. During the last century and in the instrumental catalog (1900-2012) 203 events are registered with a magnitude of 6.0 and greater in Anatolia and the surrounding region (Kalafat et al., 2011; Kadirioglu et al., 2016; Duman et al., 2018) (Figure 2).

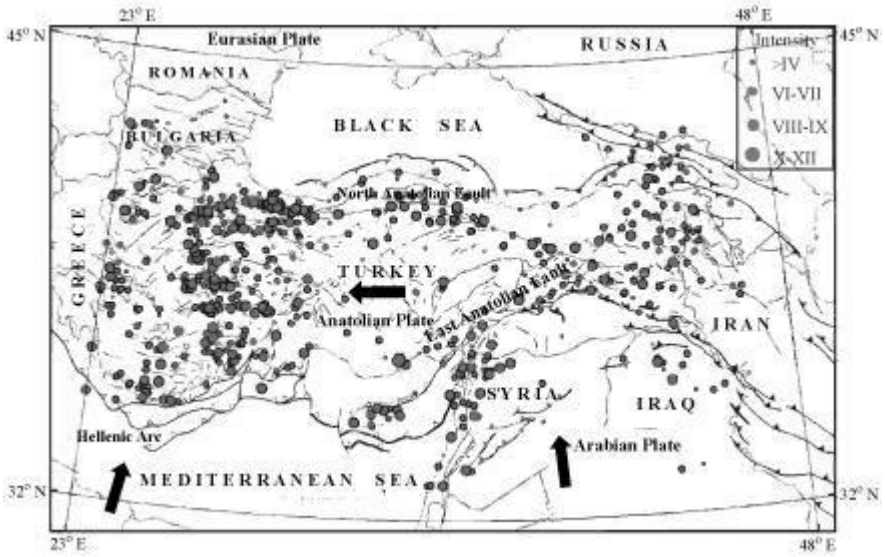


Figure 1 - *Primary, active faults (Emre et al., 2013) and the distribution of historical earthquakes (BC 2000-AD 1900) in Turkey and surrounding areas (Modified from Duman et al., 2018).*

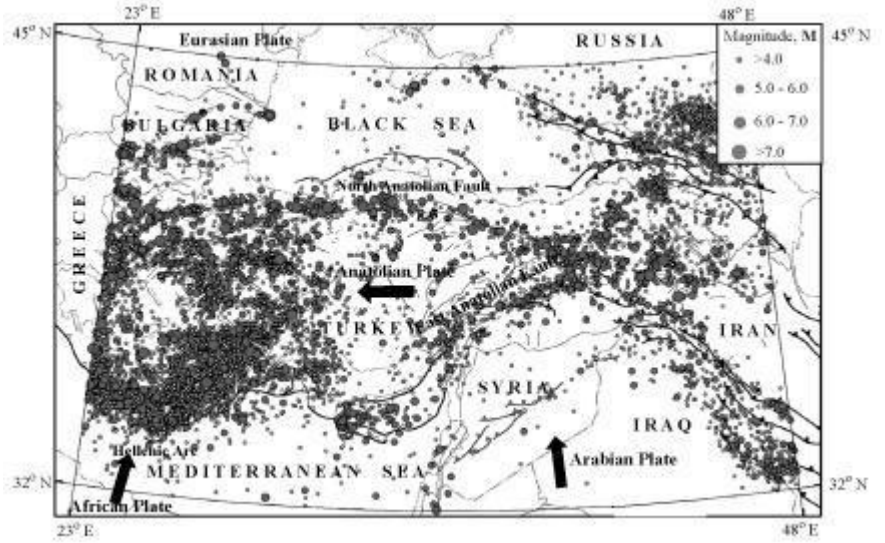


Figure 2 - *Primary, active faults (from Emre et al., 2013) and the instrumental seismicity (1900 -2012) for earthquakes M>4.0 in Turkey and surrounding areas (Modified from Duman et al., 2018).*

Epicenters of the major earthquakes are particularly concentrated in the segment boundaries of the main active faults. Major structures related to strike-slip tectonic regime are the dextral (right strike-slip)North Anatolian and sinisterly (left strike-slip) East Anatolian Fault systems, along with the interim Anatolian plate has been slipped in WSW direction onto easily deductible oceanic lithosphere of the Eastern Mediterranean Sea since the late Early Pliocene (Reilinger et al., 2006, 2010; McKenzie 1978; Le Pichon and Angelier 1979; McClusky et al., 2000; Şengör et al., 1984, 1985; Kocyigit et al., 1999).

The majority of the seismic activity is concentrated along the North Anatolian Fault (NAF) and the East Anatolian Fault (EAF) zones resulting from the westward movement of the Anatolian plate due to the collision of the Arabian and Eurasian plates (Şengör et al., 1984, 1985). The NAF is a large right-lateral strike-slip fault which is continuing roughly 1200 km from the Karliova junction in the east and to the northern Aegean Sea in the west in Turkey (Barka 1992). A sequence of devastating earthquakes occurred on this fault from east to west, starting with the Erzincan earthquake 1939 and followed by seven damaging earthquakes larger than M>7.0; 1942 Erbaa-Niksar, 1943 Tosya, 1944 Bolu-Gerede, 1957 Abant, 1967 Mudurnu and finally 1999 İzmit and Düzce in the 20th century. İstanbul, situated 20 km from the NAFZ in the Marmara Sea, is the largest city in Turkey; the area has experienced high levels of earthquake ground motion since the beginning of human history. Within the past centuries, four earthquakes of M7.6 (1509, 1719, and 1766) and M7.0 (1894) situated in the Marmara Sea have generated intensities up to ten to eleven (X-XI) in the city (Ambraseys, 1971, 2002). Recent studies have shown that the probability of having an earthquake (M≥7.0) close to İstanbul rises from a Poisson estimate of 35% to values of 47% under the time-dependent interaction model during the 30 years starting from 2014 (Murru et al., 2016).

The Eastern North Anatolian fault is also capable of producing large magnitude earthquakes and has experienced a sequence of damaging events including 1949 Karliova M6.8, 1971 and 2003 Bingol M6.9, M6.4, 2010 Elazığ-Karakoçan M6.1 earthquake (Saroglu et al., 1992; Nalbant et al., 2002; Örgülü et al., 2003; Şengör et al., 2005; Bulut et al., 2012). Compression deformation in Eastern Anatolia has resulted in thickening of the crust and includes dominantly reverse faults. The area was exposed to major damaging historical earthquakes in 1111, 1648, 1715, 1881. In 1976, M7.3 an earthquake located near the town of Caldıran, 20 km northeast of Muradiye, caused severe damage in the Van Province killing around 3840 people and

leaving around 51,000 homeless (Copley and Jackson 2006; Reillinger et al., 2006). Recently in 2011, M7.1 an earthquake occurred close to the city of Van, killing around 604 people and once again leaving thousands homeless (AFAD, 2011; Akinci and Antonioli, 2012).

Moreover, subduction of the African plate beneath the Aegean plate alongside the Hellenic trench has generated a back-arc N-S directed extensional regime and associated normal faulting in the Western Anatolia (Jackson and McKenzie, 1984; Westaway 1990). In the past fifty-year major earthquakes caused extensive damages and destruction in the zone. For example: 1949 Edremit-Ayvalik M7.0 destroyed nearly 5000 buildings; 1953 Yenice-Gonen M7.4 destroyed 1800 buildings; the 1969 Alasehir M6.9, damaged 3700 buildings and 1970 Gediz M7.3, destroyed 9500 buildings and killed the total 1400 people (Akinci et al., 2013).

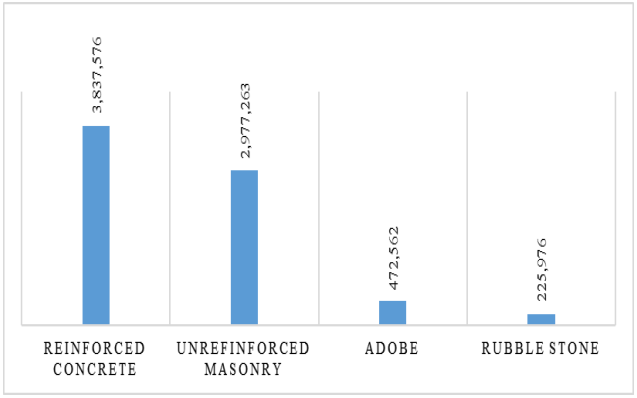
Therefore, an understanding of earthquake structure is an important and unique way to assess and evaluate the earthquake hazard estimation and mitigate losses due to earthquake in Turkey.

3. Building Inventory in Turkey

Seismic risk reduction efforts and strategies require gathering detailed information on the building inventory as well as the seismic hazard level in a country. Distribution of the population in a country affects urbanization and eventually the building inventory. The migration of people from rural areas into cities has always created demand in the construction of residential buildings. Depending on the numbers of people, the construction progress and quality can get out of control. In addition to migration, the population growth rate is another factor for the building inventory. Turkey has been a steadily growing country. The population increased from 40 million to 85 million in 40 years period between the 1970s and the 2010s. Thus, the building inventory in Turkey has been affected from both migration from rural areas to cities and the excessive population growth.

The recent building inventory can be divided into two main classifications; construction materials and height (Crowley et al 2012). The construction material is a key parameter in understanding rapid housing. If the demand of housing is huge, it is inevitable that the cheap and widely available materials are preferred. Concrete, particularly reinforced concrete, is a good example of this statement. Combining the cement, limestone, aggregate and water with reinforcing rebar is a relative new technique in building construction.

Compared to the traditional timber and stone masonry buildings those have been around for centuries, reinforced concrete has been used in buildings since the 1940s and its use has growth proportionally since then. From recent research (Demircioğlu, 2009) the total number of buildings in Turkey is 7,513,380 in which 51% of the buildings are made of reinforced concrete, Figure 3a.



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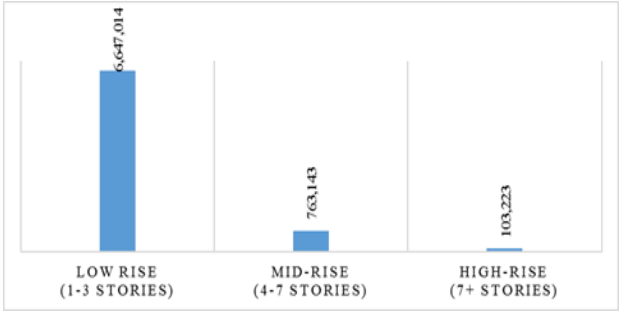


(b)

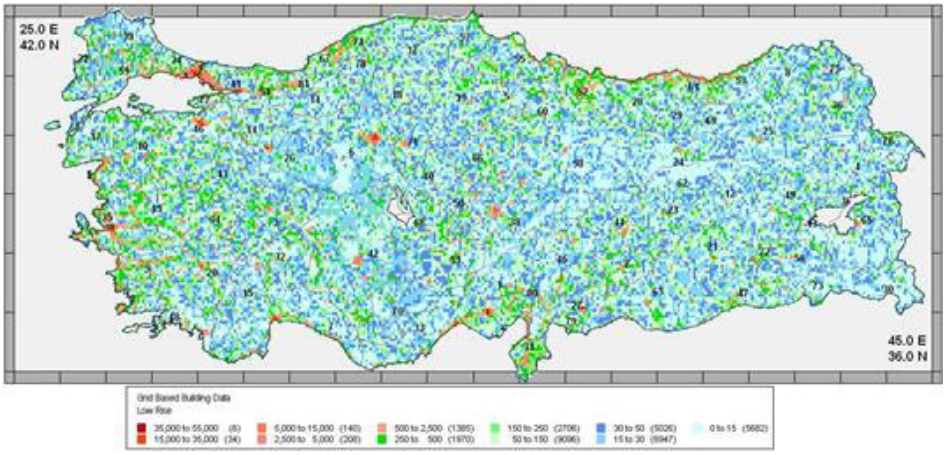
Figure 3 - *Number of buildings with respect to (a) construction materials and (b) stories (URL1).*

The cultural characteristics of societies influence social life. In countries like Turkey, it is a common convention to own a strong and durable house for a long time. Hence, people invest on the properties that they feel would last for a very long time and would protect them from all kind of natural threats. Based on this convention, reinforced concrete is the commonly preferred building material due to its cost-effective production, widespread availability and cheap labor cost in countries suffering from natural hazards. Moreover,

the weight and the toughness of concrete contribute in making people feel psychologically safe and comfortable.

The other classification in describing the building inventory is the building height in terms of number of stories. There is a strong relation between the number of stories of a building and its location. Since the area needed for buildings are expensive in the vicinity of the city centers, the mid-rise buildings are generally preferred rather than low-rise buildings. It is also true that public services such as transportation, electricity and water procurement, sewage etc. is broadly provided to high-populated districts. Thus, the number of stories in relation to the population is a valuable parameter in understanding the structural risk in the country. The distribution of the building height, named in low, mid and high-rise is given in Figure 3b. The number of stories is considered as a realistic value in the definition of the building height.

The number of high-rise buildings is significantly lower than low and mid-rise buildings. Therefore, the spatial distribution of low and mid-rise buildings provides a better understanding in the description of the inventory within the perspective of urban renewal. The building density distribution for all Turkey for low and mid-rise buildings is given in Figure 4a and b, respectively. It is apparent that building density is great in the major cities such as İstanbul, Ankara, İzmir, Antalya, Bursa.



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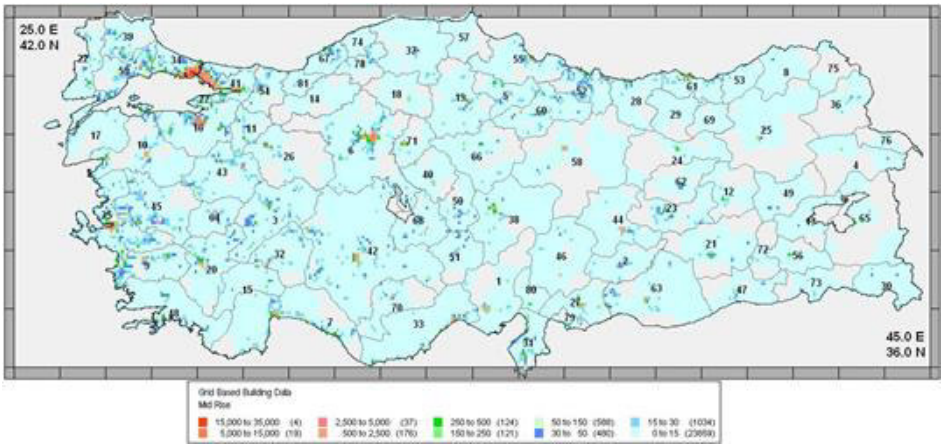


(b)

Figure 4 - *Distribution of (a) low and (b) mid-rise buildings in Turkey.*

Comparing the building inventory distribution maps (Figure 4a and b) with the seismic hazard map including most active fault lines (Figure 2) distinctly displays the most vulnerable areas in Turkey. Keeping in mind the huge and rapid increase of the building inventory and the seismic hazard, it is evident that major risk mitigation strategies are essential.

4. Urban Renewal Law in Turkey

Starting from the early 1970s, the population in urban areas increased rapidly and consequently serious social and economic arose. The major problem that the big cities faced was the need for accommodation and infrastructure for the new residents. Thus, the construction industry had a huge opportunity to meet the high demand in housing in urban areas all around Turkey, especially in İstanbul. However, the opportunity came with severe problems both in design and construction terms. The main problems can be listed as;

1. Huge demand for reconstruction in a very short time,
2. Lack of modern seismic design codes for professional design engineers,
3. Lack of a peer review process in seismic design of buildings,
4. Inadequate quality control in construction progress,
5. Low quality of workmanship.

In addition to the above-mentioned issues, urban planning strategies and regulations were not compatible with proper seismic risk mitigation principles (Özdemir and Yılmaz, 2011). This situation has lasted for more than three decades resulting with a very huge vulnerable and seismically risky building stock all around Turkey (Green, 2008).

The year of 1999 can be named as the "turning point" in Turkish earthquake history. Two major earthquakes in the north western part of Turkey, 1999 Kocaeli and Düzce earthquakes hit the most urbanized and industrialized cities of İstanbul, Kocaeli, Düzce and Yalova. The results of these earthquakes were catastrophic for Turkey both on a social as well as an economic level. The country suffered a lot from the damages and losses (Durukal and Erdik, 2008). Immediately in the following months, strict measures and actions in the education, construction, legislations and design codes were planned for a resilient society. The planned actions are chronologically listed in the Table 1.

Table 1 - *The major actions in disaster resilience*

Year	*Action*
1999	Marmara Earthquakes (M7.4 on 1999-08-17 and M7.2 on 1999-11-12)
2000	Establishment of Turkish Natural Catastrophe Insurance Pool
2004	Rehabilitation of the public schools in İstanbul
2006	Initiation of the İstanbul Seismic Risk Mitigation and Emergency Preparedness Program
2007	Revision of Turkish Earthquake Code
2008	Rehabilitation of the highway and road bridges
2009	Establishment of Disaster and Emergency Management Directorate
2010	Rehabilitation of the public schools in İzmit
2011	Declaration of the National Earthquake Strategy Plan until 2023
2012	The Law of Transformation of Areas under the Disaster Risks (No: 6306)
2013	Guidelines for the use of seismic isolations in City Hospitals and Seismic Risk Assessment Code for the Buildings
2014	Project for updated Turkish Earthquake Risk Map
2015	Initiation of the National Disaster Response Plan

2016	Detailed revision of the Turkish Seismic Design code – Draft
2016	Revision of the Design Code of the Steel Structures
2018	New Turkish Seismic Hazard Map & revision of Turkish Building Seismic Code
2019	Revision of the Seismic Risk Assessment Code for the Buildings

Among these actions, the Law of Transformation of Areas under the Disaster Risks (No: 6306) has been most effective in terms of practicality and applicability. The law is applied in three phases. It starts with the assessment of the building and ends with re-construction of the new building with reduced bureaucratic procedures. The phases are summarized in Table 2 and visualized in Figure 5.

Table 2 - *Urban Renewal Application in Turkey can be divided into three phases.*

Phases	*Steps*
Phase 1 Assessment of the building	In this phase, relevant official documents of the building are collected, and licensed engineering firms perform engineering inspections and calculations in order to prepare an assessment report that involves seismic safety of the building. As the last step of this phase, the assessment report is delivered to the local authority.
Phase 2 Seismic safety assessment approval of the building by the municipality	Local authority accepts the evaluation report and informs the property registration office. Property owners receive a warrant from the local authority for demolishing or retrofitting options. Once two thirds of the owners agree on the retrofit option, the municipality is informed accordingly. Otherwise, the municipality will have the right to cancel essential services such as electricity, gas and water. Following these measures, the property owners are expected to evacuate the building to be demolished within two months. In case of no evacuation, the owners are forced to leave the property under the control of the police officers.
Phase 3 Demolishing and rebuilding the new property	Demolishing the building is arranged by the owner or his/her representative. Government provides nonrefundable financial support to the rent cost up to 18 months. During this period, the building owners are strictly supposed to either retrofit or rebuild the new building. General practice is to agree with a contractor to get this engineering services.

The steps of the Law of Transformation of Areas under the Disaster Risks are illustrated in Figure 5.

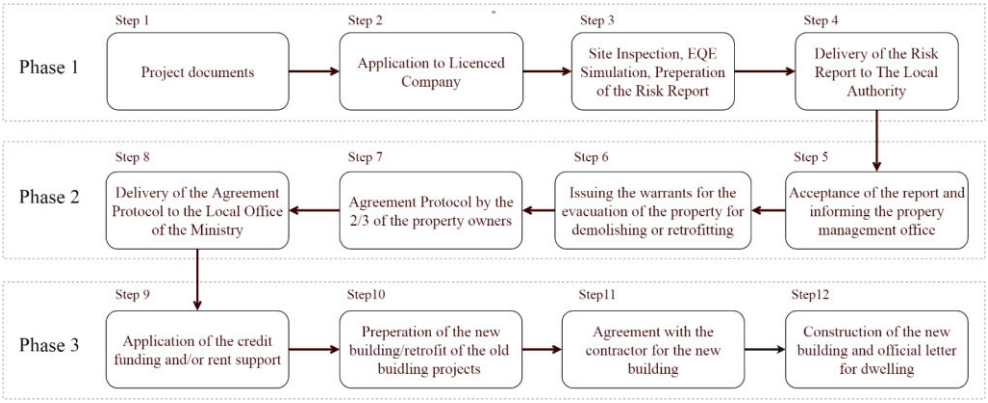


Figure 5 - *Steps of the Urban Renewal Law in Turkey.*

The law legislated by the ministry of Environment and Urbanization delegates the municipalities for the implementation. Initially, the cities of İstanbul, Bursa and İzmir were selected as the areas for preliminary implementation of the law. Since 2012, many cities have benefitted from the law. In early 2019, the ministry requested that all municipalities establish their own urban renewal strategies in their most vulnerable zones. This request was intended to extend the application of the law to almost every part of Turkey rather than major cities to compliment the national mitigation action.

5. Process and Lessons Learned from the Urban Renewal Law in Turkey

As of 2019, a large number of citizens have benefitted from the urban renewal law. Too many lessons learned within that 7 years of application. Based on the official statistics, 174,661 buildings have been assessed by licensed engineering firms. Among these buildings, only 1% was found to be safe in terms of seismic risk. The majority of the assessed buildings are Reinforced Concrete and Masonry type buildings, both 39% (Figure 6).

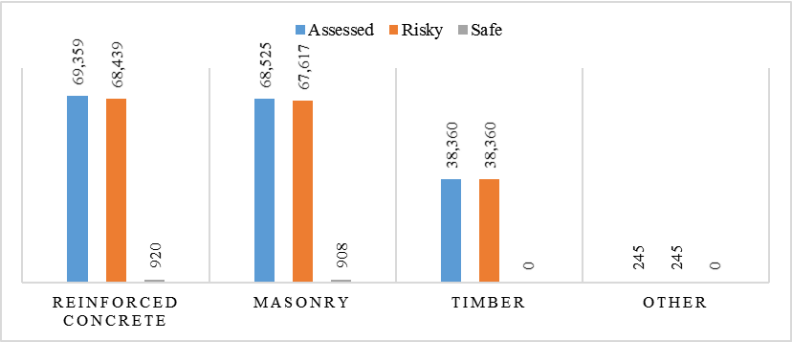


Figure 6 - *Distribution of the construction material in the assessed buildings all over Turkey (URL1).*

Considering the distribution of the assessed buildings in the city, İstanbul is significantly leading with 60%, in the application of the law, Figure 7.

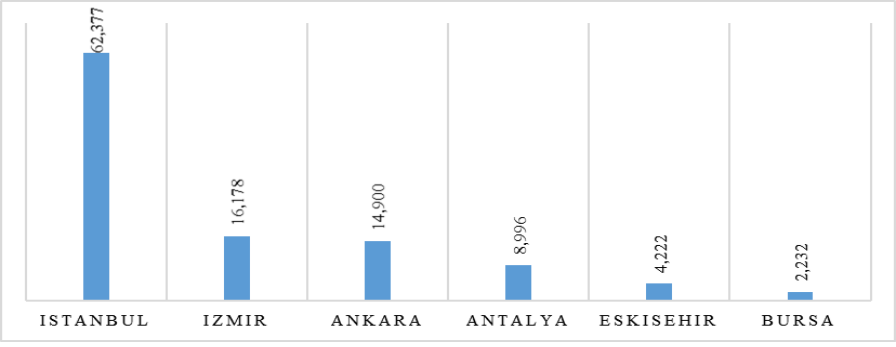
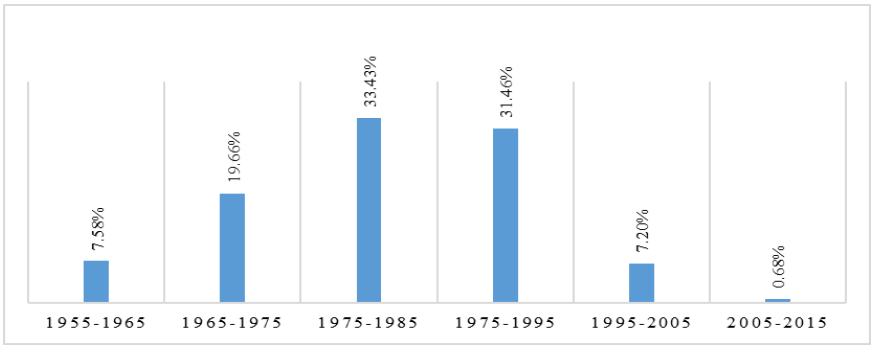


Figure 7 - *Distribution of the assessed buildings in major cities (URL1).*

The age of the assessed building is significant; the most vulnerable buildings were constructed between 1970s to 1990s where the huge demand occurred, Figure 8a.



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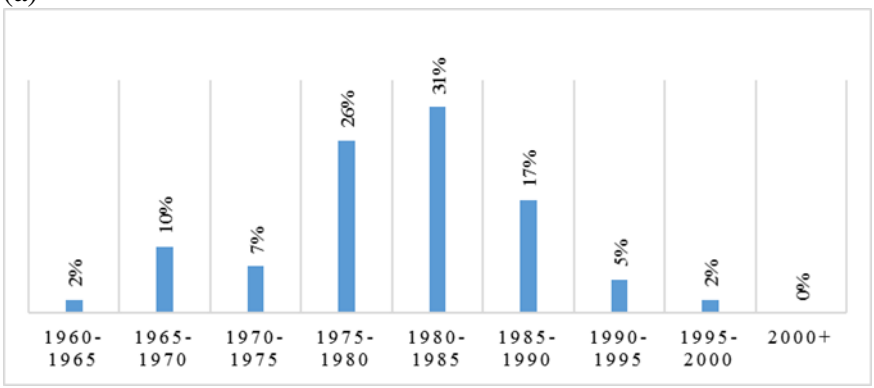

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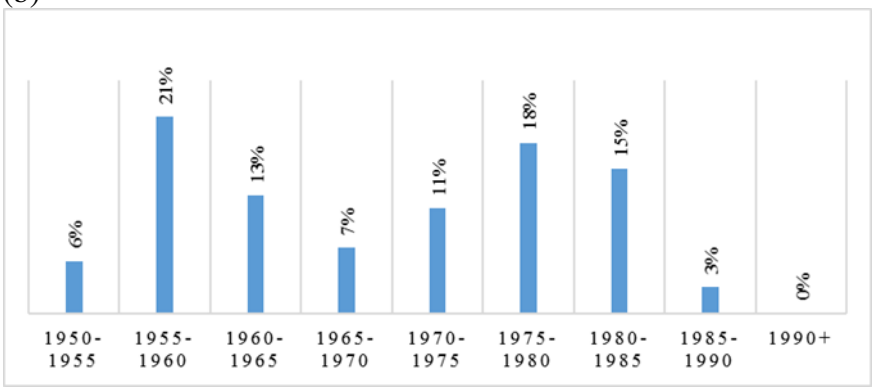

(c)

Figure 8 - *Construction year of the assessed buildings (a) all, (b) Reinforced Concrete, (c) Masonry (URL1).*

The distribution of construction years of the RC buildings given in Figure 8b, has great similarity with the overall distribution in Figure 8a. This

indication can be evaluated as the proof of the low quality RC building construction in the period. However, the trend has not been observed in the masonry building type, Figure 8c. The number of the assessed buildings represents 2% of the entire building inventory in Turkey. Whereas, 131,715 buildings, which is 76% of all assessed buildings, have been demolished. The values reveal that more time and effort are needed to reach the ultimate resilient society.

5.1. Examples for good practice

İstanbul is the largest city where the urban renewal cases occurred. Perhaps, the population and the low-quality residential buildings are the main reasons. The Ministry of Environment and Urbanization with the collaboration of municipalities have declared 40 different zones in 16 districts for the preliminary areas for the renewal (Figure 9). The total area of the selected zones is about 11 million m^2. The largest two zones are 1,582,476 m^2 and 1,341,759m^2 on European and Asian sides of the city, respectively.

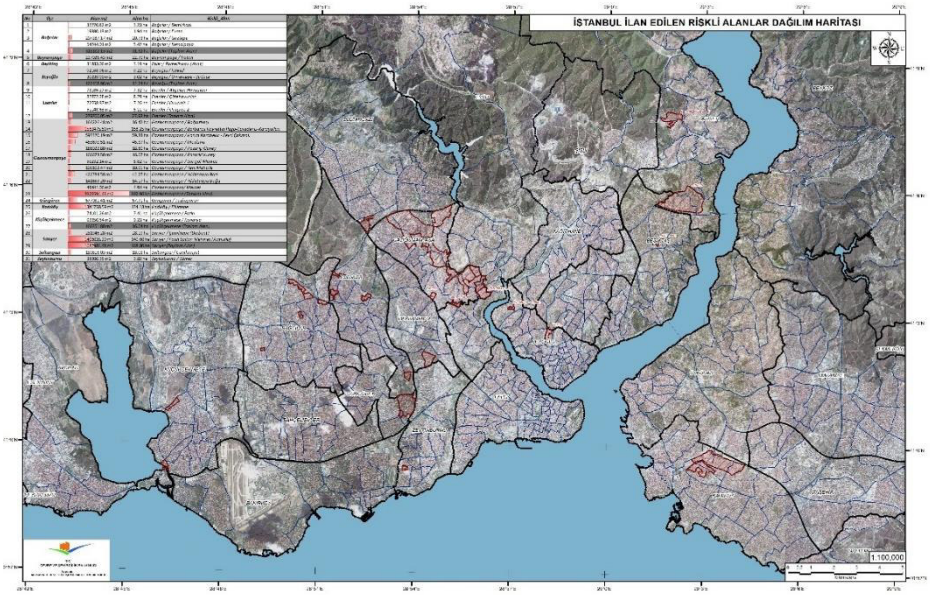

Figure 9 - *Urban Renewal Areas declared in İstanbul (URL2).*

The zone in the Asian side is called the Fikirtepe of Kadıköy district. The building stock in the zone is composed of low-rise buildings that were

constructed in the mid 1980s. The strategy followed in Fikirtepe relies on the demolishing the 1,500 small buildings to clear the area, and then the construction of high-rise buildings according to the most recent design codes and engineering practices, Figure 10. The total budget of the renewal was predicted as €4 billion. The huge budget is supposed to be funded by private investors rather than government budgets. The private investors are supposed to prepare the new building design projects and conclude agreements with the property owners. Most of the property owners had legal agreements with the investors either for payment or for ownership of the new buildings.

Figure 10 - *Conceptual view of Fikirtepe district after urban renewal.*

The view of Fikirtepe has significantly changed from a poor environment, Figure 11, to a modern environment, Figure 12.

Figure 11 - *The satellite views of Fikirtepe district in 2007 and 2019 (URL3).*

As of the current situation in 2019, work in Fikirtepe has not been completed, but the progress made has been an example of the Law for the zones, Figure 14.

Figure 12 - *Actual view of Fikirtepe District (as of May 2019)*

5.2. Examples for bad practice

Even though the zones for large-scale renewal were declared, the law has been applied to single buildings. This application has been both positive and negative consequences. The positive side is that the individual buildings in the renewal zones have benefitted from the law for demolishment. Demolishing the detached buildings with seismic risk is a common practice. However, demolishment of a single building in the non-detached buildings does not make a sound in the seismic risk reduction in the urban areas. For example, the building in the middle of Figure 13 demolished within the regulations given in the law. This action is not a real renewal success within the perspective of reducing the risk for an area but only for a single property.

The remaining buildings continue to carry the seismic risk potential for themselves or their surroundings.

Figure 13 - *Bad practice for urban renewal.*

6. Conclusion

As one of the major actions to mitigate the vulnerability of the building stock in Turkey the Turkish Government has issued "The Law of Transformation of Areas under the Disaster Risks (Law No. 6306)", which came into law in 2012 (published in the Official Gazette of 31.5.2012, no.28309). The scope of the law is to determine the procedures and principles regarding the rehabilitation, clearance, and renovations of areas and buildings at disaster risks in accordance with relevant standards with a view to create healthier and safer living environments in urbanized areas. The number of the expected building renewal is 6.5 million all over Turkey. This is the largest housing project in the world as a part of seismic hazard mitigation.

After seven years of the law, a huge and valuable experience has accumulated through these processes, which could act as a useful example for countries with similar seismic risk. The main points learned from the short history of the urban renewal law can be concluded as:

- Strategically individual assessment preferred to large areas was unsuccessful,
- New constructions are not satisfactory/appealing due to the smaller room size,

- Economic loss of the property owners due to illegally constructed stories,
- Application is more focused on areas where apartment prices are higher than the others,
- Application in the zones like Fikirtepe provided not only seismic safety but also improved infrastructure to the region,
- The law has provided a permanent plan for construction industry causing large economic benefits and increase in real estate values.

In order to provide sustainable urban renewal process for the coming years, possible actions can be recommended as;

- Increasing the economic support (rent for other building during construction) of the building owners by the central government,
- Modifications and update in application process of urban renewal in terms of bureaucracy and regulations,
- Providing benefits for the applicants in terms of land use in suburb/rural areas such as extra stories, larger building base area, exemptions in disaster insurance premiums in the cases of innovative technologies (base isolation, damper, etc.) are used in seismic design or seismic design performance level is taken higher than the seismic code requirement.

The experiences with good and bad examples of economic and engineering approaches applied in the last seven years are invaluable resources for countries suffering from similar hazardous risks for possible adaptations into their own risk mitigation strategies.

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Increasingly, socio-natural risks and disasters represent the result of an unsustainable interaction between human beings and environment. The current scientific debate has generally agreed on the idea that the impact of natural hazards needs to take into account the social vulnerabilities and exposures to risk of the affected population. The most recent earthquakes have unequivocally shown the complexity of the phenomena and their multi-scale dynamics. Indeed, the territory is the combination of natural, social and cultural environment and only by exploring its anatomy and physiology, it will be possible to manage and protect it in the best way.
This volume collects a quite wider range of national and international case studies, which investigate how socio-natural risks are perceived and communicated and which strategies the different communities are implementing to mitigate the seismic risk. This publication has been possible thanks to a fruitful discussion that some scholars had at the 36th General Assembly of the European Seismological Commission held in Malta from 2 to 7 September 2018.

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