ANALYSIS OF EXISTING BUILDING STOCK ACCORDING TO MITIGATION PLAN OBJECTIVES

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ABSTRACT

ANALYSIS OF EXISTING BUILDING STOCK ACCORDING TO MITIGATION PLAN OBJECTIVES

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Earthquakes in Turkey, among all natural disasters claim the highest losses in terms of human lives, material and economic assets. Most of the lives are lost within the collapsed buildings, and most of the material and economic losses are again directly related to the functional capacities of the building stock.

The method of risk assessment in the existing building stock is therefore an essential step in the maintenance of safer urban environments. Analysis of risks in the building stock is usually claimed to demand surveys of engineering studies. Yet risk determination studies by planners could prove not only a more comprehensive approach, but less time consuming and cheaper. As carried out by engineers, most of safety studies in the building stock are directly related with estimating the probability of collapse and damage in individual buildings. It is necessary to recognize the need for analysis of the building stock not only in terms of structural robustness, but as part of a mitigation plan, taking into consideration all sources of hazards and the urban pattern, densities, landuse, forms of ownership, social features, management capacities, and local opportunities.

Risky buildings determined by a simple set of criteria within a comprehensive planning context are comparatively explored in this study to observe the level of fit with those determined by engineering surveys. The case of Fatih District in Istanbul provides an opportunity to carry out comparative analyses. It indicates that a 'perfect fit' can not be achieved if for nothing but due to the disregard of multi-hazard areas, hazardous activities and other vulnerabilities like timber buildings other than reinforced concrete in the district by the engineering survey. Several trials indicated that there is a trade-off between ratio of fit and the total volume of relative vulnerability assumed. Ratios like 70% or more could make the planning approach a preferable method owing to its nature of least time-consuming and costly alternative in the determination of what constitutes risk in any urban area. Ultimate assessment could be made with the occurance of the earthquake itself.

Keywords: Building Stock, Earthquake Risk, Mitigation Planning.

ÖZ

MEVCUT YAPI STOKUNUN SAKINIM PLANI HEDEFLERİNE GÖRE İNCELENMESİ

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Türkiye'de deprem diğer doğal afetlere göre en fazla can ve mal kaybına sebep olan afettir. Can kayıplarının sebebi genellikle yıkılan binalar, maddi ve ekonomik kayıpların sebebi ise yapı stokunun fonksiyonel yetersizliğidir.

Kentlerin deprem riskine karşı güvenliğinin sağlanması için temel adım mevcut yapı stokunda yapılacak risk değerlendirmesidir. Yapı stoku analizleri farklı bilim dallarının konusu olan çalışmalar gerektirmektedir. Özellikle plancılar tarafından yapılan risk belirleme çalışmaları esastır. Yapı stokunun güvenli hale getirilmesine yönelik çalışmaların çoğu bina ölçeğinde, mühendisler tarafından zemin titreşimi gibi özellikler dikkate alınarak yapılan hasar ve yıkım tahminleri ile sınırlı kalmaktadır. Oysaki yapı stoku konusunda yapılacak incelemelerde yapıların depreme karşı dayanıklılığı yanında; kentsel doku, yoğunluk, arazi kullanımı, mülkiyet durumu, sosyal yapı, yönetimsel yapı ve yerel özellikler de mutlaka ele alınmalıdır. Bu tür bir yaklaşımın oluşturulması yapı stokunun sakınım planının bir parçası olarak kabul edilmesi ile sağlanabilir.

Bu çalışmada; yapıların karşı karşıya olduğu risk türleri ile yapı güvenliğinin sağlanmasında karşılaşılan çeşitli sorunların belirlenmesi ve sadece binalar için üretilen güçlendirme ya da yıkım kararlarının ötesinde planlama bağlamında karar verilmesini sağlayacak bir yöntemin geliştirilmesi amaçlanmaktadır.

Bu amaç doğrultusunda, yapı güvenliğinin sağlanması ve deprem riskine karşı güvenli kentsel çevrelerin oluşturulması konusunda sakınım planlaması yaklaşımı ve mühendislik yaklaşımı ele alınmış, bu iki yaklaşım arasındaki yöntemsel farklılıklar İstanbul İli Fatih İlçesi için yapılan bir örnek çalışma ile değerlendirilmiştir.

Anahtar Kelimeler: Yapı Stoku, Deprem Riski, Sakınım Planlaması

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Finally, I would like to thank my parents and my husband for their great support and patience during my life and education.

This study is performed based on the Project of The Mitigation Studies in Fatih carried out in City Planning Master Studio, in 2006 and 2007. The earlier work is submitted to develop a method for decision making for safety of building stock and urban environment within a comprehensive planning context.

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LIST OF ABBREVIATIONS

EMPI	Earthuake Master Plan for Istanbul
FEMA	Federal Emergency Management Agency
GIS	Geographical Information System
HAZUS	Hazards United States
HFA	Hyogo Framework for Action
IAEE	International Association for Earthquake Engineering
IDNDR	International Decade for Natural Disaster Reduction
ISDR	International Strategy for Disaster Reduction
ISMEP	Istanbul Seismic Risk Mitigation and Emergency Preparedness Project
JICA	Japan International Cooperation Agency
LCA	Local Community Administrations (proposed by EMPI)
MEER	Marmara Earthquake Emergency Reconstruction Project
METU	Middle East Technical University
MMI	Metropoliten Municipality of Istanbul
NGO	Non-Govermental Organization

PEER	Pacific Earthquake Engineering Research Center
PGA	Peak Ground Acceleration
PGA	Peak Ground Velocity
SAR	Search and Rescue
SPS	Seismic Performance Score of buildings
SPSS	Statistical Package for the Social Sciences
UN	United Nations
UNDP	United Nations Development Program
UN/ISDR	Inter-Agency Secretariat for the ISDR

CHAPTER 1

INTRODUCTION

1.1. Description of the Problem and Its Context

Turkey is prone to several natural hazards and has been affected by several natural disasters, in particular earthquakes, floods and landslides. Earthquakes in Turkey, among all natural disasters claim the highest losses in terms of human lives, material and economic assets. Most of the lives are lost within collapsed buildings and most of the material and economic losses are again directly related to the functional capacities of the building stock.

This study aims to identify various types of risks in the building stock and its environment, the mitigation problems in the safety of buildings and the city, and intends to develop a method for decision making within a comprehensive urban planning context, rather than producing simply decisions for retrofitting or removal of the existing individual buildings.

The research considers following questions consisting the conceptual framework of the thesis;

- What is the role of risk assessment in the existing building stock to provide safety of cities, and how it has been conducted in Turkey?

- What are the methodological differences between the engineering approach to safety studies in the building stock and, the mitigation planning approach to risk determination studies in building stock?

- How can we implement analysis of the building stock as part of a mitigation planning process?

The answers of these questions will crate the basic theoretical framework of the thesis and identify lines of research at further levels.

The method of risk assessment in the existing building stock is an essential step in the maintenance of safer urban environments. Analysis of risks in the building stock could demand surveys not only of engineering studies, but more comprehensive approaches from different disciplines, and particularly of risk determination studies by planners. Most of the safety studies in the building stock directly estimate probability of collapse and damage in individual buildings as a function of PGA (peak ground acceleration) as carried out by engineers.

Yet, it is necessary to recognize the need for risk analysis in the building stock, not only in terms of structural robustness, but as part of a mitigation plan, taking into consideration the urban pattern, land use, forms of ownership and management and local opportunities.

An existing survey made by engineers in Fatih District in Istanbul is employed as a case study, and in comparison, the existing building stock of Fatih is analyzed according to mitigation plan objectives.

For the purposes of mitigation planning, it may be possible to indicate the viability of a fast and simple risk assessment method for building stock in urban areas at the end of the study.

1.2. Methods Adopted to Conduct the Research

Mitigation planning examines the settlement areas, and the systems that it contains as a spatial whole. In this approach, the risk levels of infrastructure, buildings and urban environments are determined interactively in accordance with the micro-zoning data,

and hazard categories as defined by geological data (The Report of Earthquake Master Plan for Istanbul, 2003).

To determine the risk level of buildings, the database related with the existing building stock is used. The data related with the building stock can be examined under two titles:

- Physical attributes of the building stock to determine their vulnerabilities.

- Micro-zoning map of the area to determine potential level of hazard.

There are two main databases available in the Fatih (Istanbul) case. The first one, produced by JICA (Japan International Corparation Agency) contains micro-zoning studies. The other one is produced by the Istanbul Metropolitan Municipality, containing detailed building inventories for İstanbul.

Geographic Information System is used to determine risk sectors and to manage information related to building stock. The spatial analysis is carried out in the GIS format.

The analyses are expected to provide a method for decision-making related with the built environment within a comprehensive planning context.

1.3. Contributions of the Research

The negative impacts of earthquakes on people are densely caused by the risks in the built environment. According to seismologists, 96% of Turkey is in the earthquake zone. The damage from the 1999 Izmit and Duzce earthquakes in Turkey is proof of their devastating force in our urban environments.

Risk determination and assessment issues –initial steps of mitigation planning – have been limited to the development of regulations, and can not be implemented in the daily life in Turkey.

Existing studies of building stock estimate probability of collapse and damage in individual buildings, and are capable of producing decisions for retrofitting or removal.

On the other hand, mitigation planning theoretically is a comprehensive program, in which independent projects of management of the risks in all systems and the sectors of the city, are integrated.

For this reason, this study intends to develop a method for decision-making related with the built environment according to mitigation planning objectives. The intended contribution of this study is to present a new perspective combining the engineering approach to safety studies in building stock and mitigation planning approach to risk determination studies in the urban environment. It is also expected that the necessity of the comprehensive planning approach to consider not only individual buildings, but also the urban pattern, land use, forms of ownership and management and local opportunities can be exemplified. This should indicate the relevance of an integrated approach, and the relevance of the planners' role and contributions in safety studies in the urban environment.

1.4. Stages of the Research

The first chapter is the introduction part of the thesis and includes the aim, scope and the methodology of the study.

The following chapter contains a literature survey on *risk*, *seismic risk*, *risk assessment*, *risk reduction* and *mitigation planning* concepts with an overview of current understanding on global agenda. In this chapter, disaster risk reduction efforts and the major mitigation and preparedness projects in Turkey are also examined.

The prospective contribution of this thesis will be mainly to present a new perspective combining the engineering approach to safety studies in the building stock, and the urban mitigation planning approach in risk determination studies. For this aim in Chapter 3, the sector of risks in the building stock in Earthquake Master

Plan of Istanbul are examined in detail, and this study develops with the contribution of identifying building stock assessment method of mitigation planning, and building stock assessment method of engineering. After examining issues related with planning, the study reviews the approaches of civil and other engineering disciplines to compare their approach to safety studies in the building stock and the mitigation planning approach to risk determination.

In Chapter 4, existing data of building stock in Fatih is analyzed according to mitigation plan objectives as a case study. And the results are compared with the existing surveys made by engineers in the Istanbul Metropolitan Municipality for Fatih District.

The last chapter is an evaluation and conclusion which summarises the key priorities in safety studies for built environment and risk reduction, paying particular attention to the need for mitigation planning. In conclusion, risk reduction suggestions are made for existing building stock in Fatih.

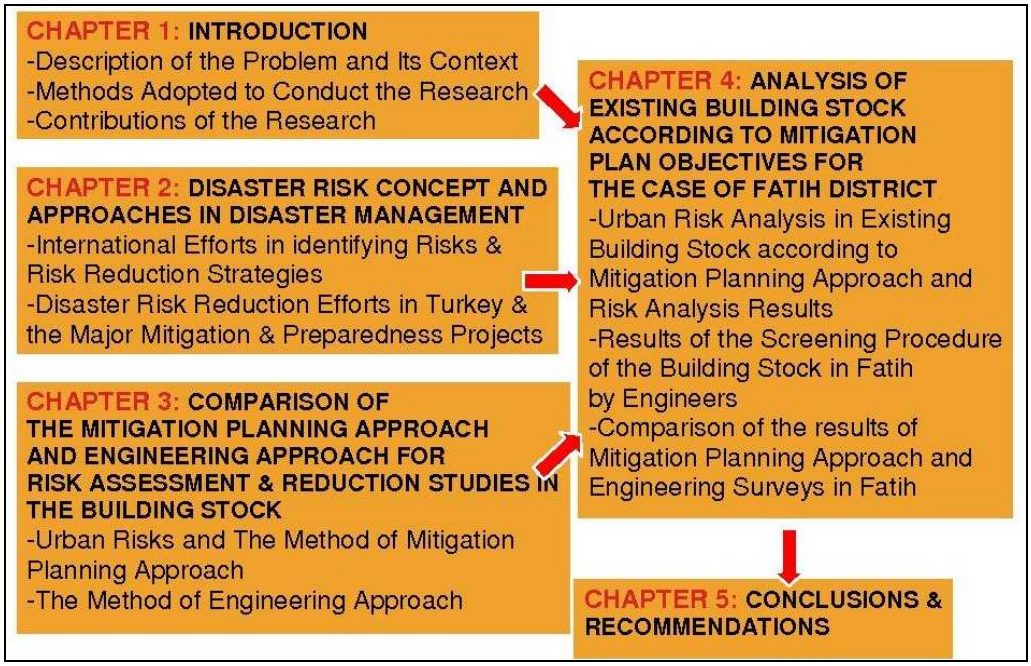


Figure 1.1 Parts of the Study

CHAPTER 2

DISASTER RISK CONCEPT AND APPROACHES IN DISASTER MANAGEMENT

2.1. International Efforts in identifying Risks and Risk Reduction Strategies

The study of risk has been the focus of different disciplines over the last two decades, all over the world. The risk concept takes part in fields such as statistics, finance, insurance etc. and has different definitions according to different fields.

"The systematic conception of risk is practically assumed by experts and specialists in the natural sciences with studies regarding geodynamic, hydrometeorological and technological phenomena such as earthquakes, volcanic eruptions, mudslides, flooding and industrial accidents" (Cardona, 2003:2).

Apart from natural sciences there are two major sources that make risk a central objective of study and action. Recent sociological analyses indicate that technological developments under market decision making has brought societies and human existence into a stage of risk society (Beck, 1992).

On the other hand, UN has radically changed its international policy related to natural hazards, from a concern of post-disaster relief activities, to one of risk reduction.

The reason of increased emphasis placed on disaster risk, and the declerad need for greater study of risk perceptions resulted due to increases in human casualties, as well as economic and physical property damage in disasters.

According to disaster statistics of ISDR, during the past 20 years, the number of recorded disasters has doubled from approximately 200 to more than 400 per year (Figure 2.1).

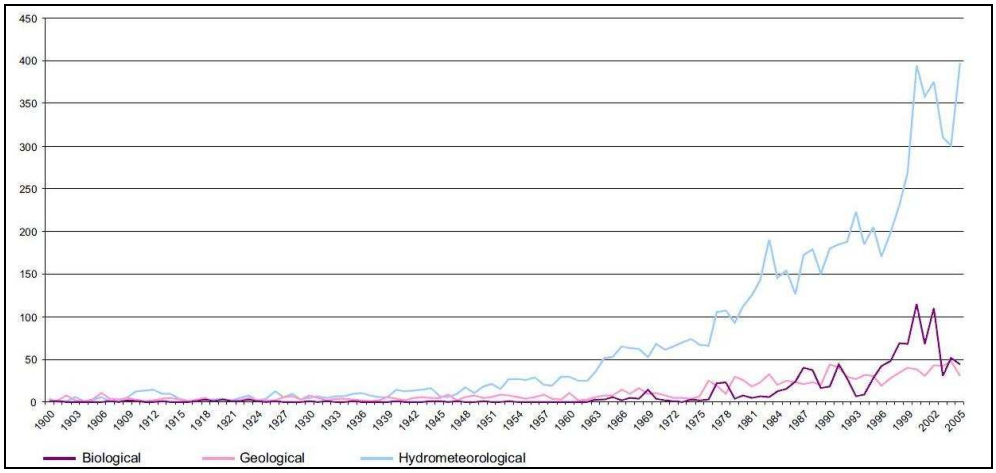


Figure 2.1 Number of Natural Disasters Registered in EMDAT 1900 – 2005 (Source: ISDR Disaster Statistics, EM-DAT, The OFDA/CRED International Disaster Database.)

As shown in the Figure 2.1, geological disasters including earthquakes are more frequent, and damage inflicted in larger areas today, than they did 20 years ago.

In the 1990's, the awareness about natural hazards has particularlly grown, researches dealing with risk gained importance and risk reduction efforts developed increasingly around the world (Cardona, 2003). Depending on these developments a series of international declarations took place on the global agenda and many terms related with risk are recognized, and principles to reduce risk are determined.

The International Decade for Natural Disaster Reduction, International Strategy for Disaster Reduction (1990-200), Yokohama Strategy and Plan of Action for a Safer

World (1994), the Millennium Declaration (2000), Kobe Conference and the Hyogo Declaration (2005) and the Hyogo Framework for Action 2005-2015: "Building the Resilience of Nations and Communities to Disasters" are the main landmarks of this trend (Balamir, 2005). To these developments, the Incheon Declaration (2009) must be added which considers urban risks as the main target, and the empowerment of local administrations.

Given the increasing concern about impacts of disasters, the UN General Assembly declared 1990-1999 the ***International Decade for Natural Disaster Reduction*** (IDNDR).

"By resolution 42/169 of 11 December 1987, the United Nations General Assembly designated the 1990s as a decade in which the international community, under United Nations auspices, would pay special attention to fostering international cooperation in the field of natural disaster reduction." (UN, 1987)

During this decade an international effort was given to prevent natural disaster risks and reduce the consequences of natural disasters. The decade showed that in many cases loss of lives and economic losses were due to a lack of coherent disaster reduction strategies by international and regional organizations, governments and decision-makers (UNISDR, 2002).

In accordance with the aim of the decade, a wide number of governments, international organizations and institutions encouraged to conduct projects and programmes related with risk prevention and reduction activities and they recognized the idea that risk management should be a fundamental strategy for sustainable development (Cardona, 2003).

Within the framework of the International Decade for Natural Disaster Reduction, ***The Yokohama Strategy and Plan of Action for a Safer World*** was conceived at the World Conference on Natural Disaster Reduction in Yokohama in 1994. The Yokohama Strategy has emphasized the importance of prevention, preparedness and mitigation of disaster risk and stressed that every country had the sovereign and

primary responsibility to protect its people, infrastructure and national, social or economic assets from the impact of natural disasters (UNISDR, 2002).

The Yokohama principles are as follows:

"1. Risk assessment is a required step for the adoption of adequate and successful disaster reduction policies and measures.

2. Disaster prevention and preparedness are of primary importance in reducing the need for disaster relief.

3. Disaster prevention and preparedness should be considered integral aspects of development policy and planning at national, regional, bilateral, multilateral and international levels.

4. The development and strengthening of capacities to prevent, reduce and mitigate disasters is a top priority area to be addressed so as to provide a strong basis for follow-up activities to IDNDR.

5. Early warnings of impending disasters and their effective dissemination are key factors to successful disaster prevention and preparedness.

6. Preventive measures are most effective when they involve participation at all levels from the local community through the national government to the regional and international level.

7. Vulnerability can be reduced by the application of proper design and patterns of development focused on target groups by appropriate education and training of the whole community.

8. The international community accepts the need to share the necessary technology to prevent, reduce and mitigate disaster.

9. Environmental protection as a component of sustainable development consistent with poverty alleviation is imperative in the prevention and mitigation of natural disasters.

10. Each country bears the primary responsibility for protecting its people, infrastructure, and other national assets from the impact of natural disasters. The international community should demonstrate strong political determination required to make efficient use of existing resources, including financial, scientific and technological means, in the field of natural disaster reduction, bearing in mind the needs of the developing countries, particularly the least developed countries" (UNISDR, 2002:10).

The UN General Assembly founded the ***ISDR*** in 2000 to continue to promote work and commitment in disaster reduction. The ISDR aims to acceptance of the disaster risk management issues all over the world.

"ISDR has worked to shift the primary focus from hazards and their physical consequences to emphasize more the processes involved in incorporating physical and socio-economic dimensions of vulnerability into the wider understanding, assessment and management of disaster risks. This highlights the integration of disaster risk reduction into the broader context of sustainable development and related environmental considerations" (UNISDR, 2002:11).

By resolution 52/2 of September 2000, the United Nations General Assembly adopted the ***Millennium Declaration*** and identified the Millennium Development Goals.

Under the heading of "Protecting our common environment", intensifying cooperation to reduce the number and effects of natural and man-made disasters has been mentioned in the decleration.

For moving ahead on this goal, ISDR established *The Road Map towards the Implementation of the United Nations Millennium Declaration* which includes:

- “Developing early warning systems, vulnerability mapping, technological transfer and training;

- Supporting interdisciplinary and intersectoral partnerships, improved scientific research on the causes of natural disasters and better international cooperation to reduce the impact of climate variables, such as El Niño and La Niña;

- Encouraging governments to address the problems created *by megacities, the location of settlements in high-risk areas* and other man-made determinants of disasters;

- Encouraging governments to incorporate disaster risk reduction into national planning processes, including building codes” (UNISDR, 2001:35).

After the first World Conference on Disaster Reduction took place in Yokohama, second World Conference on Disaster Reduction held in ***Kobe*** in 2005.

Hyogo Declaration and ***Hyogo Framework of Action*** are the main outcomes of the World Conference on Disaster Reduction in Kobe. The Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters has been adopted as a guiding framework for the next decade on disaster reduction. The priorities for action indentified by The Hyogo Framework for Action 2005-2015 are;

“1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.

2. Identify, assess and monitor disaster risks and enhance early warning.

3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.

4. Reduce the underlying risk factors.

5. Strengthen disaster preparedness for effective response at all levels”(UNISDR, 2005:6).

Additional to these developments ***The Incheon Declaration: Building a Local Government Alliance for Disaster Risk Reduction*** (2009) is the latest event which considers the empowerment of local administrations in mitigation and disaster risk reduction actions.

This declaration asserts commitment to target 'local governments', inclusive of urban and rural communities at large, in the global awareness campaign lead by ISDR, partners and the Alliance and to focus especially on reaching the poor and high risk communities.

"The campaign will primarily target mayors, other local leaders and technical staff involved in *urban development*, as well as national authorities responsible for local development and/or disaster risk reduction" (UNISDR, 2009a:1).

This declaration summarizes the challenges ahead in moving the disaster risk reduction and climate change adaptation agenda forward through an Alliance of Local Governments for Disaster Risk Reduction. The key challenges and issues have been identified in the declaration are given below briefly.

"It is certain that unplanned urbanization and poor urban governance as two main underlying factors accelerating disaster risk. Other important risk drivers are vulnerable rural livelihoods and ecosystem decline. Risk is increasing in urban agglomerations of different size due to unplanned urbanization and accelerated migration from rural areas or smaller cities. The low institutional capacity of local authorities to provide land and services to the poor leads to urban growth of informal settlements in hazard prone areas" (UNISDR, 2009a:2).

"It is the local government that is the first responder, and the one responsible for community development and sustainable disaster risk reduction. The empowerment of local governments must be a key priority in order to encourage democratic decision-making that involves the citizens and all key stakeholders at the local level. The proper confirmative authority of the local government, human capacity and allocation of appropriate resources needs to be ensured" (UNISDR, 2009a:3).

“The need for a more widespread development of municipal risk assessments and maps as well as of local vulnerability and capacity assessments exists. These studies should serve as the basis for local and urban development plans and programmes and the development of municipal disaster risk management plans. Local governments and actors can provide basic data, currently unavailable, and feedback from a local perspective on how disaster risk reduction, adaptation and climate change mitigation actions are being integrated in the local sustainable development processes” (UNISDR, 2009b:4).

“Arising from this meeting, the following concrete objectives have been identified as priorities;

1- Communicating clearly for disaster risk reduction: Effective communications is critical to delivering a clear and readily understandable set of messages about the use, value and importance of disaster risk reduction to communities and local governments in all areas.

2- Political engagement: The Alliance will establish a compact between national and local governments, particularly those who can demonstrate strong partnering and interaction towards the common goals of disaster risk reduction including the utilization of resources.

3- Promoting capacity development for local governments at all levels: Capacity development actions should be considered to actively promote capacity development and training programmes at the international, regional, national and local level, with the aim of enhancing human resource development, necessary to empower the role of local governments and actors in disaster risk reduction. The Alliance will promote decentralization and mobilization of resources especially from national to local levels to facilitate equal access to existing opportunities as well as the development of local opportunities responding to specific local needs.

4- Localizing the Hyogo Framework for Action (HFA), and mid-term review: After the first five years of implementing the Hyogo Framework, much has been learned

and achieved, however, it has been affirmed that the process needs to reach out further to local governments and local communities. The mid-term Review 2009-2010 will offer a number of opportunities and challenges for local governments and particularly local level high risk communities. The HFA midterm review is also a significant opportunity to contribute to the new urban risk reduction initiative and World Campaign 2010-2011, which will also stimulate local action for the implementation of the HFA. This shall be accompanied by a comprehensive advocacy campaign to build awareness of both the HFA and disaster risk reduction.

5- Disaster risk reduction and climate change adaptation and mitigation– what does this mean for local governments: Local governments must become the drivers of adaptation and mitigation strategies that will result in greatly reduced disaster risk and loss potential. The campaign will focus on sharing practical measures on effective climate change adaptation and the links to disaster risk reduction.

6- Select showcase local governments as role models for resilient cities: It will provide for local governments initiatives to recognize good achievements and examples of successful local risk reduction examples have to be set up - UNISDR will develop a matrix and share it with the Alliance for nominations and follow-up.

7- UNISDR will coordinate the global campaign strategy, and especially focus on:

- Facilitating the political space between local governments, national governments and the UN for disaster risk reduction,

- Providing for a coordinated public awareness and media campaign, which will build on local, national and international partners outreach capacities (engage with professional marketing and media experts),

- During the campaign, committing to facilitate the compilation of existing tools and good practices, and promoting capacity development, learning and sharing of experience between local governments and with the partners in each region" (UNISDR, 2009b:6).

After the examination of the risk concept with an overview of current understanding on global agenda, it is necessary to define few terms related with risk. These terms have gained importance during the last two decades because of international declerations mentioned previously and these terms are particularly important to the conceptual framework of urban planning.

The most comprehensive **definition of risk** is made by International Strategy for Disaster Reduction (ISDR) as a new organ of UN established in 2000 and this definition is most relevant for this study.

According to the ISDR risk is; "the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions" (UNISDR, 2002:16).

Conventionally risk is expressed by the notation **"Risk = Hazards x Vulnerability"** (UNISDR, 2002:36).

According to this notation understanding the concept of risk first requires an understanding of a hazard. A hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation (UNISDR, 2002).

The other important concept to understand risk is vulnerability. Vulnerability is the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards (UNISDR, 2002).

"Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability. Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that

people therefore do not necessarily share the same perceptions of risk and their underlying causes" (UNISDR, 2002:16).

"A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk" (UNISDR, 2002:17).

"The definition of disaster risk reflects the concept of disasters as the outcome of continuously present conditions of risk. Disaster risk comprises different types of potential losses in lives, health status, livelihoods, assets and services etc. Nevertheless, with knowledge of the prevailing hazards and the patterns of population and socio-economic development, disaster risks can be assessed and mapped, in broad terms at least" (UNISDR, 2009b:4).

The terms of Risk Assessment, Disaster Risk Reduction, Disaster Risk Management and Mitigation comprise activities that aim to reduce risks prior to any hazard event.

According to ISDR, "risk assessment is a methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend" (UNISDR, 2002:63).

"The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios" (UNISDR, 2002:16).

As shown in the figure below the identification of hazards is usually the starting point of a risk assessment process.

Figure 2.2 Risk Assessment Process

(Source: UNISDR 2002:63)

UNISDR defines disaster risk reduction as "the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development" (UNISDR, 2002:17).

"The disaster risk reduction framework is composed of the following fields of action:

- Risk awareness and assessment including hazard analysis and vulnerability/capacity analysis;

- Knowledge development including education, training, research and information;

- Public commitment and institutional frameworks, including organisational, policy, legislation and community action;

- Application of measures including environmental management, land-use and *urban planning*, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;

- Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities" (UNISDR, 2002:17).

ISDR also indicates that "disaster reduction is based on a continuous strategy of vulnerability and risk assessment, many actors need to be involved, drawn from governments, technical and educational institutions, professions, commercial interests and local communities. Their activities will need to be integrated into planning and development strategies that both enable and encourage the widespread exchange of information. New multidisciplinary relationships are essential if disaster reduction is to be comprehensive and sustainable" (UNISDR, 2002:13).

UNISDR defines **disaster risk management** as "the systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters" (UNISDR, 2002:17). According to UNISDR disaster risk management comprises *all forms of activities, including structural and non-structural measures* to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards (UNISDR, 2002).

UNISDR also defines mitigation as "structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards" (UNISDR, 2002:17).

Mitigation is defined by FEMA as "sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects." (FEMA, 1997:26)

<u>According to FEMA</u> mitigation includes such activities as:

- “Complying with or exceeding NFIP (The National Flood Insurance Program) floodplain management regulations.

- Enforcing stringent building codes, flood-proofing requirements, seismic design standards and wind-bracing requirements for new construction or repairing existing buildings.

- Adopting zoning ordinances that steer development away from areas subject to flooding, storm surge or coastal erosion.

- Retrofitting public buildings to withstand hurricane-strength winds or ground shaking.

- Acquiring damaged homes or businesses in flood-prone areas, relocating the structures, and returning the property to open space, wetlands or recreational uses.

- Building community shelters and tornado safe rooms to help protect people in their homes, public buildings and schools in hurricane- and tornado-prone areas” (FEMA, Mitigation Directorate web page).

FEMA conducts studies related with *multi-hazard mitigation planning* and indicates that “mitigation plans form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. *The planning process is as important as the plan itself*. It creates a framework for risk-based decision making to reduce damages to lives, property, and the economy from future disasters” (FEMA, Multi-Hazard Mitigation Planning web page).

Risk reduction strategies have come into prominence with recent attempts to identify risk issues and risk reduction activities by UN and its related bodies.

“International policies concerning natural and technological disasters changed radically. Previous policies that allocated large resources to post-disaster relief and reconstruction activities have proved inefficient without curbing the needs, and

without generating safer modes of conduct. The international community has therefore altered its objectives in disaster policies with a strong determination to reduce risks prior to any hazard event" (Balamir, 2007:31).

It is therefore clear that risk reduction efforts entails a systematic and comprehensive process including social, spatial, economic, administrative and legislative practices to avoid, reduce and share risks at national and local level.

When we look at the content and methods defined for risk reduction studies, we observe that it is necessary to integrate risk reduction studies in every type and scale with spatial planning processes and planning studies.

If it is considering that urban areas are the places where impact of disasters occurs more severely and damage of disasters occurs with greater intensity, it is certain that urban planning has a great role in risk reduction studies for cities faced not only with natural hazards but also human-induced hazards.

With this point of view; the relevance of clarifying urban risks and the importance of *urban mitigation planning* is emerging.

2.2. Urban Mitigation Planning

"Mitigation at all levels is the dominant paradigm today as promoted by international organizations and academic circles since 1990s, which changed the conventional mode of thinking focused on emergency and crisis management policies since 1940s" (Balamir 2006:2).

"The concepts and methods of urban mitigation planning are entirely different from conventional building-level risk mitigation. Earthquake engineering has during the past 40 years developed an area of expertise that deals with the risk of building collapse due lateral foces. The city however is not just an aggregate of buildings, but a complex system comprising its own nested sets of 'risk sectors', as well as buildings of various categories to acquire different functions and priorities in the

context of urban mitigation planning. Cities are vulnerable therefore, in very many different ways, and manifest a multitude of risks" (Balamir 2006:3).

"On the other hand, mitigation is a most relevant and rewarding effort particularly at the level of settlements. Cities as distinct physical systems have their own complex functional integrity, and are subject to failure should any of the sub-components receive a natural or man-made hazard impact. Also, cities are usually managed in their totality by an authority explicitly responsible for its functioning and safety. Risk avoidance/ reduction/ sharing as part of such responsibilities is however, a recent awareness, and often an imposed obligation. These are some of the reasons why seismic risk mitigation should be streamlined into city planning functions and must have a formal basis" (Balamir 2006:3).

Balamir (2006) defines the approaches related with identification and management of urban risks and methods of coping with them in groups given below;

1) "Urban planning services are usually demanded for the post-disaster reconstruction stages and rehabilitation works. Methodological know-how is available in this area, based on case experiences and theoretical discourse (Spangle Assoc., 1991, 1997; Schwab, et.al., 1998).

2) Risk mitigation efforts on the other hand, usually focus at national level policies (Godschalk et. al., 1999). In general, most of pre-disaster management of seismic risks in settlements is either confined to engineering tactics at the individual building level, or to the simulation modeling efforts (as in the case of HAZUS) at system level (Coburn and Spence, 1992; Coburn, 1995). Both approaches represent expert decision-making and monitoring of city systems, rather than community action and local participatory processes.

3) Another form of pre-disaster monitoring efforts can be identified to fall closer to landuse planning. Burby (1998, 1999) considers that land-use planning could provide sufficient means for mitigation in itself. An approach is to

survey and register geological attributes of land and local geographical features to determine the appropriate zoning of uses and designation of types of buildings for safer city development and functioning (Brown and Kockelman, 1983; Spangle Assoc. and Mader, 1998). Thus high hazard zones are not allowed for residential purposes, but buildings for storage or animal husbandry could be permitted, and public buildings and emergency facilities must accordingly be allocated to less hazardous zones. Fault lines must have strips of zones for total building ban, restricted zones relaxed with distance, etc. This approach suffices with an interpretation of the geological attributes, and considers an acievement of seismic safety in terms land-use constraints.

4) Cases that directly confront the problem of seismic mitigation, and intend to develop methods in comprehensive urban planning (rather than that of land-use planning alone) are very few and recent. This approach does not only consider the city systems in their entirety, but also develops a multi-disciplinary framework" (Balamir, 2006:4).

After making a brief history of disaster risk concept and risk reduction and mitigation approaches in global agenda, it is necessary to examine disaster risk reduction efforts in Turkey.

2.3. Disaster Risk Reduction Efforts in Turkey

"Excessive losses in natural disasters in Turkey are, to a large extent, a consequence of omissions and deficiencies in the structuring of disasters and development laws, as well as negligent land-use practices and avoidance of control in building processes" (Balamir, 2002:39).

Turkey is prone to several natural hazards and has been affected by several natural disasters, in particular earthquakes, floods and landslides.

These hazards, coupled with high physical and social vulnerability, have caused excessive losses of life, injury, and damage to property (JICA, 2004).

According to the Table 2.1, 146 natural disaster events occurred in Turkey since 1903 to 2009 and the earthquakes come in the first place in terms of the number of events, the number of people killed, the number of people affected and the amount of economic damages.

Table 2.1 Natural Disasters in Turkey from 1900 to 2009*
(Source: EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net - Université Catholique de Louvain - Brussels – Belgium)
(*Events recorded in the CRED EM-DAT. First Event: Apr/1903, last entry: Sep/2009)

Diasters		**Number of Events**	**Number of Killed People**	**Number of Total Affected People**	**Damage (000 US$)**
Earthquake (seismic activity)	***Earthquake (ground shaking)***	***71***	***88.538***	***6.874.596***	***22.941.400***
Epidemic	Bacterial Infectious Diseases	1	11	150	-
	Parasitic Infectious Diseases	2	-	100.000	-
	Viral Infectious Diseases	5	602	104.705	-
Extreme temperature	Cold wave	3	69	-	-
	Extreme winter conditions	2	17	8.150	-
	Heat wave	2	14	300	1.000
Flood	Unspecified	11	897	372.617	65.000
	Flash flood	10	243	1.341.362	1.342.000
	General flood	15	174	64.407	238.500
Mass movement dry	Avalanche	1	261	1.069	-
Mass movement wet	Avalanche	2	146	6	-
	Landslide	7	269	13.275	26.000
Storm	Unspecified	4	49	3	-
	Local storm	5	51	13.636	2.200
Wildfire	Forest fire	5	15	1.150	-

In Turkey's disaster history, the earthquakes come into prominence as the most effective disaster among all disasters.

Therefore, the disaster and earthquake terms seem synonymous Turkey (Ergunay et al., 2003).

When we look at the disaster policies of Turkey and applied risk reduction studies for particularly seismic risks and all disaster risks, we observe that risk reduction efforts are only limited to the development of regulations and can not be implemented in daily life.

The current disaster management model in Turkey represents a structure mainly devoted to response activities taking place after disasters.

"In Turkey, the main country disaster management policies have been identified in the 5-year development plans, but in the first three 5-year development plans had included nothing about the disasters (1963-67, 1968- 1972, 1973-1977). For the following ones, it is seen that the need of building codes, a comprehensive planning approach, proper land use plans were emphasized; yet the disaster management was not taken comprehensively. Another point about the development plans are, they included the measures about "disaster management", but they didn't include the financial need or sustainability for the measures to be taken. The last three 5-year development plans must be kept distinct from the previous ones because, these plans (1996-2000, 2001-2005, 2007-2013) took the subject in a wider approach. It can be derived from the policies that Turkey is now taking the problem as not only 'a problem of response' but also 'a problem of development'. The policies of the Turkey are reaching to a more comprehensive approach, but still, they need to be progressive" (Koçak, 2005:4).

"The Marmara Earthquake in 1999 generated a strong national determination in Turkey to devise new and effective methods of tackling disasters. Since then, much effort and debate has been taking place in political, official and academic circles to

refresh the attitudes, management and structures of responsibilities, as well as to revise the related legal framework" (Balamir, 2002:39).

"New provisions, revisions in regulations and ministerial mandates have appeared, as usually is the case after any major earthquake. Based on law 4452 (27.08.1999) that empowered the Goverment, three major decrees of the Board of Ministers were prepared and put into effect. The decrees covered the institutions of the 'Obligatory Building Insurance', 'Building Control' and 'Professional Proficiency'. Still other regulations are expected and a draft for a new 'Development Law' is circulating. These decisions may be interpreted as attemts to convert the existing system that is over-occupied with crisis management and the aftermath of disasters into some form of an overall strategy for diaster mitigation" (Balamir, 2002:39).

Turkey's conventional legislation in disaster management consists of two fundamental laws that provide public intervention capacity and improvement in the efficiency of relief operations after disasters. These are; *Disasters Law* administered by the Ministry of Public Works and Settlements in 1959 and *Development Law* administered by the Ministry of Public Works and Settlements in 1985.

The Disasters Law and its Regulations provide a formal capacity for intervention after disasters and organize the relief operations. The Disaster Law deals with a preparation for 'tents and blankets operations' rather than any form of a risk analysis, estimations of losses and a master plan for pre-disaster monitoring of forms of mitigation. In the Disasters Law, provincial and local governors are empowered extraordinarily to be the sole authority with powers of commanding all public and private and even military resources, property, all vehicles and man-power when a disaster occurs. Of the 68 articles in the main body of the Law, only a few contain provisions for pre-disaster activities and in practice disaster mitigation requirements are hardly fulfilled. (Balamir 2001a, Recent Changes in Turkish Disaster Policy: A Strategic Reorientation, Mitigation and Financing of Seismic Risks)

2.4. The Major Mitigation and Preparedness Projects in Turkey

"The Marmara earthquake is the milestone in Turkey, causing the overall disaster management system to be reviewed and the efforts to boost. After the 1999 earthquakes, several numbers of international organizations contributed to several numbers of recovery, reconstruction, prevention, mitigation and risk reduction activities" (Koçak, 2005:7).

The major organizations they improve projects in Turkey are JICA, UNDP, World Bank and European Union. The major mitigation projects undertaken by the Government of Turkey with the support of these international organizations are"Marmara Earthquake Emergency Reconstruction"(MEER), "Istanbul Seismic Mitigation and Emergency Preparedness Projects"(ISMEP), "The Study on A Disaster Prevention / Mitigation Basic Plan in İstanbul including Seismic Microzonation" and "Earthquake Master Plan for İstanbul"(EMPI).

2.4.1. MEER Marmara Earthquake Emergency Reconstruction Project

"As part of the comprehensive response to the August 17 Marmara earthquake, the Marmara Earthquake Emergency Reconstruction Project (MEER) finances reconstruction and interventions that will contain damages in the case of a similar event, especially since earthquakes are expected to hit regions in Istanbul and Izmir. This project has three main components: The first creates a comprehensive emergency management structure that coordinates and integrates risk reduction strategies, preparedness, response, and recovery. It also creates an insurance mechanism, establishing and expanding national catastrophic risk management and risk transfer capabilities by making liquidity readily available to resident owners of damaged or destroyed dwellings; reducing government fiscal exposure; ensuring the financial solvency of the pool; and reducing government dependency on the Bank and other donors. This first component also reviews legal reforms, and strengthens the municipal capability to regulate, plan, and implement disaster resistant development. Lastly, this component establishes a land information system while updating and improving obsolete registers and maps. The second component funds

the development of a trauma program for adults, which sets up community mental health centers and programs for psychological and organizational support. The third component reconstructs permanent housing in earthquake-affected areas" (WB, 1999).

2.4.2. ISMEP Istanbul Seismic Risk Mitigation and Emergency Preparedness Project

The Government of Turkey and the World Bank are working together to prepare a proposed Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (ISMEP). The objective of the project is assisting the Government in mitigating seismic risks in the municipality of Istanbul and further strengthening the capacity for emergency preparedness in order to reduce the social, economic and financial impacts of potential future earthquakes (WB, 2005).

The project consists of the following components and activities: Enhancing Emergency Preparedness, Seismic Risk Mitigation for Public Facilities, Enforcement of Building Codes and Project Management.

"ISMEP has no references with the new international understanding of mitigation and it is not familiar with the city-level mitigation approaches. ISMEP neither has any emphasis in spatial analysis of risks, a consideration of relative locations of emergency facilities, nor a recognition of place attributes. This is totally inconsistent with the intentions declared at the very beginning of the project that ISMEP aims at transforming Istanbul in the next 10-20 years into a city resilient to major earthquake, and that seeks improvements in compliance with building codes and land-use plans" (Balamir, 2006:7).

2.4.3. EMPI Earthquake Master Plan for Istanbul

The Earthquake Master Plan of Istanbul (EMPI) has been requested and procured (November 2002-July 2003) by the Metropolitan Municipality of Istanbul (MMI),

following the JICA analysis. Two teams of research universities (METU-ITU and BU-YTU) responded to the MMI tender for EMPI.

"In order to assess the risks Japan International Cooperation Agency had prepared a **Study on Disaster Mitigation/prevention in Istanbul Including Seismic Microzonation.** To follow up studies on the Assessment of Earthquake Risk in Istanbul and to find proper solutions for complex "risk mitigation" issues, the **Earthquake Master Plan for Istanbul (EMPI)** has been commissioned by Istanbul Metropolitan Municipality (IMM) to a consortium involving four leading Turkish Universities" (İlkışık, 2007:715).

"The METU-ITU approach is distinctly based on the concept of risk, the sociological and philosophical tenets of which are to be found in the expositions of Ulrich Beck (1998, 1997, 1992) and others. This does not confine the work and the analyses of risk to an academic exercise, but provides a methodology for action and a framework for the democratic involvement of the whole society in 'risk analysis and management'. This proactive approach exclusively describes 'risk sectors' in the Istanbul metropolitan area, for which independent risk analyses could be conducted, based on methods described in detail in the main report. Secondly, parties involved in each risk sector are identified with a description of tasks of risk management (risk avoidance, risk minimization, and risk sharing) attributed to each. This demands agreements and protocols between these parties on collective and organised action. Stake-holders in each risk sector are thus to be activated in relation to a general 'road map' that combines all action in independent risk sectors" (Balamir, 2004a:4).

"The Istanbul Earthquake Master Plan is comprised of three fundamental actions in its approach. The first is a Contingency Plan that must be prepared for the entire urban area that ensures coordination among different sectors. The Contingency Plan is the principal document that outlines the instruments for managing risks (avoidance, mitigation, or sharing) that all systems and sectors in the jurisdictional area of the city face from earthquakes (and other hazards). The tasks in this coverage are risk analysis studies, contingency standards and appropriate risk management methods. Commitment of the affected sectors is obtained before supervision of

implementation is guaranteed by responsible parties" (The Report of Earthquake Master Plan of Istanbul, 2003:8).

"The second item is a local action plan that contains sub-project activities or implementation packages in high-risk areas so that comprehensive urban transformation actions can be initiated. The third component is a bundle of Research and Activity Programs that will facilitate sustaining or completing of the first two sets of actions" (The Report of Earthquake Master Plan of Istanbul, 2003:8).

It can be seen in the following chart the three components of EMPI as described above (Figure 2.3).

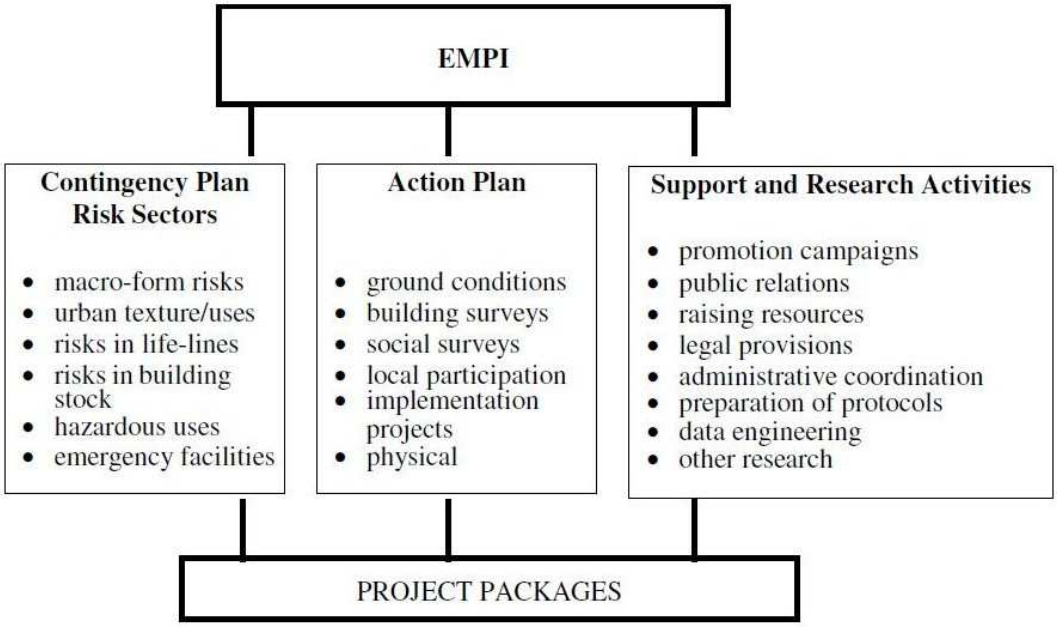


Figure 2.3 Istanbul Earthquake Master Plan Components
(Source: The Report of Earthquake Master Plan of Istanbul, 2003)

In the EMPI framework 13 risk sectors have been described.

"**1.** Macro-form Risks:These are risks involved in the structure of main access system and compatibility with urbansettlement area sizes, densities and configurations, natural boundaries to expansion, water basins, long-term development tendencies, attraction points and investments of metropolitan scale, all investigated in relation to micro-zones.

2. Risks in Urban Texture: Independent of the building safety, determination of Risks in the differential formation of urban fabric comprising plots, building coverage and density, access roads and car parking, ownership pattern, and other environmental properties;

3. Risks Related to Incompatible Uses: Analysis of Risks arising from adverse affects of incompatible urban uses in neighboring areas, buildings or within a building in the event of an earthquake;

4. Risks of Productivity Loss: Seismic vulnerability of industrial enterprises and risks of productivity losses in the industrial establishments, in the case of earthquakes, based on their size, location, building and facilities robustness, technology employed, materials processed, and dependencies on infrastructures, access, input-output relations, etc.;

5. Risks in Special Areas: The seashore, infill areas, dams and down-stream basins, river beds and other areas subject to liquefaction and landslide are areas that require detailed and special analyses of risks;

6. Open Space Scarcity Risks: If open areas (green, car-park, sports-fields, etc.) are not of sufficient size, not in proximity to residential districts, and are not appropriate for the emergency requirements, than scarcities prevail;

7. Risks Related to Hazardous Materials: Urban uses that process, store, and distribute combustible, explosive, poisonous and pollutant materials are sources of

further risks, the location, environment and routes of which should be separately investigated;

8. Vulnerabilities of Historical and Cultural Heritage: Buildings of historical and cultural significance demand special analysis of structural and other forms of risks; A priorities list of the registered stock need to take into consideration the ground conditions, historical and architectural significance of the building and its environs, the other forms of vulnerabilities the building or complex may have in the face of earthquake;

9. Risks in Lifelines: Analysis of life-lines in terms of structure of networks, routes, service area, volume of flow, construction and materials, with reference to microzonation and ground conditions; The access network; Vulnerable points and congestion risks;

10. Risks in Building Stock: Evaluation of private and public buildings in their design and constructional performance; Classification of stock and assessment of retrofit feasibilities;

11. Risks Related to Emergency Facilities: Hospitals, schools/ dormitories, communications centers, fire-stations, police quarters, major commercial centers and storage facilities, banks, and other public and private buildings that are expected to provide emergency services after the earthquake are investigated for their satisfactory functioning; Their malfunctioning imply further risks for the city;

12. External Risks: These cover all possible forms of deliberate or macro accidental events or actions that would nullify the mitigation measures taken against the earthquake, or make emergency activities less effective, or inflict damages; The risks that could materialize as losses in the face of unfavorable weather conditions, or acts of sabotage or terrorism; Investigation of factors to give rise to reactionary spontaneous movements of social unrest or actions to disrupt public order;

13. Risks of Incapacitated Management: Investigation of risks due to incapacities of the city administrations in risk management and emergency circumstances" (The Report of Earthquake Master Plan of Istanbul, 2003:264-269).

Earthquake Master Plan for İstanbul is a pioneering example of mitigation planning and disaster risk reduction studies in Turkey.

The core of the Master Plan is formed by "seismic evaluation of existing buildings and strengthening of those" (The Report of Earthquake Master Plan of Istanbul, 2003:108).

The evaluation of existing buildings, risks in building stock and the role of building surveys in the mitigation plan consist the starting point of this thesis.

As it is well known, there are various evaluation and strengthening methods available implementing by engineers. According to Balamir (2006), earthquake engineering has during the past 40 years developed an area of expertise that deals with the risk of building collapse due lateral foces. However, concepts and methods of urban mitigation planning are entirely different from those of conventional building-level risk mitigation.

The main prospective contribution of this thesis will be to present a new perspective combining *the engineering approach to safety studies in building stock* and *the mitigation planning approach to risk determination studies in building stock.*

For this aim in the following chapter, the sector of risks in building stock in EMPI is examined in detail, and this study will develop with the contribution of comparisons in identifying building stock assessment method of mitigation planning and building stock assessment method of engineering.

CHAPTER 3

COMPARISON OF THE MITIGATION PLANNING APPROACH AND ENGINEERING APPROACH FOR RISK ASSESSMENT AND REDUCTION STUDIES IN THE BUILDING STOCK

3.1. Urban Risks and the Method of Mitigation Planning Approach

Turkish cities constitute risk pools of natural and technological hazards. Therefore, it is essential to determine risk sectors at settlement level to mitigate disaster risks in urban areas especially faced with the earthquake hazard.

"The city is not just an aggregate of buildings, but a complex system comprising its own nested sets of 'risk sectors', as well as buildings of various categories to acquire different functions and priorities in the context of urban mitigation planning. Cities are vulnerable therefore in very many different ways, and manifest a multitude of risks" (Balamir, 2006:3).

"Mitigation is a most relevant and rewarding effort particularly at the level of settlements. Cities as distinct physical systems have their own complex functional integrity, and are subject to failure should any of the sub-components receive a natural or man-made hazard impact" (Balamir, 2006:3).

"In Turkey, existing approaches to urban seismic risk management could be considered broadly in two groups. Often seismic properties of sets of individual buildings are investigated by geophysical and engineering analysis, and recommendations for retrofitting/removal made according to technical and economic feasibility criteria. A second family of management efforts focuses on urban systems

vulnerabilities due to natural hazards and undertakes scenario analyses. The Earthquake Master Plan of Istanbul (EMPI) completed in 2003 has provided **the opportunity for an alternative to the existing methods of urban seismic risk management**"(Balamir, 2004a:1).

EMPI is a guiding study for mitigation planning in Turkey. In the proposed model of EMPI, besides response activities, mitigation and planning activities including pre-disaster stages are also emphasized.

"The approach considers hazards of natural and human origin in combination, within a framework of 'risk sectors', and proposes lines of action to involve all factions of the urban society. The purpose is to bring together and activate in every risk sector, related components of public administration, business and industry, NGOs and local community representation in the long-term management of urban risks, to draw mutual agreements of conduct and control, and to run various subproject packages. Altogether, 13 relatively exclusive risk sectors have been identified for the whole city. The nature of risks in each sector are exhibited, methods of 'avoiding, minimizing, and sharing' of risks demonstrated, and the agents responsible and to be involved indicated. High-risk districts are designated as areas for Action Planning, where comprehensive rehabilitation/ transformation projects are recommended for immediate implementation. A reassessment of existing city administration procedures, enriched powers of implementation, new tools for physical planning, encouragement of partnerships and private investments in comprehensive rehabilitation are complementary aspects of EMPI" (Balamir, 2004a:1).

As EMPI is a pioneering example of mitigation planning approach, this thesis has been shaped by the method of EMPI framework which describes 13 risk sectors in the city. However, within this thesis, only "risks in building stock" are considered.

"Risks in the building stock" is one of the risk sectors described for the whole city and its scope, related problems, risk management strategy, responsible bodies and proposals have been explained in EMPI as;

"- *Scope*: Evaluation of private and public buildings in their design and constructional performance; Classification of stock and assessment of retrofit feasibilities;

- *Problems*: Great volume of unauthorized buildings; Little information on the state of building stock, and extensive structural changes; Deficiencies in public buildings and the siting of emergency facilities; Many special cases as in the case of historic buildings;

- *Risk Management*: Determination of building robustness in relation to surveys and microzonation information; Determination of retrofitting methods feasible for the different categories of buildings; Determination of comprehensive rehabilitation and action planning areas with respect to the concentration of deficient buildings;

- *Responsible Bodies*: MMI, municipalities and the Governorate; LCAs; NGOs;

- *Proposals*: Surveying by visual inspection and scanning of the total stock of around a million buildings in stages and three phases; Building up a detailed spatial data-base for the building stock for multiple purposes; Developing retrofitting models for standard cases; Facilitating decisions for retrofitting with modifications in Flat Ownership Law (634); Changes in Development Law (3194) in special high risk zoning and enforcement capacities for comprehensive rehabilitation." (The Report of Earthquake Master Plan of Istanbul, 2003:267-268)

In Turkey the current applications about risk identification ignore the risk sectors except building stock risks and the risk analysis studies in the building stock have been performed on a limited basis in terms of pilot projects in particular areas.

"The existing approach is contented with projects of individual buildings, singularly an engineering mission. Engineering profession tend to consider city-level mitigation solely as a building-retrofitting task. A powerful lobby has maneuvered to attain most of the requirements for a medium, congenial to such singular building operations in isolation. However, the retrofitting operations must be considered

within the context of local planning requirements which should take place prior to building-level mitigation investments" (Balamir 2006:6).

It is clear that the discourse of "it is the buildings that kill people" has been adopted in Turkey and all risk identification and reduction efforts have concentrated on robustness of buildings and retrofitting or removal of the individual buildings.

As a result of this approach, engineering tactics have gained importance, a vast market for professional services for retrofitting operations has been created and mitigation planning has been excluded.

Although the seismic evaluation of existing buildings and strengthening of those constitutes one of the mitigation activities most largely implemented in Turkey, there is no legal or organizational arrangement related with evaluating earthquake performance and strengthening of existing buildings.

The studies for identifying earthquake performance of buildings is a new issue in terms of our country and these studies has started to be implemented in some cities in Marmara Region, including İstanbul, after the 1999 Marmara Earthquake particularly. Current applications are only based on terms of reference of the study prapared by responsible municipality of study or the Prime Ministry Project Implementation Unit (The Ministry of Public Works and Settlement, 2009).

According to Balamir (2004b:14), mitigation efforts would be effective only if local hazard conditions are determined and measures taken accordingly. Responsibilities and capabilities for the proactive approach must reside within local administrations and communities. In other words, reactive or proactive attitudes have different priorities for different levels of administration.

In accordance with this perspective, risk reduction activities including building surveys at city level should be carried out by municipalities for effective results. Also this arrangement could create an convenient environment to implement risk reduction studies and land-use planning activites made by municipalities coherently.

With regard to the issue of responsibilities and tasks of local governments, a legal arrangement made in 2004 with Municipalities Law and Metropolitan Municipalities Law.

In the Municipalities Law (5215) under the title of “Emergency Planning” there is an article that “Municipalities make disaster plans and emergency plans taking into account the characteristics of the settlement and provide team and equipment, in order to avoid fire, industrial accidents, earthquakes and other natural disasters or reduce their losses”(Municipalities Law, Article 53).

In the Metropolitan Municipalities Law (5216) under the title of “Tasks, Authorization and Responsibilities of Metropolitan Municipalities” mentioned that “making plans and other preparedness arrangements related with natural diasters at metropolitan area level in accordance with the plans at the provincial level” is one of the responsibilities of Metropolitan Municipalities. Also “vacating or tearing down the risky buildings in terms of disaster or life and property safety” is one of the responsibilities of Metropolitan Municipalities (Metropolitan Municipalities Law, Article 7/u and 7/z).

Although disaster risk reduction issue in two laws is mentioned, these articles are insufficient. There is no detailed explanation about content of tasks, implamentation of tasks, methods, application techniques, financial resources etc.

With regard to the issue of responsibilities and tasks of local governments, it has been obligatory to prepare microzonation maps for municipalities after 1999 Marmara Earthquakes.

“Since specially standardized geological maps and maps, as well as integrated information related to other disasters are not considered a prerequisite in the development system, an objective basis for the evaluation of land-use and building permission decisions for their contributions to mitigation efforts does not exist. Geological evaluation reports for individual sites as required by some municipalities, are piecemeal. In cases where more comprehensive geological/seismic etc.

information and recommendations are available, no formal method of taking these into account in the practises of land use planning exists" (Balamir, 2001:217).

Microzonation maps identify hazards in the city and it is a prerequisite for land-use planning activities at city level. Municipalities obliged to prepare development plans should be also responsible for preparing microzonation maps in order to achive effective results in integration of mitigation studies and urban planning studies. However in current situation municipalities are lack of financial capacity and technical capacity to involve this task (Balamir, 2001).

Consequently, for effective city-level mitigation it is necessary to consider all risk sectors in city as a whole and taking into account local hazards by using microzonation maps. Microzonation map for settlements is a primary step for any mitigation program and an essential data for urban planning studies. Identification of high risk areas depending on assessment of all risk sectors incorporated and microzonation maps is another essential step for mitigation planning and it contributes to introducing a planning vision for mitigation efforts.

At this point, the role of city planners gains importance. Mitigation activities described above requires "a capacity for identifiying various types of risks at different levels, making projections for likely consequences, and also a capacity for devising methods to 'avoid, reduce, and share' risks. This means an entirely different recruitment of professional expertise than employed under the conventional policies" (Balamir, 2007:1).

As mitigation planning needs to be based on comprehensive and multidisciplinary studies, an intensive collaboration of the disciplines is required. City planners have a dominant role to play in risk mitigation activities at the city level (Balamir, 2004a).

Based on a review of the method of mitigation planning approach and deficiencies in current approach, it is obvious that mitigation efforts should be focus on introducing a planning vision and an integrated approach for mitigation studies and urban planning studies. It is also clear that analysis of risks in the building stock is a part of

mitigation planning process taking into consideration the other risk sectors in the city and local attributes of the city.

This thesis intends to *develop a method for decision-making related with the built environment according to mitigation planning objectives* and *present a new perspective combining the engineering approach to safety studies in building stock and mitigation planning approach to risk determination studies in the urban environment.*

After examining the method of mitigation planning approach, it is necessary to review the approaches of civil and other engineering disciplines to compare their approach to safety studies in the building stock and the mitigation planning approach to risk determination.

3.2. The Method of Engineering Approach

Most of the safety studies concerning building stock directly estimate the probability of collapse and damage in individual buildings by using geophysical and engineering analysis as carried out by engineers. Within the context of Earthquake Master Plan of Istanbul (EMPI), vulnerability of existing building stock in Istanbul was asessed and seismic retrofitting methods were developed.

“Seismic evaluation of existing buildings and strengthening of those, which do not have acceptable seismic safety, constitutes one of the mitigation activities considered in the EMPI. Although there are various evaluation and strengthening methods available for individual buildings, there exists a strong need for the development of screening procedures for large numbers of undocumented buildings in campaign-type applications. In the evaluation of the seismic safety of buildings, three stages were adopted. The first stage inspection/evaluation works are also referred as "street survey" and correspond to preliminary assessment. In the second stage assessment, starting with the high priority buildings and regions established in the first stage, more detailed investigation/evaluation works are executed for the seismic assessment of buildings. The third stage involves almost through analysis of the building and

decision on its earthquake worthiness and economic feasibility of retrofit" (İlkışık, 2007:5).

3.2.1. Stages in the Evaluation of the Seismic Safety of Buildings

Within the scope of EMPI, **Multistage Building Assessment Procedure** is used for evaluation of the seismic safety of buildings. The procedure consists of 3 stages and at the end of these stages strengthening procedures are applicated in the building stock.

3.2.1.1. First Stage: Sidewalk Survey Procedure

"The goal of these works is to make a preliminary grading of all buildings in Istanbul with respect to their seismic performance, and therefore to collect limited data on buildings by visual inspection from outside which can be processed in a rational manner for seismic assessment. This will enable to set priorities for second stage assessment at both individual building basis and regional basis" (The Report of Earthquake Master Plan of Istanbul, 2003:10).

The first stage studies are also referred as **street survey** or **sidewalk survey procedure**. This procedure was developed by Sucuoglu and Yazgan in 2003.

"The sidewalk survey procedure based on observing selected building parameters from the street side, and calculating a performance score for determining the risk priorities for buildings. Statistical correlations have been obtained for measuring the sensitivity of damage to the assigned performance score by employing a database consisting of 454 damaged buildings surveyed after the 1999 Düzce earthquake in Turkey. The results revealed that the proposed screening procedure provides a simple but effective tool for selecting those buildings that have significant damage risk. These buildings have to be subjected to a more detailed assessment for a final decision on their seismic risk level" (Sucuoğlu et al., 2007: 441).

The proposed methodology of sidewalk survey procedure and structural parameters that have to be observed during the surveys are briefly given below. Within the scope of sidewalk surveys different parameters are used for **1-7 storey reinforced concrete buildings** and **1-5 storey masonry buildings.**

"**Number of Stories:** This is the total number of floors above the ground level.

Apparent Building Quality: A close relationship has been observed between apparent quality -good, moderate, poor- and experienced damage during recent earthquakes in Turkey.

Pounding Effect: When there is no sufficient clearance between adjacent buildings, they pound each other during an earthquake as a result of different vibration periods. Uneven floor levels aggravate the effect of pounding " (Özcebe et al., 2006:2).

These parameters given above are used for both 1-7 storey reinforced concrete buildings and 1-5 storey masonry buildings.

"**Existence of a soft Story:** A soft story usually exists in a building when one particular story, usually employed as a commercial space, has less stiffness and strength compared to the other stories.

Existence of heavy Overhangs: Heavy balconies and overhanging floors in multistory reinforced concrete buildings shift the mass center upwards; accordingly give rise to increased seismic lateral forces and overturning moments during earthquakes.

Apparent Building Quality: A close relationship has been observed between apparent quality [good, moderate, poor] and experienced damage during recent earthquakes in Turkey.

Existence of short Columns: Frames with partial infills lead to the formation of short columns which sustain heavy damage since they are not designed for the high shear forces due to shortened heights that will result from a strong earthquake.

Topographic Effects: Buildings on slopes steeper than 30 degrees have stepped foundations, which cannot distribute ground distortions evenly to structural members above" (Özcebe et al., 2006:2).

These parameters given above are used for 1-7 storey reinforced concrete buildings only.

Wall Opening Ratio: The wall with largest openings is probably the front facade wall. If the ratio of the total length of openings to the total length of wall is less than 1/3, it is small, if it is between 1/3 and 2/3 it is moderate, if more, it is large. These ratios can be selected by visual proportioning.

Orientation of Wall Openings: If openings in the walls of multistory buildings are aligned, this is a regularity. If not, it increases the damage risk. When the openings are completely misaligned, it is defined as an an irregularity.

These parameters given above are used for 1-5 storey masonry buildings only.

Local Soil Conditions: The intensity of ground motion at a particular site predominantly depends on the distance the causative fault and local soil conditions. As there exists a strong correlation between PGV and the shear wave velocities of local soils, the PGV is selected as to represent the ground motion intensity" (Özcebe et al., 2006:2). *This parameter is used for all buildings in the area.*

In the first stage of the Evaluation of the Seismic Safety of Buildings, **local soil conditions** and **ground motion intensity** are considered as the other parameters besides structural properties of the buildings. Local soil conditions and ground motion intensity are assessed depending on Geotechnical Classification Map and Peak Ground Velocity Distribution Map praperad by JICA (Figure 3.1 and 3.2).

According to Multistage Building Assessment Procedure part of The Report of Earthquake Master Plan of Istanbul, the PGV map in the JICA (2002) report has

contour increments of 20 cm/s². The intensity zones in Istanbul are expressed accordingly, in terms of the associated PGV ranges.

Zone I : 60<PGV<80 cm/s²

Zone II : 40<PGV<60 cm/s²

Zone III : 20<PGV<40 cm/s²

The differences in ground motion intensities at three PGV zones are reflected in the initial scores given in Tables 3.1 and 3.2, according to a study conducted by Sucuoglu (2003).

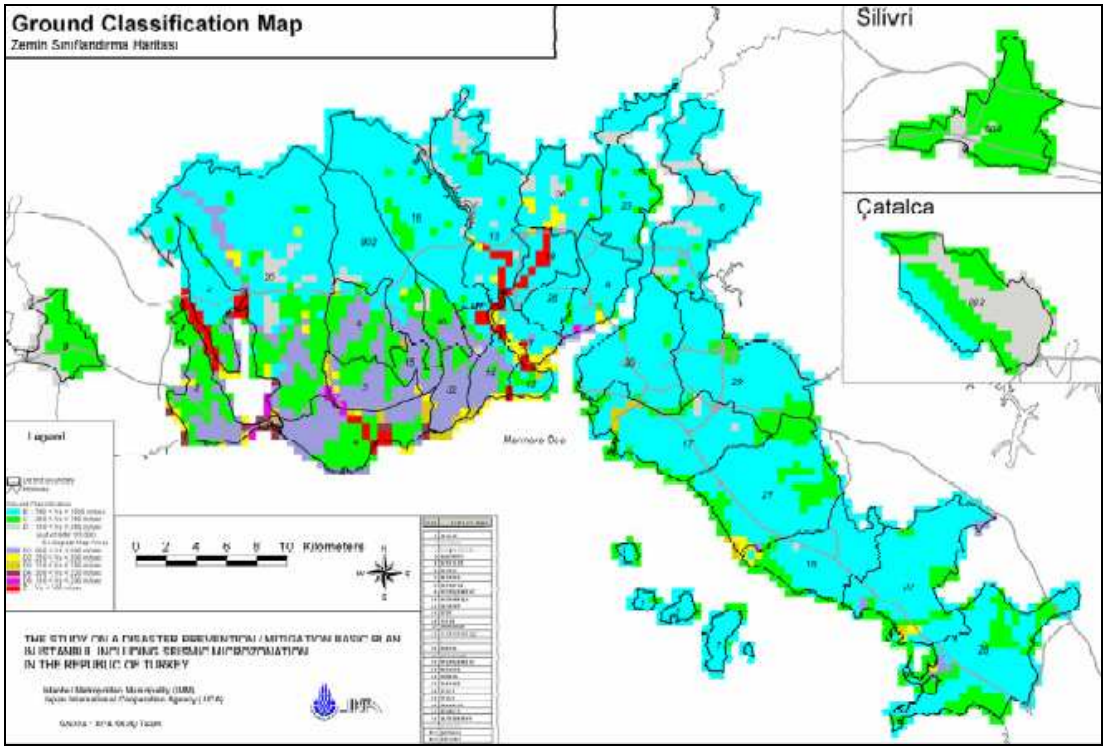


Figure 3.1 Geotechnical Classification Map of JICA

Source: The Report of Earthquake Master Plan of Istanbul, 2003

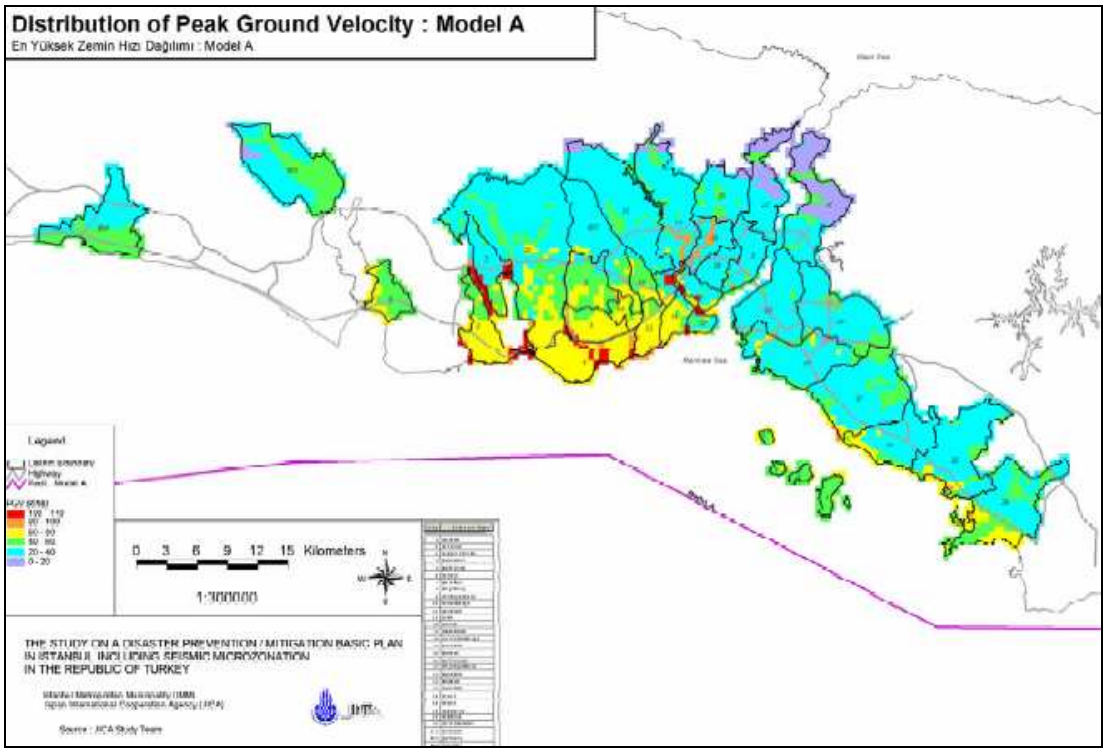


Figure 3.2 Peak Ground Velocity Distribution Map of JICA

Source: The Report of Earthquake Master Plan of Istanbul, 2003

"Once the vulnerability parameters of a building are obtained from walk-down surveys and its location is determined, **the seismic performance score is calculated** by using Table 3.1 and Table 3.2. In these tables, an initial score is given first with respect to the number of stories and the intensity zone. Then, the initial score is reduced for every vulnerability parameter that is observed or calculated. A general equation for calculating the seismic performance score (PS) of all buildings can be formulated as follows.

PS = (Initial Score) - Σ(Vulnerability Parameter) × (Vulnerability Score)

The weight of each building vulnerability parameter is evaluated by statistical procedures, based on the Düzce database. Statistical analysis is conducted by the

program package SPSS Version 11, using the "*Multivariable Stepwise Linear Regression Analysis*" procedure. The results are then smoothed, and the weights of the parameters for which there was no available data (soft storey, pounding, topography) are assigned by using engineering judgment" (The Report of Earthquake Master Plan of Istanbul, 2003:113).

Table 3.1 Initial and Vulnerability Scores for Reinforced Concrete Buildings
(Source: The Report of Earthquake Master Plan of Istanbul, 2003)

Storey #	**Base (Initial) Scores**			**Vulnerability Scores**					
	Zone 1 60<PGV<80	Zone 2 40<PGV<60	Zone 3 20<PGV<40	Soft storey	Heavy overhang	Apparent quality	Short column	Pounding	Topographic effects
1-2	90	125	160	0	-5	-5	-5	0	0
3	90	125	160	-10	-10	-10	-5	-2	0
4	80	100	130	-15	-10	-10	-5	-3	-2
5	80	90	115	-15	-15	-15	-5	-3	-2
6,7	70	80	95	-20	-15	-15	-5	-3	-2

Table 3.2 Initial and Vulnerability Scores for Masonry Buildings
(Source: The Report of Earthquake Master Plan of Istanbul, 2003)

Storey #	**Base (Initial) Scores**			**Vulnerability Scores**			
	Zone 1 60<PGV<80	Zone 2 40<PGV<60	Zone 3 20<PGV<40	Apparent quality	Wall openings	Opening orientation	Pounding
1-2	100	130	150	-10	-5	-2	0
3	85	110	125	-10	-5	-5	-3
4	70	90	110	-10	-5	-5	-5
5	50	60	70	-10	-5	-5	-5

"The values given in Tables 3.1 ve 3.2 are preliminary figures and they have to be calibrated during pilot field studies" (The Report of Earthquake Master Plan of Istanbul, 2003:117).

According to Multistage Building Assessment Procedure part of The Report of Earthquake Master Plan of Istanbul, the values given to each vulnerability parameter by the observer are:

Apparent quality	: Good (0); Moderate (1); Poor (2)
Pounding effect	: No (0); Yes (1)
Soft storey	: No (0); Yes (1)
Heavy overhangs	: No (0); Yes (1)
Short columns	: No (0); Yes (1)
Topography effect	: No (0); Yes (1)
Wall openings	: Small (0); Moderate (1); Large (2)
Opening orientation	: Regular (0); Less regular (1); Irregular (2)

3.2.1.2. Second Stage

In the second stage assessment, starting with the high priority buildings and regions, more detailed investigation/evaluation works are executed for seismic assessment of buildings. The goal of this phase of investigations is to make reliable performance evaluations to reach final decisions.

Within the scope of Earthquake Master Plan of Istanbul, more than one method depending on different alternative approaches is developed. In the second stage there are six methods. One of these methods is developed by METU and it is explained briefly for mentioning the content of second stage assessments in general.

"In the proposed method of METU, a preliminary evaluation methodology for assessing seismic vulnerability of existing low- to mid-rise reinforced concrete buildings is presented. The damage scores obtained from the derived discriminant functions are used to classify existing buildings as safe, unsafe and intermediate. The

discriminant functions are generated based on the basic damage inducing parameters" (The Report of Earthquake Master Plan of Istanbul, 2003:125). These parameters are;

- Number of stories,
- Minimum normalized lateral stiffness index (this index is the indication of
- The lateral rigidity of the ground story, which is usually the most critical story)
- Minimum normalized lateral strength index (this index is the indication of the base shear capacity of the critical story)
- Normalized redundancy score (Redundancy is the indication of the degree of the continuity of multiple frame lines to distribute lateral forces throughout the structural system)
- Soft story index
- Overhang ratio

"According to these parameters, the damage index or the damage score corresponding to the life safety performance classification is calculated. At the end of this procedure it is possible to classify the buildings in three groups. These groups are named as **safe, unsafe and intermediate**. Although a major portion of the buildings in the intermediate group is expected to experience moderate damage, this group encompasses buildings with all degrees of damage, which can not be identified at the level of desired accuracy, i.e. the correct classification rate in each group should be at least 70 % and, the maximum classification error related to damage states leading to life loss should be 5 % at the most. It is therefore strongly sugessted that further detailed analyses should be performed on these buildings before reaching a final decision about their expected performance levels" (The Report of Earthquake Master Plan of Istanbul, 2003:125).

3.2.1.3. Third Stage

The third stage involves an almost through analysis of the building and decision on its earthquake worthiness and economic feasibility of retrofit. This stage of evaluation works comprises especially high rise buildings and socially essential buildings. It is carried out by registered expert engineering firms in accordance with specified methods and performance criteria.

Within the scope of Earthquake Master Plan of Istanbul, more than one method depending on different alternative approaches is develpoed. In the third stage there are three methods. One of these methods is developed by METU and it is explained briefly for mentioning the content of third stage assessments in general.

"The proposed method of METU is based on a 14-step force-based assessment method and it is developed for 1-7 story concrete buildings. An important feature of the procedure is conducting linear elastic analysis only once. The steps of the proposed procedure are:

- Modeling
- Natural Vibration Properties
- Linear Elastic Analysis of the Structure
- Determination of Moment Capacities of Beams
- Calculation of Axial Forces Acting on Columns
- Determination of Beam-Column Capacity Ratios
- Decision on the Potential Yielding Member Ends
- Determination of Demand-to-Capacity Ratios
- Construction of the Simplified Capacity Curve
- Estimation of Maximum Inelastic Displacement

- Modification of Lateral Forces and Demand-to-Capacity Ratios
- Determination of Final Plastic Hinge Mechanism
- Controlling Component Acceptability
- Decision on the Seismic Performance of the Structure" (The Report of Earthquake Master Plan of Istanbul, 2003:151)

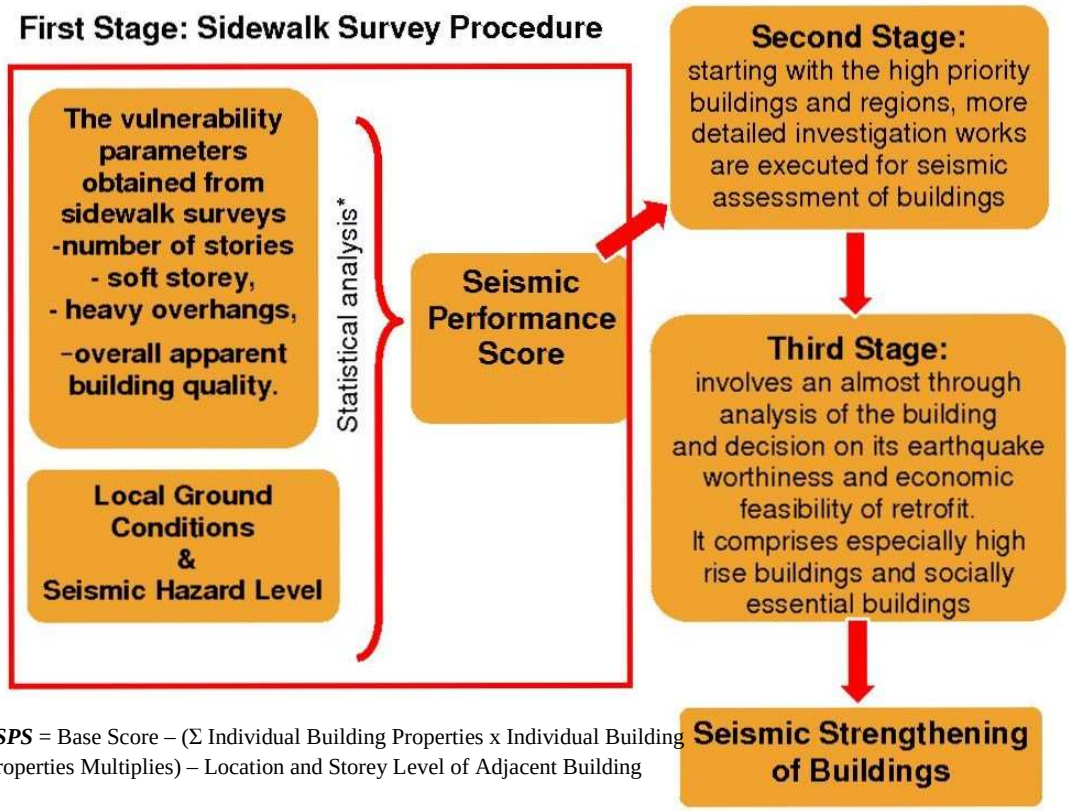
"According to the obtained results, decision is made on the global seismic performance of the structure, depending on the distribution of plastic hinges, and the magnitude of the estimated plastic rotations at yielding member ends" (The Report of Earthquake Master Plan of Istanbul, 2003:157).

3.2.2. Seismic Strengthening Procedure of Buildings

"The strengthening procedures are considered in two stages depending on the extent of their detail. The first one is called the simplified procedure and its application is expected to be very wide. The second one, the comprehensive strengthening, is applied high-rise, socially essential and other selected buildings. The strengthening of an existing building may be thought as increasing of its earthquake performance or decreasing of its present risk to an acceptable level" (Erdik, 2004:3).

Several methods are proposed for seismic strengthening of buildings. These methods are compiled under **simplified strengthening** and **comprehensive strengthening** titles. The simplified strengthening methods are proposed to be applied on a larger number of buildings. The target of the simplified strengthening is to prevent the total collapse of the structural system and consequently to provide live safety under the scenario earthquake. By applying the comprehensive strengthening, the structural system is updated to satisfy provisions of the current seismic code (Erdik, 2004 and The Report of Earthquake Master Plan of Istanbul, 2003).

The stages of in the evalution of the seismic safety of buildings according to engineering approach are presented in Figure 3.3.



***SPS** = Base Score – (Σ Individual Building Properties x Individual Building Properties Multiplies) – Location and Storey Level of Adjacent Building

Figure 3.3 The Evalution of the Seismic Safety of Buildings according to Engineering Approach

CHAPTER 4

ANALYSIS OF EXISTING BUILDING STOCK ACCORDING TO MITIGATION PLAN OBJECTIVES FOR THE CASE OF FATIH DISTRICT, ISTANBUL

4.1. The Reasons for Fatih Case Selection

Istanbul is located at the bottom of the North Anatolian Fault Line where one of the most seismically active regions in Turkey. According to The Earthquake Hazard Map of Turkey prepared by the General Directorate of Disaster Affairs (GDDA) of the Ministry of Public Works and Settlement, many of the settlement areas in Istanbul are located on *The First and Second Degree Earthquake Zones* (Figure 4.1).

Besides geographical attributes of Istanbul, uncontrolled urban development and construction quality of the buildings are other factors increasing the earthquake risk on Istanbul Metropolitan area boundaries. “Existing building stock in İstanbul consists of one million buildings, half of which are expected to be affected significantly from a severe earthquake.”(Hopkins et al 2006:2)

Study on Disaster Mitigation/Prevention in Istanbul Including Seismic Microzonation prepared by Japan International Cooperation Agency is a starting point of risk assessment and risk reduction activities in Istanbul. After this study, Earthquake Master Plan for Istanbul (EMPI), the most detailed and comprehensive mitigation study carried out in Turkey, is prepared by Istanbul Metropolitan Municipality and a consortium consisting of four Turkish Universities.

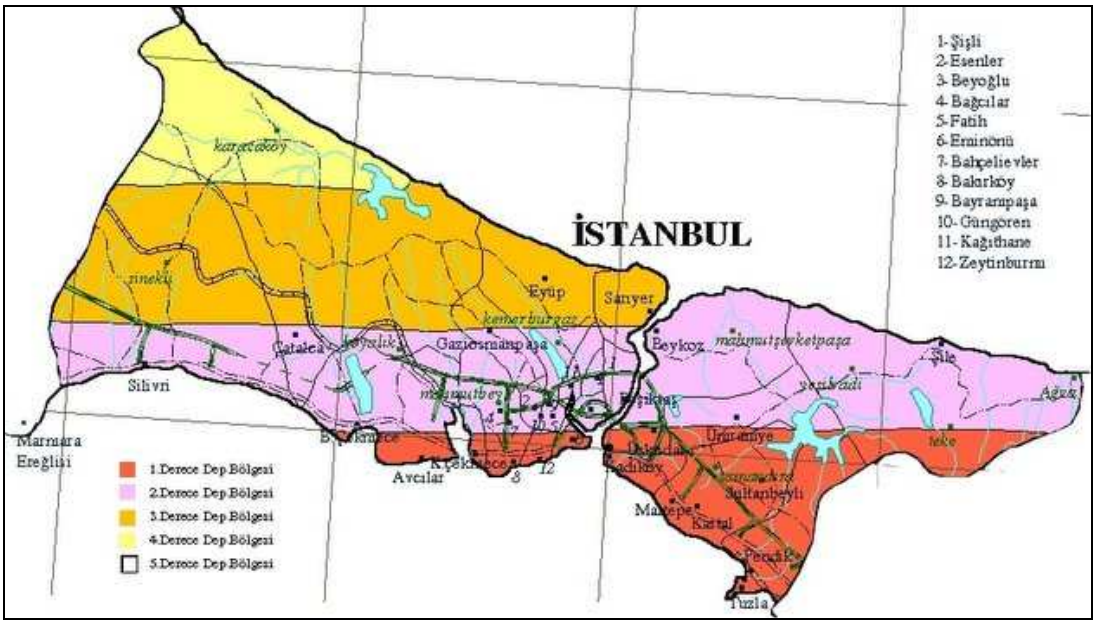


Figure 4.1 Earthquake Hazard Zoning Map of Turkey
(Source: GDDA, 1996)

Study on Disaster Mitigation/Prevention in Istanbul Including Seismic Microzonation prepared by Japan International Cooperation Agency is a starting point of risk assessment and risk reduction activities in Istanbul. After this study, Earthquake Master Plan for Istanbul (EMPI), the most detailed and comprehensive mitigation study carried out in Turkey is prepared by Istanbul Metropolitan Municipality and a consortium consisting of four Turkish Universities.

“An important aspect to be covered by the Earthquake Master Plan for Istanbul is decided to be the assessment of seismic vulnerability of existing building stock in Istanbul, the development of seismic retrofitting methods and the determination of technical, social, administrative, legal and financial measures to be taken in order to be able to implement such methods” (Erdik, 2004:1).

"Urban re-development and definitions of the project areas are two important strategies of Earthquake Master Plan for Istanbul and they are constituted from four ordered steps:

- Researches on the identification of local dynamics in the selected strategic areas.

- Preparation of the strategic plan drafts by IMM and publication of the plan for the widespread discussions.

- Feed back of editing, objections and alternatives provided by the local municipalities, related groups, civilian social groups etc.

- Official production of the settlement strategic master plan" (Demir et al, 2008:8).

Within the context of EMPI, primary areas are defined respect to the risk indicators and the other city planning parameters in order to create disaster resisted areas (Figure 4.2).

As shown in the Figure 4.2, the Fatih District takes place in Intervention Area-1 that contains historical patterns.

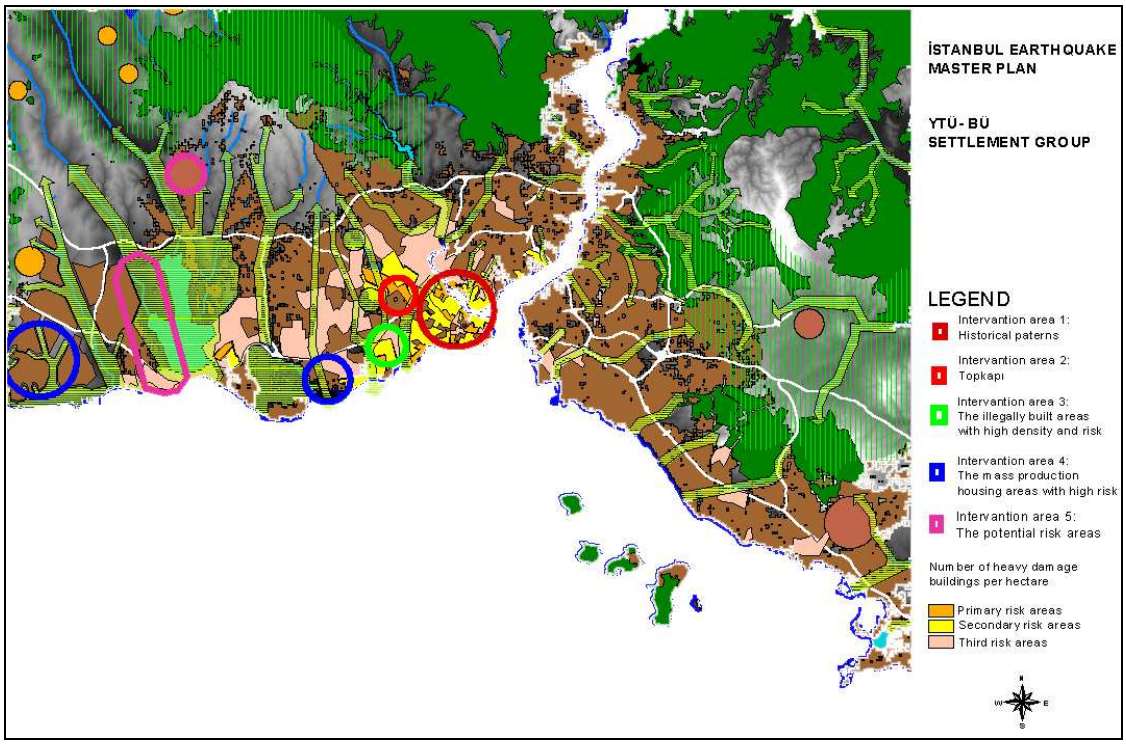


Figure 4.2 Primary Intervention Sub-regions of EMPI

(Source: Demir et al, 2008)

The implementation of EMPI was done at most risky districts by carrying out pilot projects. One of the projects, which focus on the earthquake safety of the urban environment, is *Earthquake Based Urban Renewal Project of Fatih District.* The project includes regeneration strategies oriented towards the ensuring of earthquake safety in Fatih and it develops sustainable and feasible regeneration models for different regions and neighbourhoods.

In this project, there have been many analyses regarding to mainly engineering and planning issues. Concerning these analyses, various maps and reports have been prepared. Structural analysis, parcel (plot) analysis, building analysis and infrastructural analysis are example of these studies. Building analysis is a part of

this project and it contains individual building assessments, earthquake performance score calculation of buildings and determination of risky buildings.

In this respect, it would be useful to examine this analysis carried out in Fatih and its results, in order to identify methodological differences between the engineering approach to safety studies in the building stock and, the mitigation planning approach to risk determination studies in building stock.

4.2. Characteristics of Fatih District

Fatih is one of the oldest districts of Istanbul and located in Historical Peninsula. The geographical location, administrative structure, demographic, socio-economic, historical, cultural structure, natural conditions and urban land use pattern of the district are reviewed in this part of the chapter.

4.2.1. The Location of Fatih in Istanbul Metropolitan Area

The district of Fatih is located in the southern part of the Istanbul. At the west of the district is the Zeytinburnu District, at northwest is the Bayrampaşa District, at northeast is Haliç, at the east is the Eminönü District and at the south is Marmara Sea. The east and northeast side of the district is bordered with city wall (Figure 4.3).

The area of the district is 1051 hectares. Location of Fatih District has a strategically importance as a result of factors such as being located in **Historical Peninsula** where the first settlement area of Istanbul, its proximity to the central business district, existence of major highway and railway connections of the city etc.

Figure 4.3 Sub-provinces of Istanbul and the Location of Fatih
Source: Official web site of Fatih Municipality, http://www.fatih.bel.tr

4.2.2. Administrative Structure of the Fatih District

In 1928, Fatih was separated from Eminönü and it has been officially established as the district of Istanbul.

The district of Fatih consists of 69 neighbourhoods. The neighbourhoods within the borders of the district are given Table 4.1, Figure 4.4 and regions of the district are given Figure 4.5.

Table 4.1 The Neighbourhoods of Fatih District (Source: BİMTAŞ Project Group Database, 2007)

Abdi Subaşı	Guraba Hüseyin Ağa	Keçeci Karabaş	Seyit Ömer
Abdi Çelebi	Hacı Evhaddin	Keçihatun	Sofular
Ali Fakih	Hacı Hamza	Kırk Çeşme	Sinanağa
Arabacı Beyazıt	Hacı Hüseyin Ağa	Koca Dede	Tahta Minare
Arpa Emini	Hamamı Muhittin	Koca Mustafa Paşa	Tevkii Cafer
Atik Mustafa Paşa	Haraççı Kara Mehmet	Kürkçübaşı	Uzun Yusuf
Avcıbey	Hasan Halife	Küçük Mustafa Paşa	Veledi Karabaş
Babahasan Alemi	Hatice Sultan	Kirmasti	Yalı
Balat Karabaş	Hatip Muslahittin	Melek Hatun	Çakırağa
Beyazıt Ağa	Haydar	Molla Aşkı	Ördek Kasap
Beyceğiz	Hızır Çavuş	Molla Şeref	İbrahim Çavuş
Canbaziye	Hoca Üveyz	Muhtesip İskender	İmrahor
Cerrahpaşa	Hüsam Bey	Muratpaşa	İnebey
Davutpaşa	Kariye	Müftü Ali	İskender Paşa
Deniz Abdal	Kasap Demirhun	Mimar Sinan	Şeyh Resmi
Derviş Ali	Kasap İlyas	Neslişah	
Ereğli	Kasım Güranı	Nevbahar	
Fatma Sultan	Katip Muslahittin	Sancaktar Hayrettin	

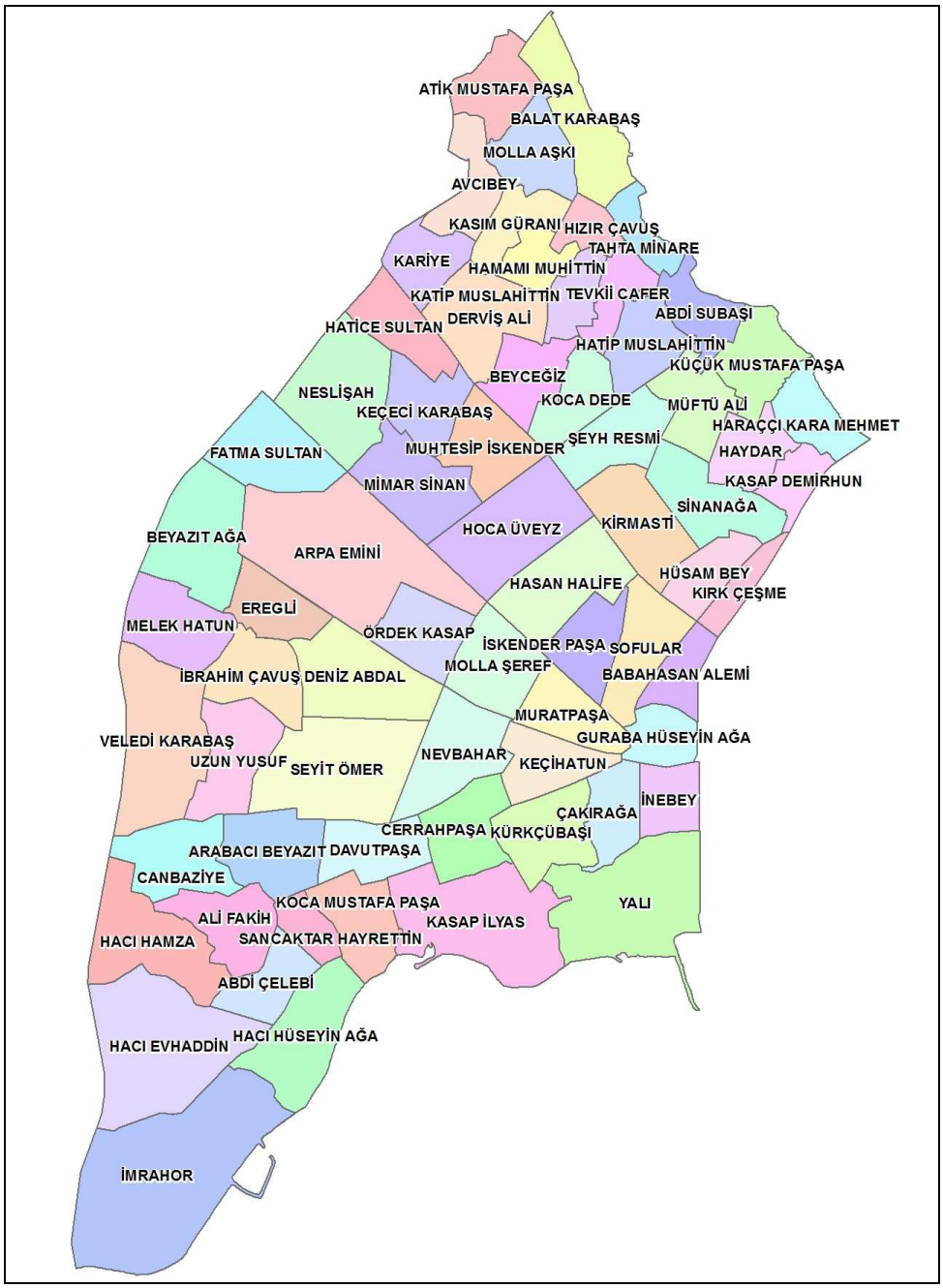


Figure 4.4 The Neighbourhoods of Fatih District

(Source: BİMTAŞ Project Group Database)

Figure 4.5 Satellite Image of Fatih and Regions of District

(Source: Goggle Earth, Date of image: 2007)

4.2.3. Demographic and Social Structure of Fatih District

According to last population census of Turkish Statistical Institute in 2008, the population of Fatih is **443.955** inhabitants. The population density is 422 inhabitants per hectare.

The population of Fatih was 226.853 inhabitants in 1950 and it grown at a rate of approximately 20%, in parallel with overall population growth in Istanbul until 1975. After 1975, when rapid population growth continues in Istanbul, the population growth rate of the Fatih District has decreased due to lack of new development areas in the district (Official web site of Fatih Municipality, 2009).

The social and economic structure of Fatih can mainly be characterized by squatter housing and squatter housing life. This life style has had important influences on the determination of the socio-economic structure, formation of the social institutions, and location and distribution of the economic activities. Fatih shelters people from many different ethnic origins such as Eastern Orthodox, Armenian and Georgian (Official web site of Fatih Municipality, 2009).

4.2.4. Urban Land Use Pattern

When urban land use of Fatih is investigated, it can be seen that, the residential areas have the largest share with a percentage of 60 in district's total area. In Fatih, there are multi-functional buildings also. In general the commercial function is intense in ground floor usage. Workshops and small scale industrial uses have the majority in underground usages within residential areas. The usage of upper surface floors is generally residential (Figure 4.6)

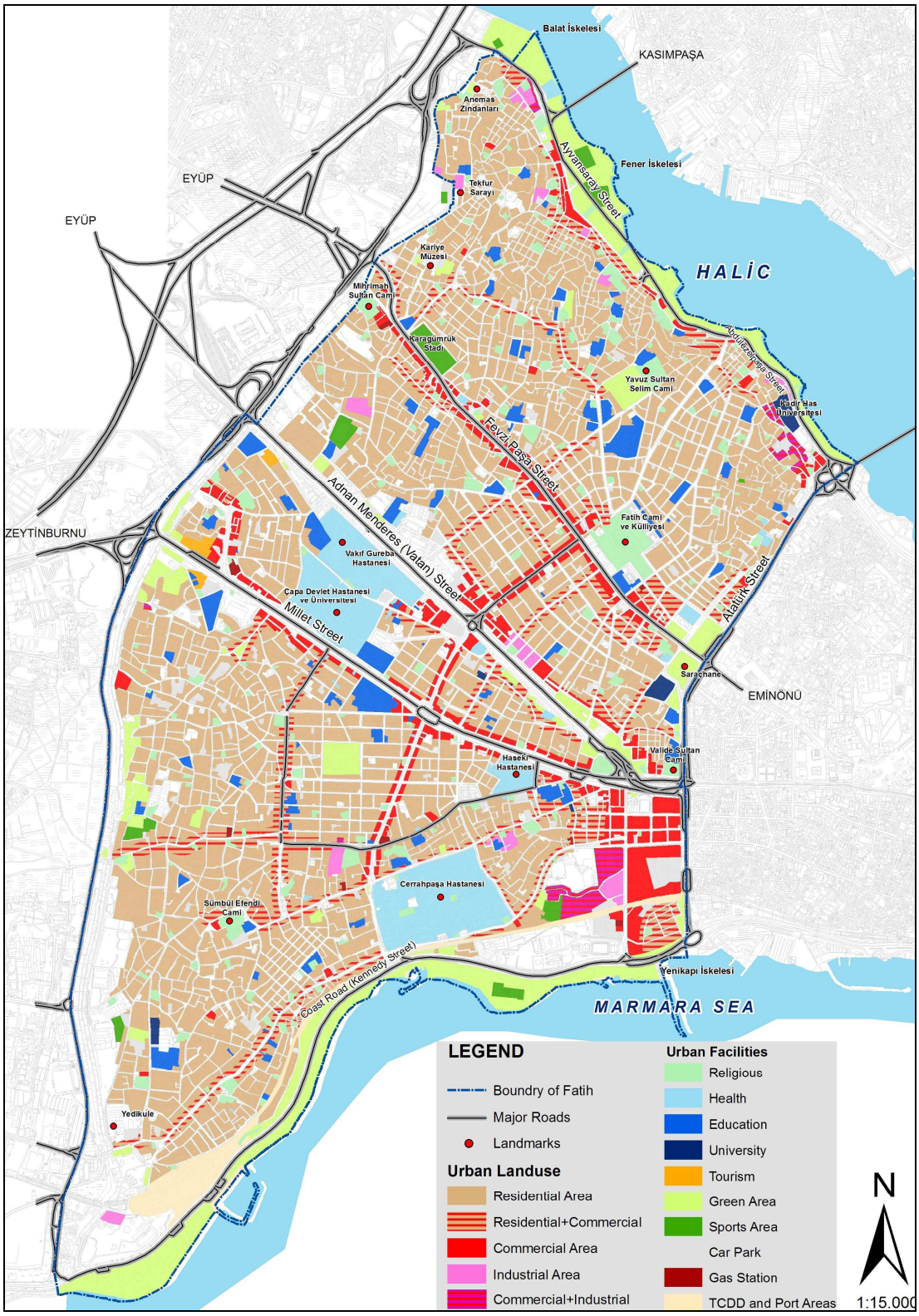


Figure 4.6 Urban Pattern of the Fatih District

(Source: BİMTAŞ Project Group Database)

Some of the essential health and education facilities of Istanbul are located in Fatih: Cerrahpaşa Tıp Fakültesi, Vakıf Gureba Hospital, Haseki Hospital, Samatya Hospital, Çapa Faculty of Medicine, Cerrahpaşa Faculty of Medicine and Haliç University, Kadir Has University.

Also, the headquarters of some of the main units of the Istanbul Metropolitan Municipality, including the Fire Department are located in Fatih.

Vatan (Adnan Menderes) Street is major road of Fatih, and other main roads of the district are Millet Street and Atatürk Boulevard.

In Fatih, there are exist major highway (E-5 and TEM highways) and railway connections of the city. Yenikapı Port is located in the southern part of Fatih, on the shores of Marmara Sea and it is main ferryboat port of Istanbul.

4.2.5. Historical Peninsula Conservation Plan

Historical Peninsula (Sur-u Sultani), including Fatih and Eminönü districts, has been declared as the 1st Degree Archaeological Site in 1995 by The Council of Conservation of Cultural and Natural Assets of Istanbul. Historical Peninsula Conservation Plan was prepared by MMI and approved in 2005.

According to Historical Peninsula Conservation Plan decisions, Historical Peninsula is divided into 3 degrees of protection areas; 1st Degree Protection Areas, 2nd Degree Protection Areas, 3A and 3B Protection Areas. 1st Degree and 2nd Degree Protection Areas includes monumental structures, historical squares, historical urban areas, city walls and other important cultural heritages. In 1st Degree and 2nd Degree Protection Areas, physical intervention is not allowed and allowed at minimum level as road widening excluding buildings.

In 3A and 3B Protection Areas, samples of civil architecture and monumental buildings are located scarcely. In Historical Peninsula Plan, these areas are defined as short term and long term regeneration areas.

1. Fatih Mosque

2. Yedikule

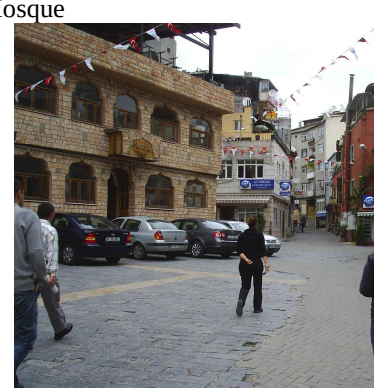
3. Tekfur Palace

4. Kariye Museum

5. Mihrimah Sultan Mosque

6. Zeyrek Mosque

7. Greek Orthodox College



8. Samatya Square

9.Anemas Dungeon Restoration

Figure 4.7 Views in the Fatih District (Source: City Planning Master Studio Archive, www.fatih.bel.tr, http://en.wikipedia.org/wiki/Fatih_Mosque)

4.3. The Stages of Analysis of Existing Building Stock in Fatih According to Mitigation Plan Objectives

The method used in the case study for decision-making related with the built environment of Fatih, developed based on mitigation planning objectives.

According to the mitigation planning approach, identifying local natural hazards is a prerequisite for the determination of risk in cities. In this context, the first stage of the Analysis of Existing Building Stock in Fatih is the identification of local natural hazards and development of multi-hazard map of Fatih.

The second stage consists of urban risk analysis in existing building stock. Within the scope of these analyses, the attributes of existing building stock in Fatih is examined regarding structural parameters and usage of buildings. These parameters are used for the definition of relative vulnerabilities in the building stock. According to relative vulnerability analysis results, more vulnerable sub-groups of buildings are defined and their spatial location, distribution in multi-hazard zones, and distribution according to Protection Areas of Historical Peninsula Conservation Plan are assessed.

In the third stage of analysis, methodological differences between mitigation planning approach and engineering approach to safety studies in the building stock are identified.

The Screening Procedure of the building stock in Fatih conducted by engineers within the scope of Earthquake Based Urban Renewal Project of the Fatih District is examined. The procedure contains individual building assessments, calculation of buildings' earthquake performance score and estimation of risky buildings.

Consequently, the results of mitigation planning approach and engineering approach are compared and the consistency between two studies is assessed. The attributes of the residual groups excluded in either of the approaches are reviewed.

The data is obtained from the BİMTAŞ Project Group, a subsidiary of Istanbul Metropolitan Municipality.

Multi-Hazard Map and analyses related with the building stock is developed using ArcGIS Version 9,2 programme. Geographic information system (GIS) is software and a hardware system which connects the spatial and non-spatial data in order to evaluate the system together. GIS technologies offer many methods of inquiry facilitating vulnerability analysis. Because of its conveniences academically and systemically, geographic information system (GIS) is preferred as an instrument for this study.

The stages of analysis of existing building stock in Fatih according to mitigation plan objectives can be seen in Figure 4.8.

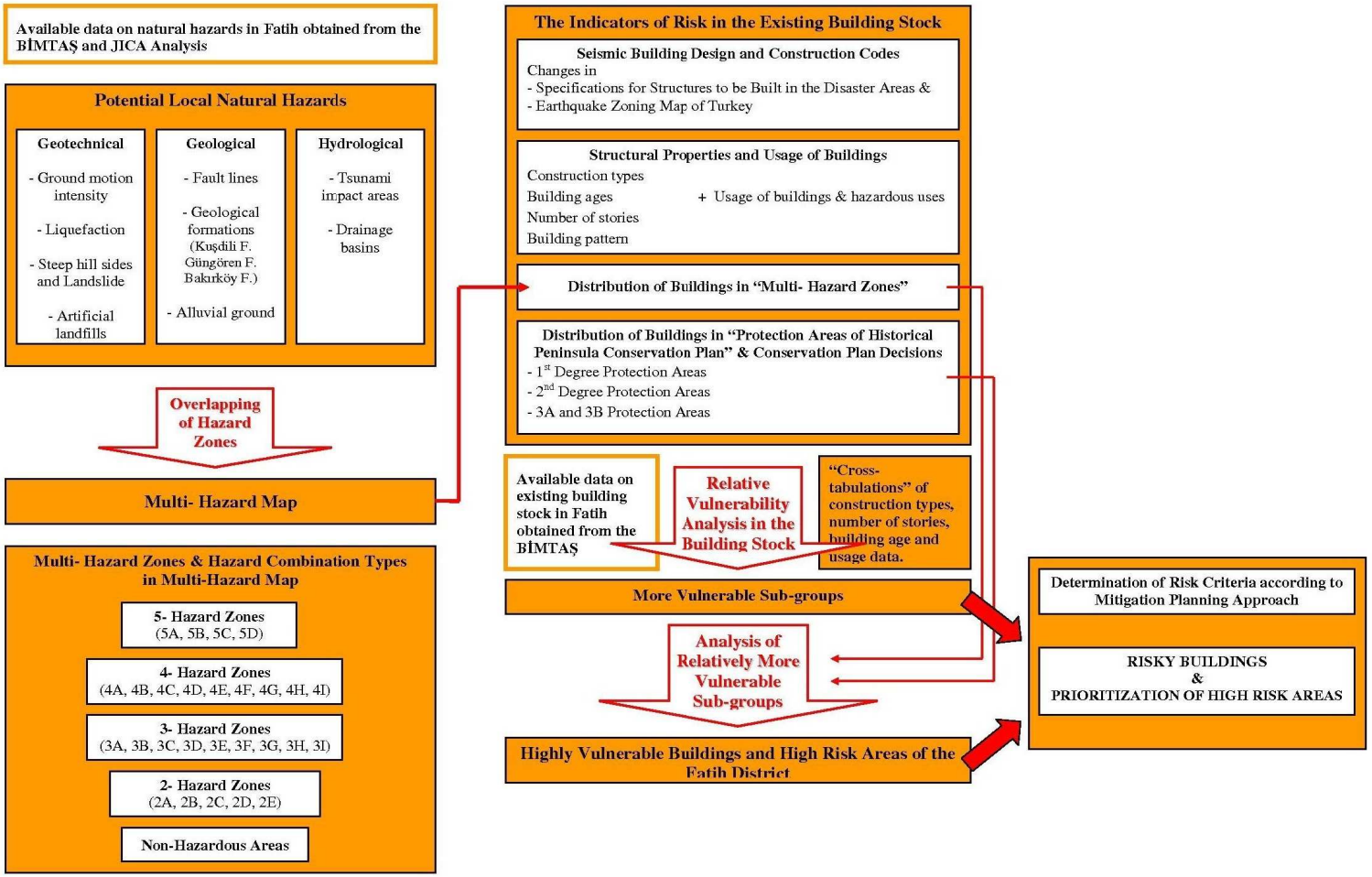


Figure 4.8 Flowchart of the Analysis of Existing Building Stock according to Mitigation Planning Approach for The Case of Fatih

4.3.1. Identification of Local Natural Hazards and Multi-Hazard Map of Fatih

The data related with natural characteristics of area consists of geotechnical, geological and hydrological data sets. The available data provided by the Istanbul Metropolitan Municipality BİMTAŞ Project Group and JICA database.

Within the scope of the study of identification of natural hazards, the factors considered as source of natural hazard are liquefaction, ground motion intensity (peak ground acceleration), landslide, land fill areas, geological formations, fault lines, tsunami and drainage basins (Table 4.2).

Table 4.2 Local Natural Hazards

Geological	Geotechnical	Hydrological
Fault lines	Ground motion intensity	Tsunami impact areas
Kuşdili formation	Liquefaction	Drainage basins
Güngören formation	Steep hill sides and Landslide	
Bakırköy formation	Artificial landfills	
Alluvial ground		

These natural hazard factors are examined under titles Geological Hazards, Geotechnical Hazards and Hydrological Hazards and the overlapping hazard areas are identified.

4.3.1.1. Geological Formations

Alluvial ground and Kusdili formation which have fine-grained structure, are most hazardous formations in district in terms of conductivity of ground motion. Güngören formation and Çukurçeşme formation have a coarse-grain structure. Although Güngören formation is a coarse-grain ground, it creates landslide hazard in

areas which slope higher than 20%. Trakya formation is most stable ground in district because of being rock. Bakırköy formation is not a hazardous formation but Güngören formation lies under it. Because of this stratification, Bakırköy formation is also considered hazardous ground. Consequently, alluvial ground, Kuşdili formation, Güngören formation and Bakırköy formation are taken into consideration in Multi-Hazard Map.

4.3.1.2. Fault Lines

In terms of seismicity, fault lines and their impact areas that 50-meter area around this lines are taken into consideration as component of Multi-Hazard Map.

4.3.1.3. Ground Motion Intensity (Peak Ground Acceleration)

Peak ground acceleration is one of the best measures of the potential damage of earthquake ground motion.

"Local site response to an earthquake is measured by recording the magnitude of ground motion at that site. PGA is the most common instrumental measure of ground motion. It is a measure of ground motion amplitude, and represents the highest acceleration of the ground motion." (Tangri et al 2006)

In the study of identification of natural hazards, the areas having high peak ground acceleration, according to JICA database, are used as a component of Multi-Hazard Map.

4.3.1.4. Liquefaction

"Under certain conditions, layers that are below the ground water level lose their resistance and behave as liquids instead of solids. This is called liquefaction. Soils which have low clay content such as sand, gravel, or even silt have a larger liquefaction potential"(The Report of Earthquake Master Plan of Istanbul, 2003:314).

The areas having high potential for liquefaction, determined by JICA analyses, are used as a component of Multi-Hazard Map.

4.3.1.5. Steep Hill Sides and Landslide

Potential landslide areas generally have terrain slope higher than 20% and located at Haliç seashore. As landslide could be a secondary disaster after an earthquake, potential landslide areas, defining in JICA database, are used as a component of Multi-Hazard Map.

4.3.1.6. Land Fill Areas

The artificial landfills located at Marmara seashore are potential hazard areas defined by JICA database, and these areas are taken into consideration in Multi-Hazard Map.

4.3.1.7. Tsunami Impact Areas

In the JICA analyses, it is accepted that tsunami will occur in case of an earthquake in the Marmara Sea with a magnitude 7,5. Possible tsunami impact areas, defined by JICA are considered as component of Multi-Hazard Map.

4.3.1.8. Drainage Basins

In Fatih, there is a valley extending from the west part of the district towards the central part, and the valley divides the district into two parts as the north side and the south side. The valley is also a drainage basin according to slope and flow direction analyses. Currently, Vatan Street, one of the main roads of Fatih, and a built-up area with high density are located on the valley. This situation increases a potential water flood impacts. In this respect, drainage basins are considered as a component of Multi-Hazard Map. Coast of Haliç and artificial landfill areas on the coast of The Marmara Sea are other areas having potential for water flood.

4.3.1.9. Multi-Hazard Zones and Hazard Map

After examining local natural hazards in the Fatih District, Multi-Hazard Map is developed to see spatial distribution of hazard areas and overlap hazard areas.

When we look at the distribution of hazard areas, we observe that hazard areas are generally overlapped and they generate hazard combinations consisting of 2, 3, 4 and 5-hazards. Only in some part of the district, some hazard areas are located singly, depending on the increase in combination number the intensity of hazards increases, 5-hazard zones are the most hazardous areas.

Although a simplification, in terms of identifying intensity of hazards, this order of overlapping is assumed to refer to level of hazardousness.

When size of multi-hazard zones is investigated; 2-hazard zone covers the largest area (306 hectares) in the total area of the district, and 3-hazard zone covers approximately 40 hectares area, 4-hazard zone covers approximately 52 hectares area, 5-hazard zone covers approximately 52 hectares area. In the district, approximately 600 hectares area, contain only a hazard type or no hazard (Table 4.3, Figure 4.9).

Table 4.3 Size of Multi-Hazard Zones

Hazard Zones	**Size (Hectare)**	**Percentage in total area (%)**	**Number of Buildings in Hazard Zones**
2 Hazard	306,17	29	8508
3 Hazard	39,89	4	656
4 Hazard	52,44	5	315
5 Hazard	52,21	5	175
Non-Hazardous Areas	600,29	57	16508
Total Area of Fatih District	1051,00	100	26162

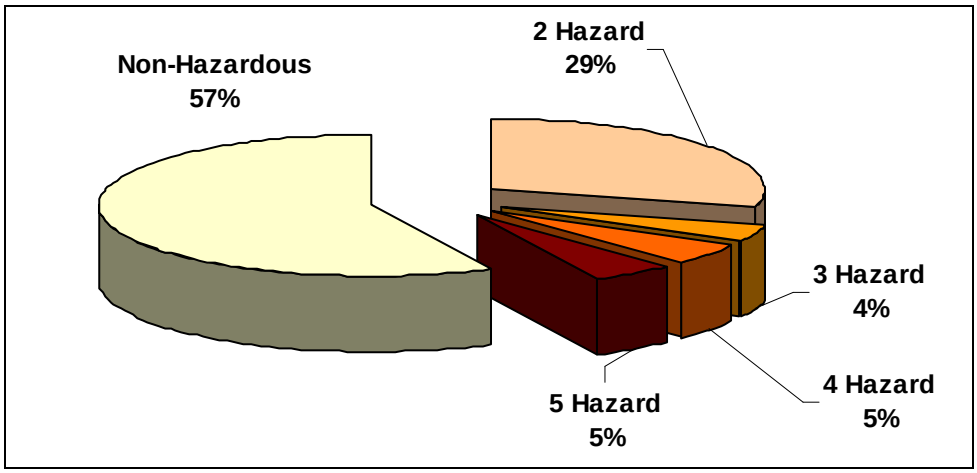


Figure 4.9 Size of Multi-Hazard Zones

Each hazard zone named by numbering in accordance with hazard combination number, are also separated into parts by lettering in accordance with hazard combination types. As a result of this separation, 27 types of hazard combination are emerged in Multi-Hazard Map (Table 4.4). According to Multi-Hazard Map, natural hazard zones which contain different hazard combinations are densely located in coastal regions of Haliç and the Marmara Sea (Figure 4.10).

Table 4.4 Multi-Hazard Zones according to Hazard Combination Types (Source: City Planning Master Studio, the Project of the Mitigation Studies in Fatih, 2007)

Multi-Hazard Zones		**Hazard Combinations**		Area (Ha.)	No. of buildings
5-HAZARD	1	**5A**	Artificial landfill+High PGA+Liquefaction+ Tsunami+ Drainage basin	44,67	160
	2	**5B**	Kusdili formation+Liquefaction+High PGA+Tsunami+ Drainage basin	4,08	13
	3	**5C**	Kusdili formation+Fault line+High PGA+Alluvial ground+Drainage basin	1,92	0
	4	**5D**	Kusdili formation+Fault line+High PGA+ Tsunami+ Drainage basin	1,53	2
4-HAZARD	5	**4A**	Kusdili formation+High PGA+Liquefaction+ Drainage basin	0,36	0
	6	**4B**	Kusdili formation+High PGA+ Alluvial ground+ Drainage basin	4,88	6
	7	**4C**	Artificial landfill+High PGA+ Tsunami+Drainage basin	34,98	85
	8	**4D**	Kusdili formation+Fault line+ Liquefaction+Drainage basin	4,58	96
	9	**4E**	Kusdili formation+Landslide+High PGA+Drainage basin	0,43	20
	10	**4F**	Kusdili formation+ Liquefaction+Alluvial ground+ Drainage basin	3,20	43
	11	**4G**	Kusdili formation+Fault line+Landslide+Drainage basin	0,25	0
	12	**4H**	Kusdili formation+Fault line+High PGA+ Drainage basin	0,31	2
	13	**4I**	Kusdili formation+Fault line+ Alluvial ground+ Drainage basin	3,45	63
3-HAZARD	14	**3A**	Gungoren formation+Landslide+ Drainage basin	1,53	68
	15	**3B**	Kusdili formation+Tsunami+ Drainage basin	14,27	110
	16	**3C**	Kusdili formation+Landslide+ Drainage basin	2,63	107
	17	**3D**	Gungoren formation+Artificial landfill+High PGA	1,36	7
	18	**3E**	High PGA+Tsunami+Drainage basin	2,50	57
	19	**3F**	Kusdili formation+Alluvial ground+Drainage basin	7,32	3
	20	**3G**	Kusdili formation+Liquefaction+Drainage basin	2,18	50
	21	**3H**	Kusdili formation+Fault line+Drainage basin	6,69	212
	22	**3I**	Kusdili formation+High PGA+ Drainage basin	1,42	42
2-HAZARD	23	**2A**	Kusdili formation+Drainage basin	5,54	394
	24	**2B**	Bakirkoy formation+ High PGA	275,32	7210
	25	**2C**	Gungoren formation+Landslide	0,38	13
	26	**2D**	Fault line+High PGA	12,37	391
	27	**2E**	Landslide+Drainage basin	12,57	500

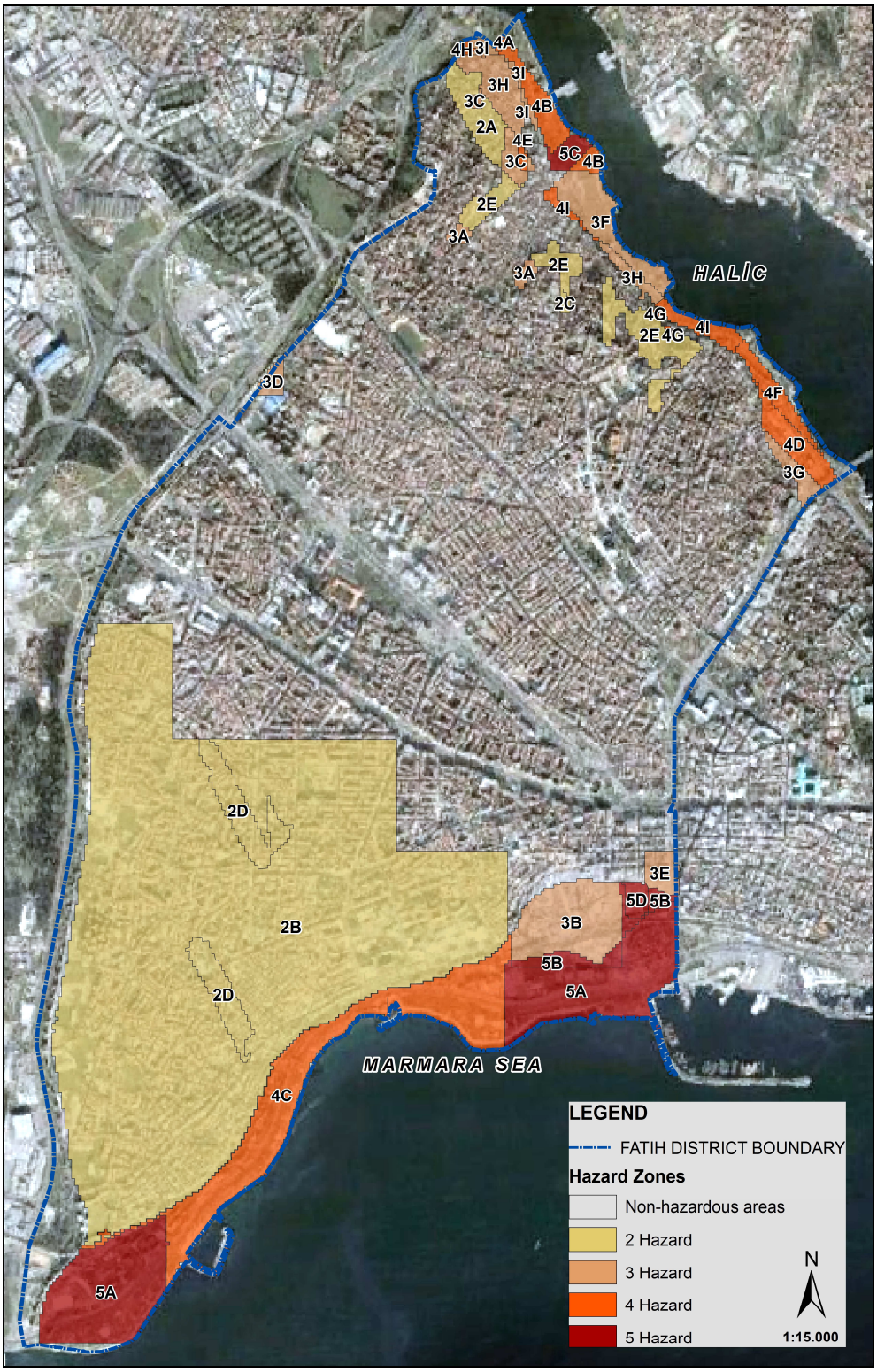


Figure 4.10 Multi-Hazard Map of the Fatih District

(Source: City Planning Master Studio, Project of the Mitigation Studies in Fatih, 2007)

4.3.2. Urban Risk Analysis in the Existing Building Stock according to the Mitigation Planning Approach

The building stock analysed within the scope of this study consists generally of residential buildings. Besides residential buildings, commercial buildings and simple industrial buildings except factories are included in the analysis. The total number of buildings surveyed amount to 26.162.

Historical and cultural buildings and public buildings in the district are excluded in the building analyses. These need to be investigated within separate studies.

Historical and cultural buildings need for instance special analyses in terms of historical and architectural significance, design, structure and material of the building. As hospitals, schools, fire stations, police quarters, communication centers, major commercial centers, banks, and other public buildings provide emergency services after a disaster; they require special attention in mitigation studies. Public buildings need not only be considered within comprehensive risk analyses, but also technical investigations are necessary about their capacity, sufficiency, spatial distribution etc (The Report of Earthquake Master Plan of Istanbul, 2003).

4.3.2.1. The Indicators of Risk in the Existing Building Stock

Changes in **"**Specifications for Structures to be built in the Disaster Areas", structural properties of buildings and usage types of buildings are considered as indicators of risk for determining risks in the building stock.

SEISMIC BUILDING DESIGN AND CONSTRUCTION EVOLUTION IN TURKEY

Due to disasters experienced in the past, Building Regulations have been frequently revised, particularly following the earthquakes, which changed, renewed to establish certain standards for safer buildings. Specifications for Structures to be built in the

Disaster Areas administered by the Ministry of Public Works and Settlements have been changed many times (Table 4.5).

The first seismic design code for buildings was published in 1940, one year after the destructive Erzincan earthquake. Following that earthquake, the Turkish Ministry of Public Works and Settlement formed a committee to prepare a seismic zone map. The formation of this committee was the first step toward developing regulations for the seismic design of buildings in Turkey (PEER, 2000).

Table 4.5 Key Events in the Evolution of Seismic Design Codes in Turkey
(Source: PEER, 2000)

Year	*Event*	*Code development*
1939	Erzincan earthquake (M7.9)	
1940	Committee formed to develop a seismic zonation map for Turkey	First seismic code published
1942		Earthquake zone map prepared; map promulgated in 1945
1943	Tosya earthquake (M7.2)	
1944	Gerede earthquake (M7.2)	Seismic code revised
1947		Seismic code revised
1949		Seismic code revised
1953		Seismic code revised
1958	Ministry of Reconstruction and Resettlement established	
1961		Seismic code revised
1963		Earthquake zone map revised
1966	Varto earthquake (M7.1)	
1967	Adapazari earthquake (M7.1)	
1968		Seismic code revised
1975		Seismic code revised; ductile detailing introduced
1992	Erzincan earthquake (M6.9)	
1997		Seismic code revised; ductile detailing required
1999	Izmit earthquake (M7.4) Düzce earthquake (M7.2)	

“An earthquake zonation map for Turkey was prepared in 1942 and promulgated in 1945. Three seismic zones were identified in the map: first degree (hazardous); second degree (less hazardous); and no hazard. No earthquake analysis was required for the no-hazard zone. The interzonal boundaries followed administrative boundaries. According to Duyguluer, the zonation of a province or region was based on the observed or projected intensity of earthquake shaking” (PEER, 2000:11).

The 1947 code utilized the 1942 maps. The values assigned to ‘lateral force coefficient’ were established on the basis of seismic zones. In 1949, the zonation map was drawn and appended to the revised code. The coefficients were changed in accordance with the soil formation at the construction site and the constructional characteristics of the building. The 1953 code introduced load combinations for earthquake effects (PEER, 2000).

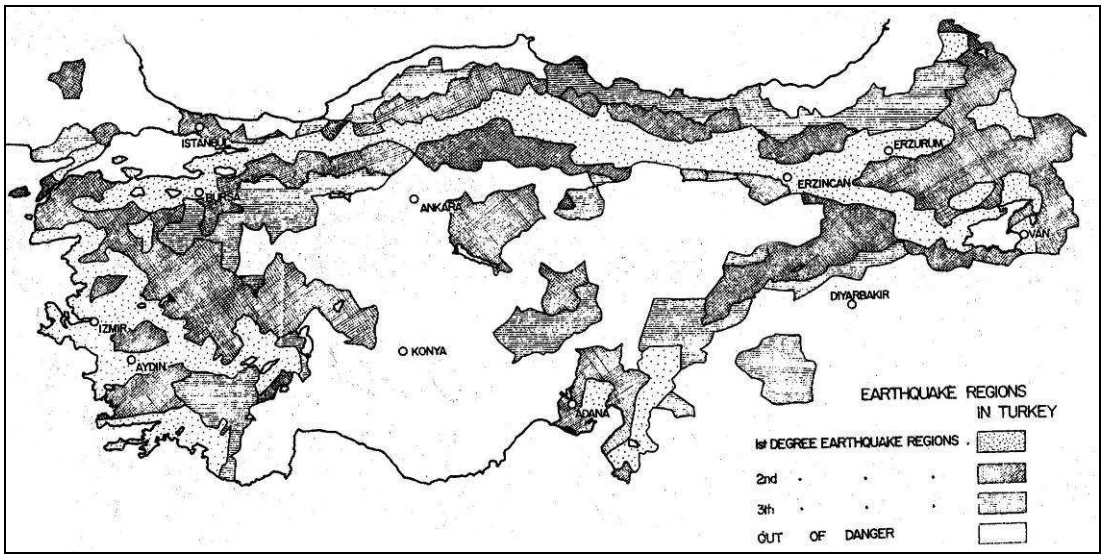


Figure 4.11 1963 Earthquake Zoning Map (Source: IAEE 1966)

In the 1961 revision of the seismic code, the procedure for calculating the lateral force coefficient was changed (PEER, 2000). “In 1963 the earthquake zonation map was substantially revised and the number of zones was increased to four: Zone 1 (first degree), Zone 2 (second degree), Zone 3 (third degree), and Zone 4 (no hazard). The four zones were defined on the basis of the maximum expected shaking. In 1963 earthquake zonation map for Turkey, the interzonal boundaries continued to follow the administrative boundaries” (PEER, 2000: 13).

“The 1968 seismic code was substantially different from earlier codes. The 1968 code changed the procedures for calculating earthquake demands (safety requirements) on building components, introduced geometry and detailing requirements for reinforced concrete components, and introduced contemporary concepts relating to spectral shape and dynamic response. The addendum to the 1968 code also included requirements for the use of shears walls” (PEER, 2000: 13).

“In 1972, the earthquake zonation map was updated based on new information on geologic structure, plate tectonics, historical seismicity, and earthquake occurrence. Key changes to the zonation map included an increase in the number of zones from 4 to 5. The seismic code was revised in 1975. Important additions to the seismic code included new methods for calculating earthquake loads on buildings and ductile detailing requirements for reinforced concrete. Geometry and detailing requirements for reinforced concrete components were modified in the 1975 code. The 1975 code provided much information on minimum details for columns” (PEER, 2000:15).

“The earthquake zonation map was updated and the seismic code revised in 1997. In addition to the equivalent static load method, the mode superposition method and linear and nonlinear dynamic analyses were introduced for the seismic design of buildings. Reinforced concrete buildings are classified as systems of either high or nominal ductility based on the detailing of the components. Detailing requirements are more stringent for systems with high ductility” (PEER, 2000:17).

The 1996 Earthquake Zoning Map in use today indicates 5 types of zones in Turkey. “The Earthquake Zoning Map Of Turkey was prepared by the Ministry of Public

Works and Settlement considering the latest knowledge and approved by the Government of Turkey and published in 1996. The earthquake zones determined by using the acceleration contour map which has calculated with the probabilistic method. Specifications for Structures to be Built in the Disaster Areas refers to this map for the calculation of acceleration values that will effect the construction" (http://www.deprem.gov.tr/depbolge/haritaciklama.htm).

Earthquake zones of Turkey classified as fallow due to expected acceleration values; g: gravity (981 cm/s²)

"1st degree earthquake zone: more than 0.4g

2nd degree earthquake zone: between 0.3g - 0.4g

3rd degree earthquake zone: between 0.2g - 0.3g

4th degree earthquake zone: between 0.2g - 0.1g

5th degree earthquake zone: less than 0.1g"

(http://www.deprem.gov.tr/depbolge/haritaciklama.htm)

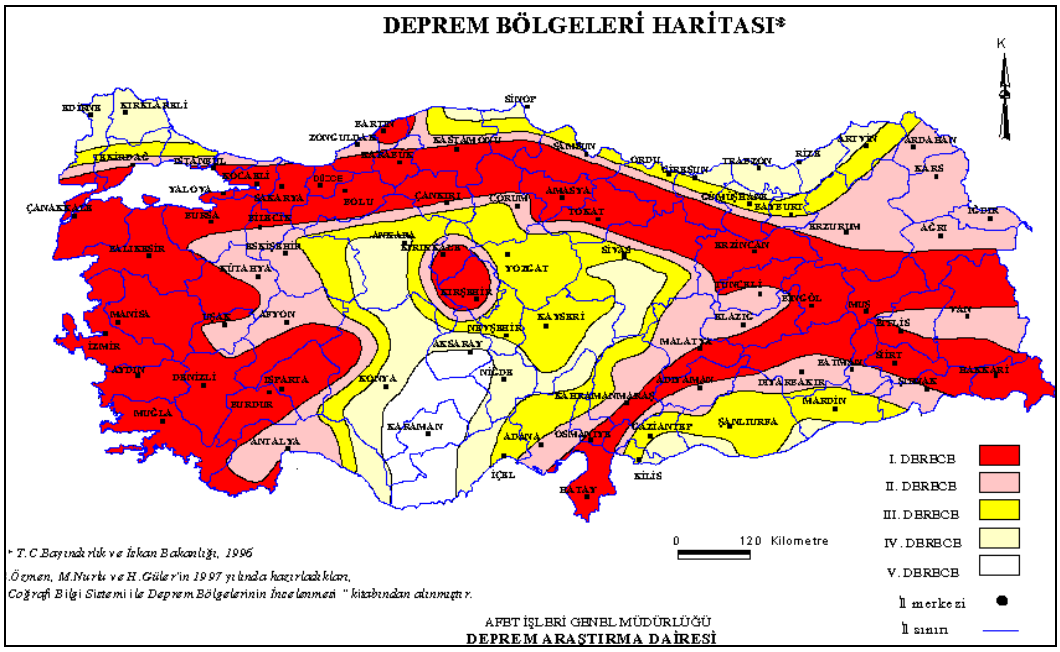


Figure 4.12 The Earthquake Zoning Map Of Turkey 1996 (Source: GDDA official web site http://www.deprem.gov.tr/depbolge/haritaciklama.htm)

“Provisions for special detailing of reinforced concrete moment-resisting frames for ductile response were introduced in Turkey in 1975. However, the construction of buildings with ductile details was not mandated. Rather, buildings could be constructed without special details for ductile response (frames of nominal ductility) or ductile details (frames of high ductility). Because it was cheaper to construct stronger buildings without special details for ductile response (non-ductile detailing) than weaker buildings with ductile detailing, non-ductile moment-resisting frame construction was most prevalent in Turkey up to the time of the Izmit earthquake.” (PEER, 2000:19)

One of the basic facts reaffirmed in the 1999 Marmara earthquakes in Turkey, was the deficiency of the building stock in meeting the earthquake design codes even at project stage, let alone those due to production faults and delinquencies (Balamir, 2001).

Consequently, the substantial changes in the practice of seismic design and construction in Turkey have generally followed major earthquakes. The 1996 Earthquake Zoning Map in use today indicates 5 types of zones in Turkey and “Specifications for Structures to be built in the Disaster Areas” has become more comprehensive with the revision in 1997. In the period after the Marmara earthquakes, the most recent changes has been made in “Specifications for Structures to be Built in the Disaster Areas” in 2007.

In urban risk analysis in building stock according to mitigation planning approach, the building stock of Fatih examined according to 5 periods that draws attention about revisions in Specifications for Structures to be built in the Disaster Areas. These periods are; *before 1940, 1940-1948, 1949-1952, 1953-1960, 1961-1967, 1968-1974, 1975-1996, 1997-2006 and after 2006.*

STRUCTURAL PROPERTIES AND USAGE OF BUILDINGS

Within the scope of building stock analysis, structural properties of buildings and usage are more available and essential indicators to help identify risks in the building

stock. Structural properties of existing buildings in Fatih district examined in terms of construction type, number of stories and age of the buildings. Usage of buildings is also examined.

These indicators of risk are used for definition of relative vulnerabilities in building stock. According to relative vulnerability analysis results, more vulnerable sub-groups are defined. Vulnerable buildings also assessed regarding their spatial location, distribution in multi-hazard zones and distribution in Protection Areas of Historical Peninsula Conservation Plan.

Construction Types: In terms of construction types, existing building stock in Fatih consists of reinforced, masonry, mixed and timber structure buildings. Reinforced concrete is the most common construction type in Fatih with a percentage of 63. Masonry buildings with a percentage of 31 are intensively located in Yalı Neighborhood, Fener-Balat and Yedikule-Samatya regions. Mixed buildings have a percentage of 5 and timber structure buildings have a percentage of 1. Timber structure buildings are clustered Zeyrek and Fener-Balat regions (Figure 4.14).

Table 4.6 Distribution of Construction Types (Source: BİMTAŞ Database, 2007)

Construction Types	Number of Buildings	%
Timber structure	184	1
Mixed	1355	5
Masonry	8102	31
Reinforced concrete	16521	63
Total	**26162**	**100**

Figure 4.13 Samples of Buildings in the Fatih District

Number of Stories: In the Fatih District, number of storey is between 1 and 7. Within the scope of building stock analysis number of stories classified as 1, 2, 3, 4, 5, 6 and 7 storey. 5 and 6 storey buildings have a majority in the district with a percentage of 47. Low-rise buildings (1, 2 and 3 storey) have a percentage of 32 and these buildings are mostly located in Fener-Balat, Zeyrek-Cibali regions and next to the city walls. High-rise buildings are generally located around main arteries of the district. Especially on Vatan and Millet streets, 6-7 storey buildings are located (Figure 4.15).

Table 4.7 Distribution of Number of Stories (Source: BİMTAŞ Database, 2007)

Number of stories	Number of buildings	%
1-storey	2713	10
2-storey	2749	11
3-storey	2896	11
4-storey	4254	16
5-storey	7172	28
6-storey	5084	19
7-storey	1294	5
Total	**26162**	**100**

Age of Buildings: Within the scope of building stock analysis, distribution of number of buildings regarding their ages have been considered, and age ranges have been determined according to 5 periods that draws attention about revisions in Specifications for Structures to be built in the Disaster Areas.

Table 4.8 Age of the Buildings according to Revisions in Specifications for Structures to be built in the Disaster Areas (Source: BİMTAŞ Database, 2007)

Age of buildings / Construction date		Number of buildings	%
Older than 67	(Years before 1940)	1353	5
59-67	(Years 1940 through 1948)	1679	6
55-58	(Years 1949 through 1952)	1054	4
47-54	(Years 1953 through 1960)	2190	8
40-46	(Years 1961 through 1967)	4839	19
33-39	(Years **1968** through 1974)	4488	17
11-32	(Years 1975 through 1996)	8230	32
1-10	(Years 1997 through 2006)	957	4
0	(Years after 2006)	1372	5
Total		**26162**	**100**

Depending on the table, in the building stock analysis the buildings 40 year-old and older than 40 years considered more vulnerable due to constructed before the "Specifications for Structures to be built in the Disaster Areas" revised in 1968. The revision made in 1968 is substantially different from previous revisions as it considers earthquake safety requirements on building components. In the Fatih District, buildings built in 1975 between 1996 have a majority with a percentage of 31 (Figure 4.16).

Usage of Buildings: Within the scope of building stock analysis, usages are examined on building bases and usage types classified as residential, commercial, corporate usage of residential and commercial and industrial (Figure 4.17).

65% of total buildings of the district are residential buildings. 27% of the total buildings are residential+commercial buildings and they are located in Yalı, Çakırağa, Kırkçeşme, Hüsambey, Sofular neighbourhoods and in the centre of some neighbourhoods. 8% of the total buildings consist of commercial buildings and they are clustered in Aksaray, İnebey, Çakırağa and Yalı neighbourhoods. Commercial buildings are densely loceted on the Vatan, Millet, Fevzi Paşa streets and they continue until city walls. Commercial buildings are also located on Coast Road. Industrial buildings are very small number in the total, and include simple industrial facilities such as atelier, storage, etc. Industrial buildings are not intensively located in a single region rather they are gathered in small clusters in different areas.

Table 4.9 Distribution of Usage of Buildings (Source: BİMTAŞ Database, 2007)

Usage	Number of buildings	%
Residential	16835	65
Residential + Commercial	7189	27
Commercial	2059	8
Industrial	79	0
Total	**26162**	**100**

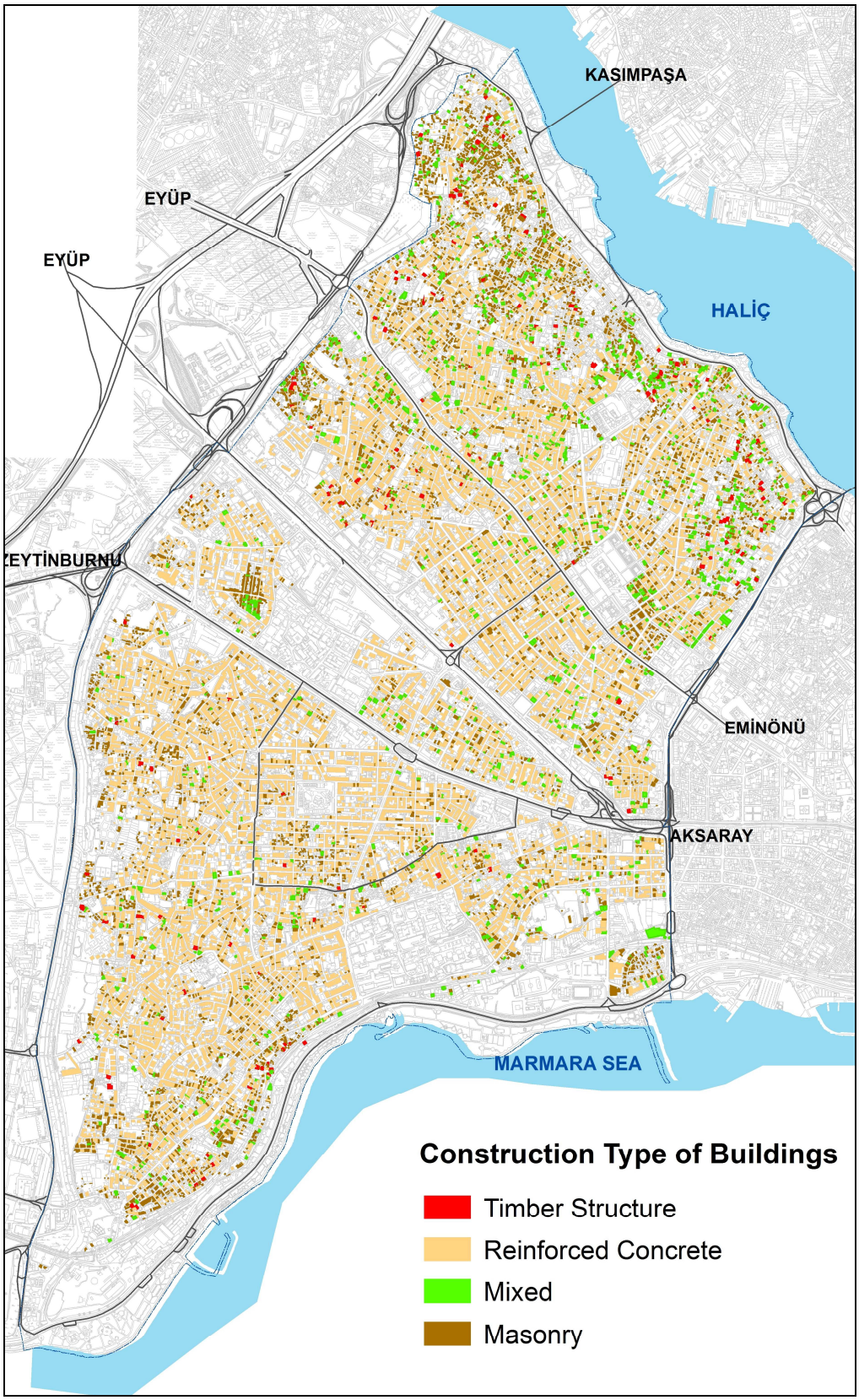


Figure 4.14 Construction Types of Buildings in Fatih

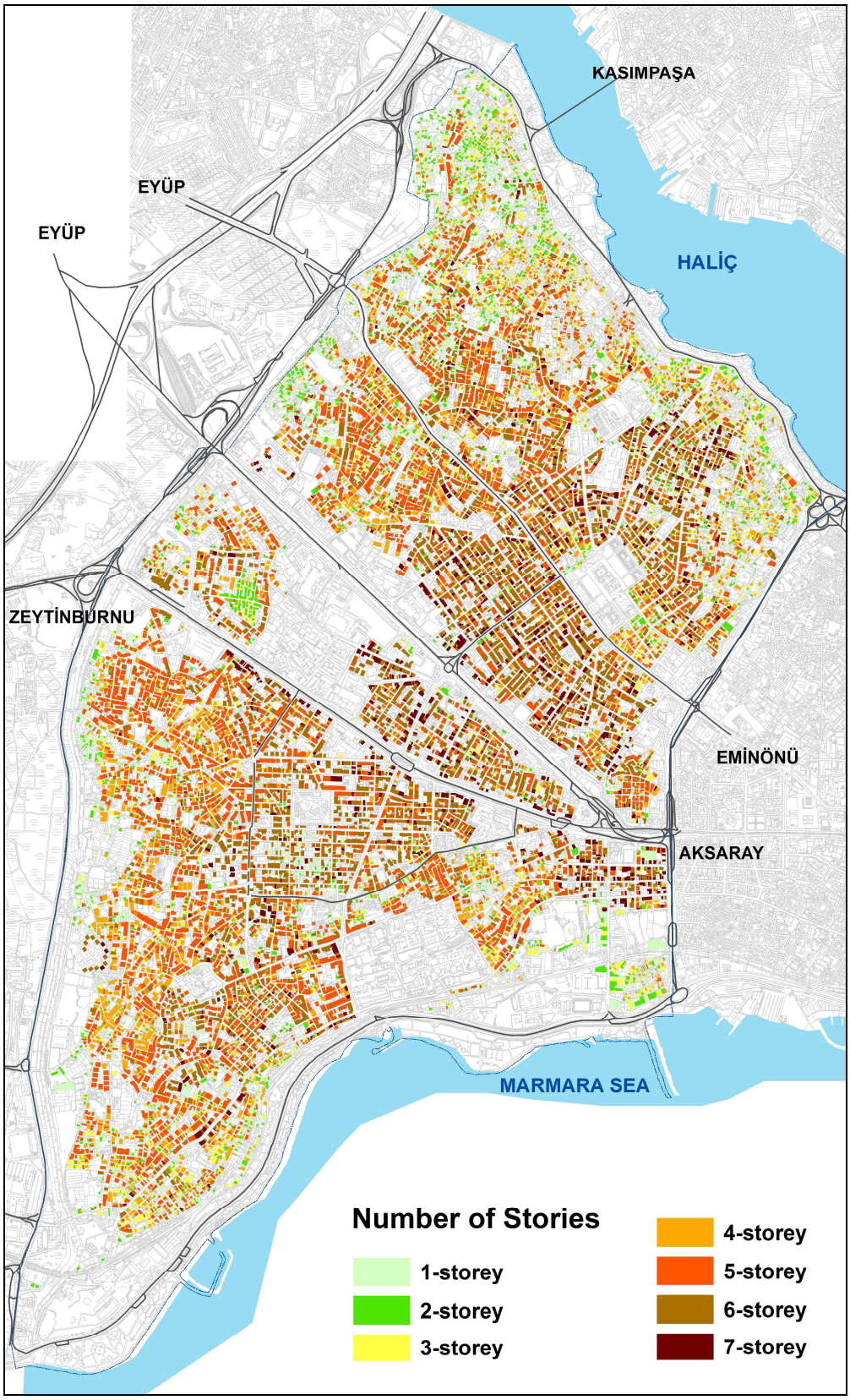


Figure 4.15 Number of Stories in Fatih

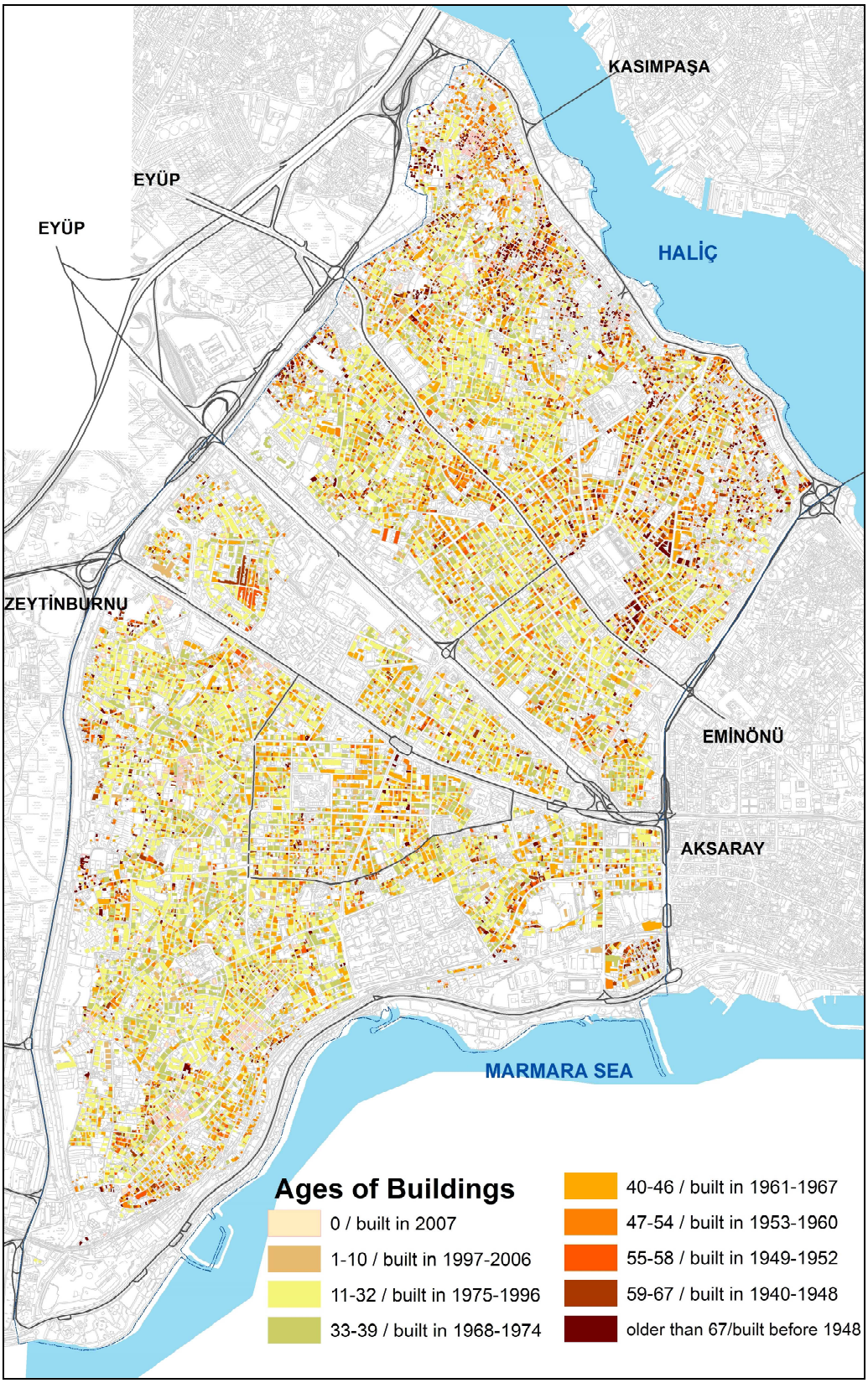


Figure 4.16 Age of Buildings in Fatih according to Building Code Revisions

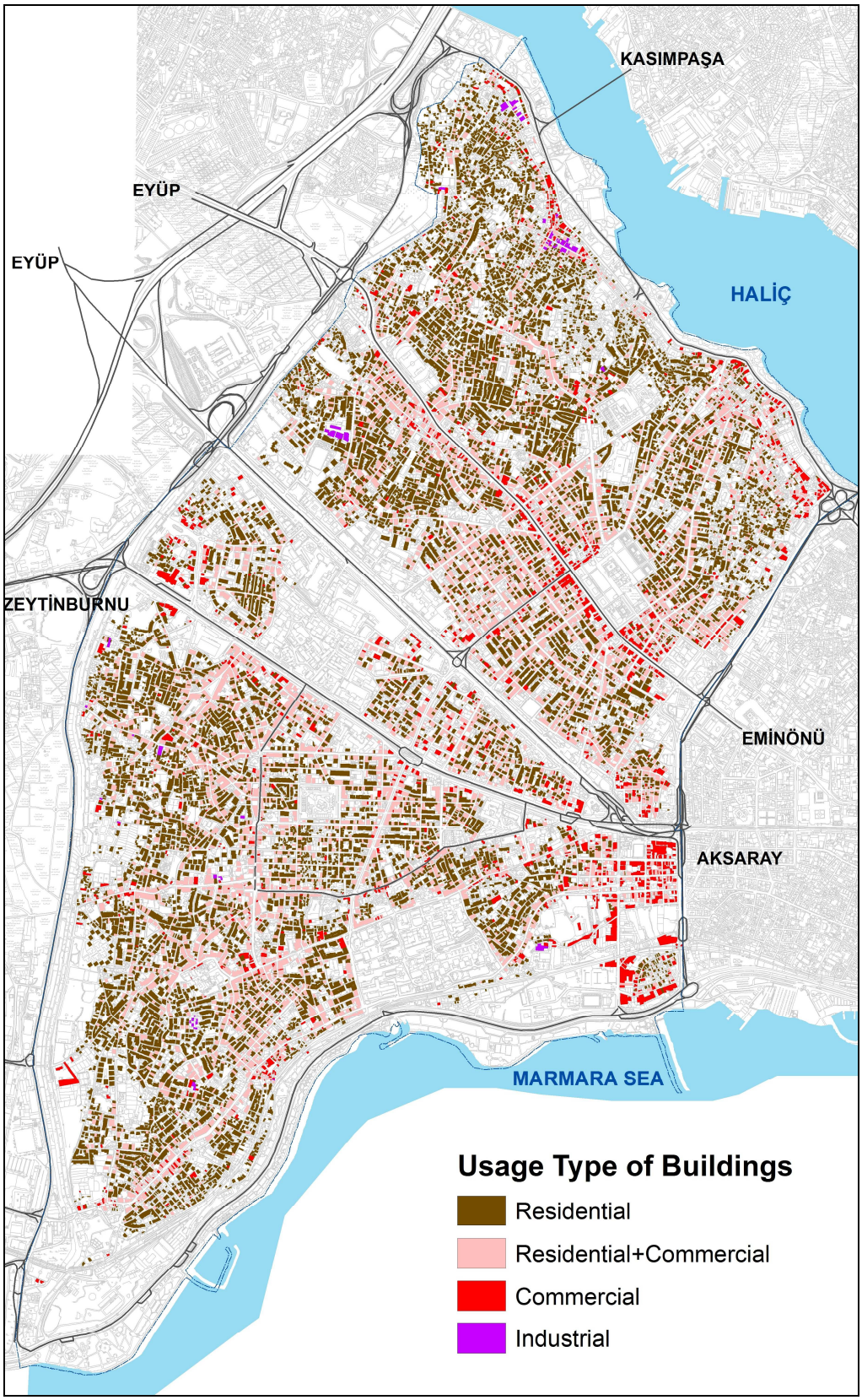


Figure 4.17 Usage Types of Buildings in Fatih

4.3.2.2. Relative Vulnerability Analysis in the Building Stock

Cross-tabulations of construction types, number of storey, usage and age data of buildings are also analysed to see and interpret the relations between them and to determine more vulnerable sub-groups. Cross-tables are related with the groups-of-two presented below.

- Construction Type and Usage
- Construction Type and Number of Stories
- Construction Type and Building Age
- Usage and Number of Stories
- Usage and Building Age
- Building Age and Number of Stories

The aim of the Relative Vulnerability Analysis is determination of more vulnerable subsections of the building stock in Fatih. In accordance with Relative Vulnerability Analysis results, more vulnerable sub-groups are;

- Timber structure buildings that have more than 2 stories, masonry and mixed buildings that have more than 3 stories and reinforced concrete buildings that have more than 4 stories could be more vulnerable regarding construction type and number of stories.

- Multi-storey and old buildings could be more vulnerable regarding number of storey and building age. Also, their location in multi-hazard zones increases the vulnerability of these buildings.

- Buildings older than 40 years, in other words constructed before Specifications for Structures to be built in the Disaster Areas revised in 1968 could be more vulnerable regarding age of building and number of stories.

- Buildings attached to the adjacent building in the street corner could be more vulnerable regarding building pattern.

- Industrial buildings and commercial buildings including manufacturing and storage function could be more vulnerable regarding usage of building.

- Also, their location in multi-hazard zones increases the vulnerability of these buildings.

More vulnerable sub-groups are assessed in detail in "Analysis of Relatively More Vulnerable Sub Groups" according to their spatial location, distribution in multi-hazard zones and distribution in Protection Areas of Historical Peninsula Conservation Plan.

CONSTRUCTION TYPE AND USAGE

When we look at the relation between construction type and usage of buildings in Fatih, it is observed that reinforced concrete buildings have the majority in terms of all usage types of the buildings. Reinforced concrete buildings consist 56% of total residential buildings, 83% of total residential+commercial buildings, 51% of total commercial buildings and 49% of total industrial buildings.

Table 4.10 Relation of Construction Type and Usage

Construction type/ Usage	Residential	Residential+ Commercial	Commercial	Industrial	Total
Timber structure	156	7	20	1	184
Mixed	884	265	202	4	1355
Masonry	6358	918	791	35	8102
Reinforced concrete	9437	5999	1046	39	16521
Total	16835	7189	2059	79	26162

Secondly it draws attention in the table; ***timber structure buildings have commercial and industrial function.*** The timber structure buildings, particularly timber structure buildings which have commercial and industrial function, are more vulnerable in terms of risk of fire after the earthquake. Due to their possible damage against themselves and their environment***, these timber structure buildings should be examined in detail in accordance with their spatial distribution and usage of other buildings in their environment.***

All industrial buildings in Fatih should also be examined in detail in accordance with their spatial distribution and usage of other buildings in their environment.

CONSTRUCTION TYPE AND NUMBER OF STORIES

When we look at the relation between construction type and number of storey in Fatih, it is observed that reinforced buildings, the most common construction type in Fatih, mostly consist of 5 and 6- storey buildings. 39% of reinforced concrete buildings have 5 stories and 31% of those have 6 stories.

Table 4.11 Relation of Construction Type and Number of Stories

Construction type/ Number of Stories	**1 storey**	**2 storey**	**3 storey**	**4 storey**	**5 storey**	**6 storey**	**7 storey**	**Total**
Timber structure	43	94	41	5	1	-	-	184
Mixed	182	301	338	305	229	-	-	1355
Masonry	2264	2033	1854	1371	580	-	-	8102
Reinforced Concrete	224	321	663	2573	6362	5084	1294	16521
Total	2713	2749	2896	4254	7172	5084	1294	26162

In the table, it is remarkable that there are ***3, 4 and 5-storey timber structure buildings*** in the district. These buildings could be considered more vulnerable, therefore they should be examined in detail.

According to the Building Regulation administered in 2007, maximum number of storey must be 2-storey in 1st Degree Earthquake Zones and must be 3-storey in 2nd Degree Earthquake Zones for masonry buildings (Specifications for Structures to be Built in the Earthquake Areas, 2007). However, in building regulations administrated before 1975, 4-storey masonry buildings are allowed to be constructed in 2nd Degree Earthquake Zones. Number of stories was limited (maximum 2 stories for 1st Degree Earthquake Zones, and 3 stories for 2nd Degree Earthquake Zones) by the 1975 revision of Specifications for Structures to be built in the Disaster Areas. In this context, ***4 and 5-storey masonry buildings*** can be considered more vulnerable.

CONSTRUCTION TYPE AND BUILDING AGE

When we look at the relation between construction type and age of buildings in Fatih, it is observed that 68% of timber structure buildings, 71% of mixed buildings and 75% of masonry buildings are older than 40 years. As distinct from other buildings, age of reinforce concrete buildings is generally younger than 40 years with a percentage of 76.

Table 4.12 Relation of Construction Type and Building Age

Construction type/ Building Age	**0**	**1-10**	**11-32**	**33-39**	**40-46**	**47-54**	**55-58**	**59-67**	**67+**	**Total**
Timber structure	35	9	12	3	15	13	9	24	64	184
Mixed	90	12	182	103	341	188	119	166	154	1355
Masonry	686	67	763	496	1505	1446	725	1343	1071	8102
Reinforced Concrete	561	869	7273	3886	2978	543	201	146	64	16521
Total	1372	957	8230	4488	4839	2190	1054	1679	1353	26162

All buildings which are 40 year-old and older than 40 years are vulnerable because of their economical life and the absence of modern seismic design codes. These buildings were constructed before 1968 when the "Specifications for Structures to be built in the Disaster Areas" revised comprehensively. These buildings were designed and constructed in accordance with past codes and standards, most of them are considered inadequate today. Also it is necessary to examine their spatial distribution regarding to multi-hazard zones.

USAGE AND NUMBER OF STORIES

"Field observations after the 1999 Kocaeli and Düzce earthquakes revealed that there is a very significant correlation between the number of stories and the severity of building damage. After the two earthquakes in 1999, damage distribution for all 9685 buildings in Düzce is obtained with respect to the number of stories. As the number of stories increase, the ratio of undamaged and lightly damaged buildings decrease steadily whereas the ratio of moderately and severely damaged buildings increase in an opposite trend. This is a clear indication that the number of stories is a very significant, perhaps the most dominant parameter in determining the seismic vulnerability of typical multi-storey concrete buildings in Turkey" (The Report of Earthquake Master Plan of Istanbul, 2003:111).

Accordingly, damage increases almost linearly with the number of stories and multi-storey buildings are very vulnerable to the earthquake. In Fatih, multi-storey buildings generally have residential and residential+commercial usage. As can be seen from the table, 96% of 5, 6, 7-storey buildings are residential and residential+commercial buildings. 48% of residential buildings and 69% of residential+commercial buildings consist of 5, 6 and 7-storey buildings. Consequently it is possible to say that in case of an earthquake, casualties increase because of multi-storey buildings containing residential function. ***This situation draws attention to high vulnerability of multi-storey buildings having residential usage***.

Table 4.13 Relation of Usage and Number of Stories

Usage/ Number of stories	1 storey	2 storey	3 storey	4 storey	5 storey	6 storey	7 storey	Total
Residential	1974	2056	2101	2687	4459	3033	525	16835
Residential + Commercial	23	245	556	1374	2522	1838	631	7189
Commercial	684	422	230	184	190	211	138	2059
Industrial	32	26	9	9	1	2	-	79
Total	2713	2749	2896	4254	7172	5084	1294	26162

Multi-storey buildings also have commercial and industrial function although the number of multi-storey buildings having commercial or industrial function are not remarkable as number of multi-storey buildings having residential function. ***As a result, it is thought that all multi-storey buildings in Fatih are more vulnerable.***

USAGE AND BUILDING AGE

When we look at the relation between usage and age of buildings in Fatih, it is observed that 92% of the buildings older than 40 years are consist of residential and residential+commercial buildings.

Table 4.14 Relation of Usage and Building Age

Usage/ Building Age	0	1-10	11-32	33-39	40-46	47-54	55-58	59-67	67+	Total
Residential	941	504	4818	2796	3162	1592	738	1280	1004	16835
Residential + Commercial	278	283	2744	1451	1359	410	223	253	188	7189
Commercial	149	170	654	232	304	171	86	138	155	2059
Industrial	4	0	14	9	14	17	7	8	6	79
Total	1372	957	8230	4488	4839	2190	1054	1679	1353	26162

As the buildings older than 40 years were constructed in accordance with inadequate and past codes, they are defined more vulnerable. Moreover, the majority of these old buildings have residential function. In this case, ***the vulnerability of buildings older than 40 years gains more importance in respect to their residential usage***.

BUILDING AGE AND NUMBER OF STORIES

When we look at the relation between building age and number of stories in Fatih, it is observed that the buildings between 11 and 32 year-old (constructed in 1975-1996) constitute the majority in the district with a percentage of 31 and %62 of these buildings consist of 5 and 6-storey buildings.

Table 4.15 Relation of Building Age and Number of Stories

Building age / Number of stories	1 storey	2 storey	3 storey	4 storey	5 storey	6 storey	7 storey	Total
0	211	279	222	200	260	167	33	1372
1-10 years	98	47	59	106	236	271	140	957
11-32 years	578	312	373	1278	2980	2147	562	8230
33-39 years	217	169	246	681	1581	1312	282	4488
40-46 years	450	473	590	804	1346	960	216	4839
47-54 years	404	429	423	401	374	123	36	2190
55-58 years	163	235	245	212	136	48	15	1054
59-67 years	330	416	397	328	163	38	7	1679
67+	262	389	341	244	96	18	3	1353
Total	2713	2749	2896	4254	7172	5084	1294	26162

After making this determination concerning the current situation, ***it is necessary to point out the buildings 5, 6, 7-storey and older than 40 years. These buildings are vulnerable to the earthquake in terms of age as well as number of storey.***

4.3.2.3. Analysis of Relatively More Vulnerable Sub-groups

The main objective of these analyses is identifying the buildings that are **highly vulnerable** and identifying the **high risk areas** of the Fatih District.

TIMBER STRUCTURE BUILDINGS

With regard to analyses of groups-of-two; timber structure buildings are vulnerable, especially 4 and 5-storey timber structure buildings and commercial and industrial timber structure buildings. Therefore, timber structure buildings in Fatih analysed in detail according to their spatial distribution, distribution in protection areas of Historical Peninsula Conservation Plan, distribution in multi-hazard zones, containing function and neighbouring functions etc.(Figure 4.18).

In the district, there are 184 timber structure buildings and they have a share of 1% in total building stock.

There is a project for Fener-Balat region where timber structure buildings located densely. “Rehabilitation of Fener and Balat Districts Programme is a joint programme of European Union and Fatih Municipality and its implementation started in January 2003. The Programme was completed in 2007. The Programme continues to work under four titles: restoration of dwellings, social rehabilitation, renovation of the historical centre of Balat and establishment of a waste management strategy” (http://www.fenerbalat.org/index.php?&chlang=_t, last accessed at 10.01.2010).

Within the scope of analysis of timber structure buildings, usage of buildings neighbouring timber structure buildings are also analysed and hazardous uses are determined taking place in the 50 meter radius zone of timber structure buildings. These hazardous uses are: according to the database, workshops producing drugs, dye, chemicals etc.; LPG stations and restaurants and cafes where LPG is using during production period. After an earthquake, hazardous uses are the sources of the urban risks such as fire, explosion etc.

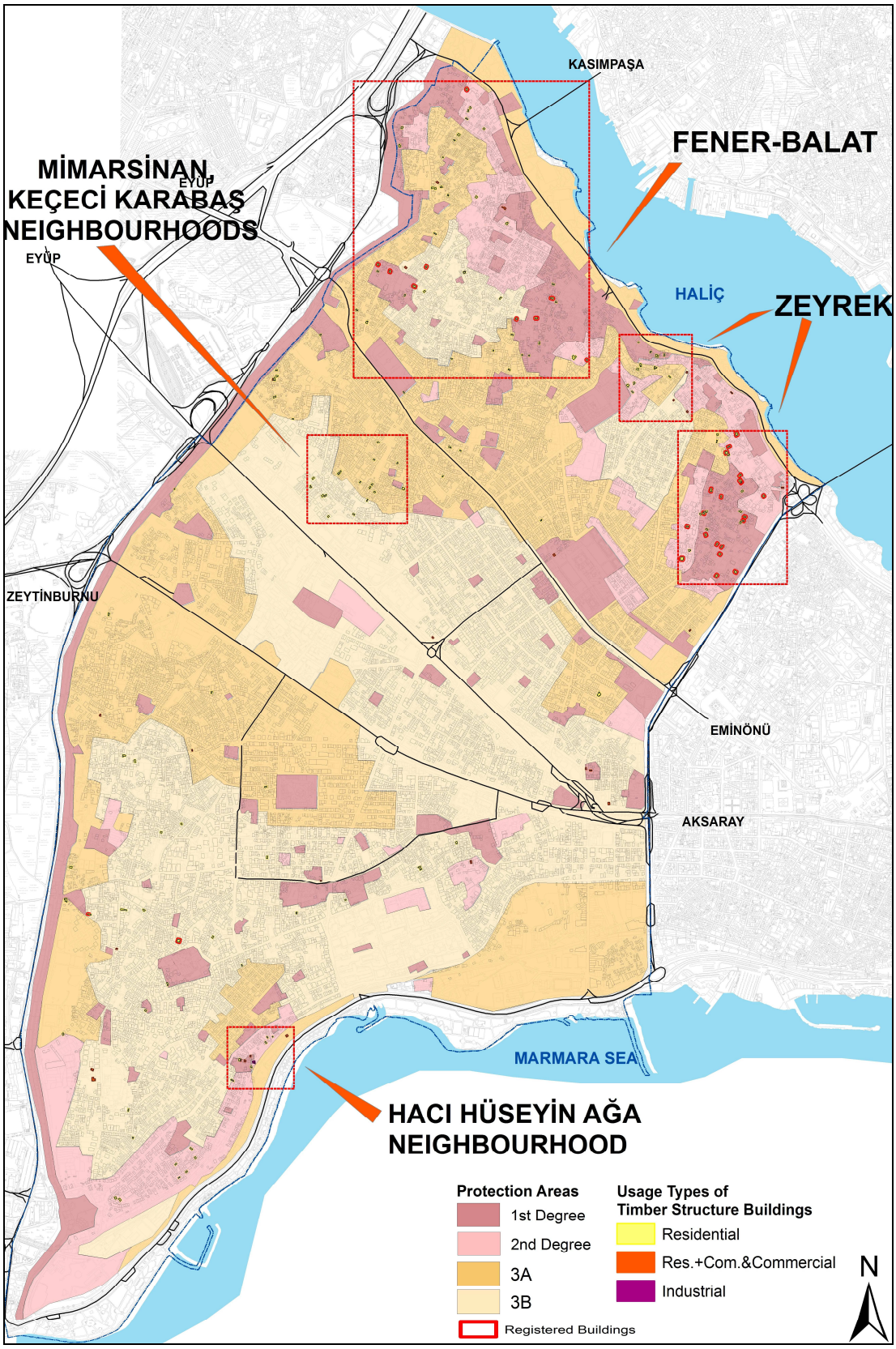


Figure 4.18 Distributions of Timber Structure Buildings in the Fatih District

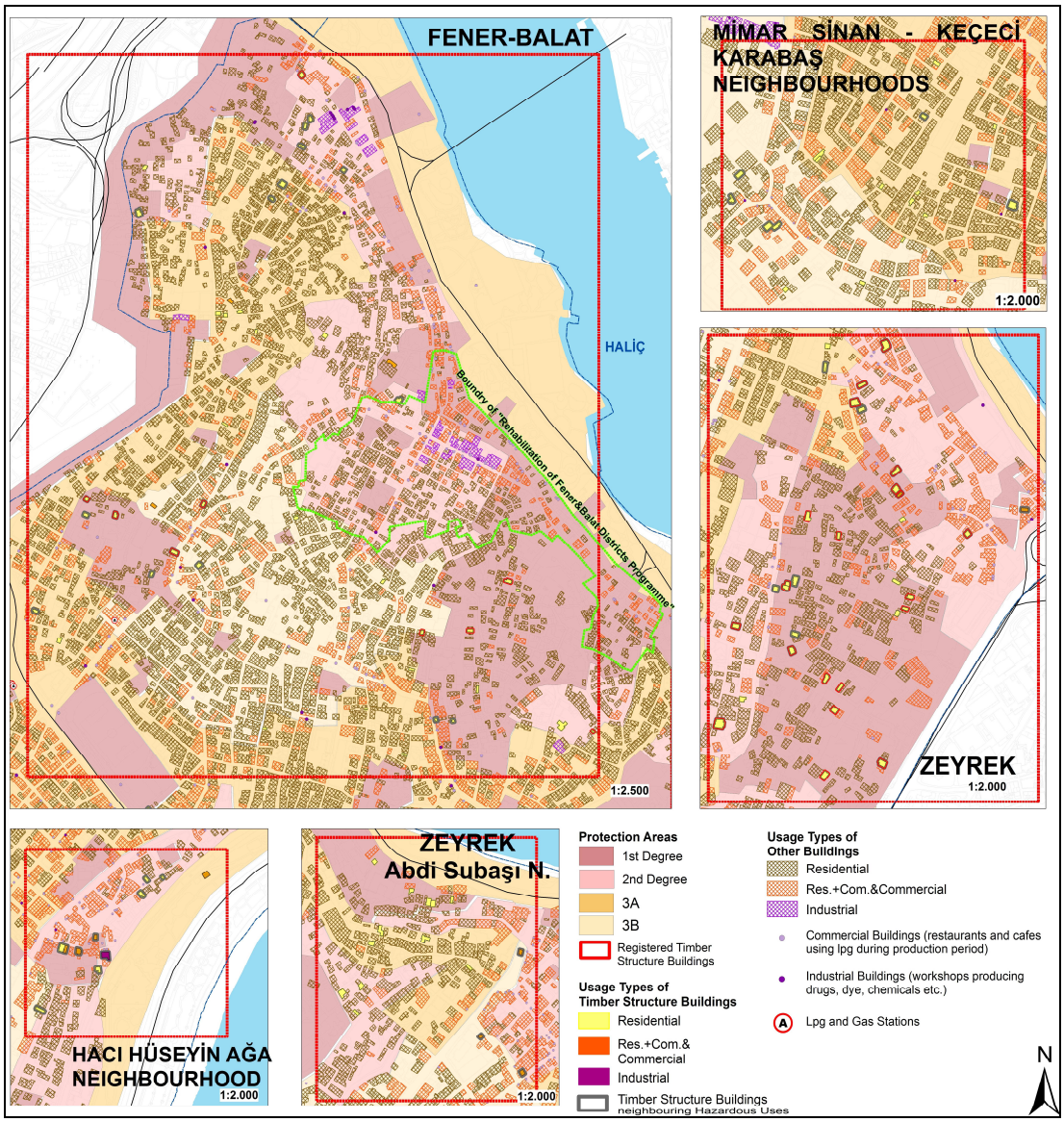


Figure 4.19 Densely Located Regions of Timber Structure Buildings

When we look at spatial distributions of timber structure buildings, it is observed that they located in Zeyrek region, Fener-Balat region, Mimar Sinan- Kececi Karabas neighbourhoods and Hacı Huseyin Aga neighbourhood intensely (Figure 4.19). It is also observed that most of the registered timber structure buildings take place in 1st and 2nd Degree Protection Areas of Historical Peninsula Conservation Plan. The distribution of timber structure buildings according to Protection Areas is presented in Table 4.16 and their attributes are presented in detail below.

Table 4.16 Properties of Timber Structure Buildings according to Protection Areas

Protection Areas	Number of timber structure buildings	Number of registered buildings	Average age	Average number of stories
1st Degree	52	18	49	2,25
2nd Degree	37	8	58	2,32
3A	54	2	46	1,85
3B	41	4	40	1,85

Timber Structure Buildings in 1st Degree Protection Areas: There are 52 timber structure buildings in 1st Degree Protection Areas. 18 of them are officially registered for protection.

In regard to age of timber structure buildings in 1st Degree Protection Areas; 40% of all timber structure buildings in Ist Degree Protection Area are younger than 45 years and 60% of those are older than 45 years. Average age is 49.

In regard to number of storey in 1st Degree Protection Areas; 65% of all timber structure buildings have 1 and 2 stories and 35% of those have 3 and 4 stories. Average number of storey is 2.

In regard to usage of timber structure buildings in 1st Degree Protection Areas; residential buildings occupies the first place with a percentage of 85. Residential+commercial buildings constitute 4% of all timber structure buildings in 1st Degree Protection Area and commercial buildings constitute 11% of this.

Following table presents distribution of age, number of storey and usage of timber structure buildings in 1st Degree Protection Area (Table 4.17).

Table 4.17 Timber Structure Buildings in 1st Degree Protection Areas

Distribution of Building Age		**Distribution of Number of Stories**	
Building age	Number of buildings	Number of stories	Number of buildings
0	9	1	10
2	1	2	24
3	1	3	13
15	1	4	5
20	1	Average number of stories	2
30	1		
35	1		
40	5	**Distribution of Usage Types**	
45	1		
50	5		
55	2	Residential	44
60	4	Res. + commercial	2
70	4	Commercial	6
80	10		
85	1	**Total timber structure buildings 52**	**Registered timber structure buildings 18**
90	4		
95	1		
Average age	49		

Timber Structure Buildings in 2nd Degree Protection Areas: There are 37 timber structure buildings in 2nd Degree Protection Areas. 8 of them are officially registered for protection.

In regard to age of timber structure buildings in 2nd Degree Protection Areas; 29% of those are younger than 45 years and 71% of those are older than 45 years. Looking at general distribution, it is observed that 80 year-old buildings have the majority and average age is 58 in 2nd Degree Protection Areas.

In regard to distribution number of storey it is observed that there is not any building that has more than 3 stories and 57% of all timber structure buildings in 2nd Degree Protection Areas has 1 and 2 stories and 43% of those has 3 and 4 stories. Average number of storey is 2.

In regard to usage of timber structure buildings in 2nd Degree Protection Areas; 85% of those are residential buildings. Residential+commercial buildings constitute 6%, commercial buildings constitute 6% and industrial buildings constitute 3% of all.

Following table presents distribution of age, number of floors and utilization types of timber structure buildings in 2nd Degree Protection Area (Table 4.18).

Table 4.18 Timber Structure Buildings in 2st Degree Protection Areas

Distribution of Building Age		**Distribution of Number of Stories**	
Building age	Number of buildings	Number of stories	Number of buildings
0	5	1	4
30	1	2	17
35	1	3	16
38	1	Average number of stories	2
40	1		
45	2		
50	3	**Distribution of Usage Types**	
55	2		
60	2		
65	2	Residential	32
70	1	Res. + commercial	2
75	3	Industry	1
80	7	Commercial	2
85	1		
90	2	**Total Timber Structure Buildings 37**	**Registered Timber Structure Buildings 8**
95	3		
Average age	58		

Timber Structure Buildings in 3A Protection Areas: There are 54 timber structure buildings in 3A Protection Areas. 2 of them are officially registered for protection.

In regard to age of timber structure buildings in 3A Protection Areas; 39% of those are younger than 45 years and 61% of those are older than 45 years. Average age of timber structure buildings in 3A Protection Areas is 46.

In regard to number of storey in 3A Protection Areas; 83% of all timber structure buildings have 1 and 2 stories and 17% of those have 3 and 5 stories. Average number of storey is 2.

In regard to usage of timber structure buildings in 3A Protection Areas; residential buildings are prominent with a percentage of 89 in all timber structure buildings in 3A Protection Area. Residential+commercial buildings constitute 4% of all timber structure buildings in 3A Protection Area and commercial buildings constitute 7% of this. Following table presents distribution of age, number of storey and usage of timber structure buildings in 3A Protection Area (Table 4.19).

Table 4.19 Timber Structure Buildings in 3A Protection Areas

Distribution of Building Age		**Distribution of Number of Stories**	
Building age	Number of buildings	Number of stories	Number of buildings
0	12	1	17
5	1	2	28
15	4	3	8
25	1	5	1
40	2	Average number of storey	2
45	1		
50	4		
55	1	**Distribution of Usage Types**	
60	5		
65	7		
70	4	Residential	48
75	4	Res. + commercial	2
80	5	Commercial	4
85	1		
90	2	**Total Timber Structure Buildings 54**	**Registered Timber Structure Buildings 2**
Average age	46		

Timber Structure Buildings in 3B Protection Areas: There are 41 timber structure buildings in 3B Protection Areas. 4 of them are officially registered for protection (Table 4.20).

Table 4.20 Timber Structure Buildings in 3B Protection Areas

Distribution of Building Age		**Distribution of Number of Stories**	
Building age	Number of buildings	Number of stories	Number of buildings
0	9	1	12
1	1	2	25
3	1	3	4
5	2	Average number of storey	2
7	1		
10	1		
15	1	**Distribution of Usage Types**	
25	1		
30	1		
40	2	Residential	32
45	1	Res. + commercial	1
50	1	Commercial	8
55	4		
60	1		
65	3		
70	2		
75	2	**Total Timber Structure Buildings 41**	**Registered Timber Structure Buildings 4**
80	2		
85	4		
90	1		
Average age	40		

In regard to age of timber structure buildings in 3B Protection Areas; 51% of all timber structure buildings in 3B Protection Areas are younger than 45 years and 49% of those are older than 45 years. Average age of timber structure buildings in 3B Protection Areas is 40.

In regard to number of storey in 3B Protection Areas; it is observed that there is not any building that has more than 3 stories and 90% of all timber structure buildings in 3B Protection Area have 1 and 2 stories and 10% of those have 3 stories. Average number of storey is 2.

In regard to usage of timber structure buildings in 3B Protection Areas; 78% of all timber structure buildings in 3B Protection Areas are residential buildings. Residential+commercial buildings constitute 2% and commercial buildings constitute 20% of all. Following table presents distribution of age, number of stories and usage of timber structure buildings in 3B Protection Areas.

OLD (OLDER THAN 40 YEARS) AND MULTI-STOREY (FIVE AND MORE STOREY) BUILDINGS

Relatively older and multi-storey buildings are expected to be more vulnerable. Therefore, buildings older than 40 years and with 5 and more storey in Fatih, are surveyed in detail according to their location, distribution according to protection areas of Historical Peninsula Conservation Plan, distribution according to multi-hazard zones.

In the Fatih District, there are 3579 buildings classified as old and multi-storey building. 81% of old and multi-storey buildings are reinforced concrete, 9% of those is mixed and masonry buildings and there is only one timber structure building in old and multi-storey buildings. It is possible to say that structural system of those buildings is considerably aged and their designs are in accordance with the standards of former regulations which are not in force today.

59% of all old and multi-storey buildings are residential buildings. In addition to prominent residential usage, there are residential+commercial buildings and commercial buildings too. Also there is only one industrial building in old and multi-storey buildings.

Spatial distribution of old and multi-storey buildings are presented in Figure 4.20 and results of analysis are presented in the Table 4.21 and 4.22.

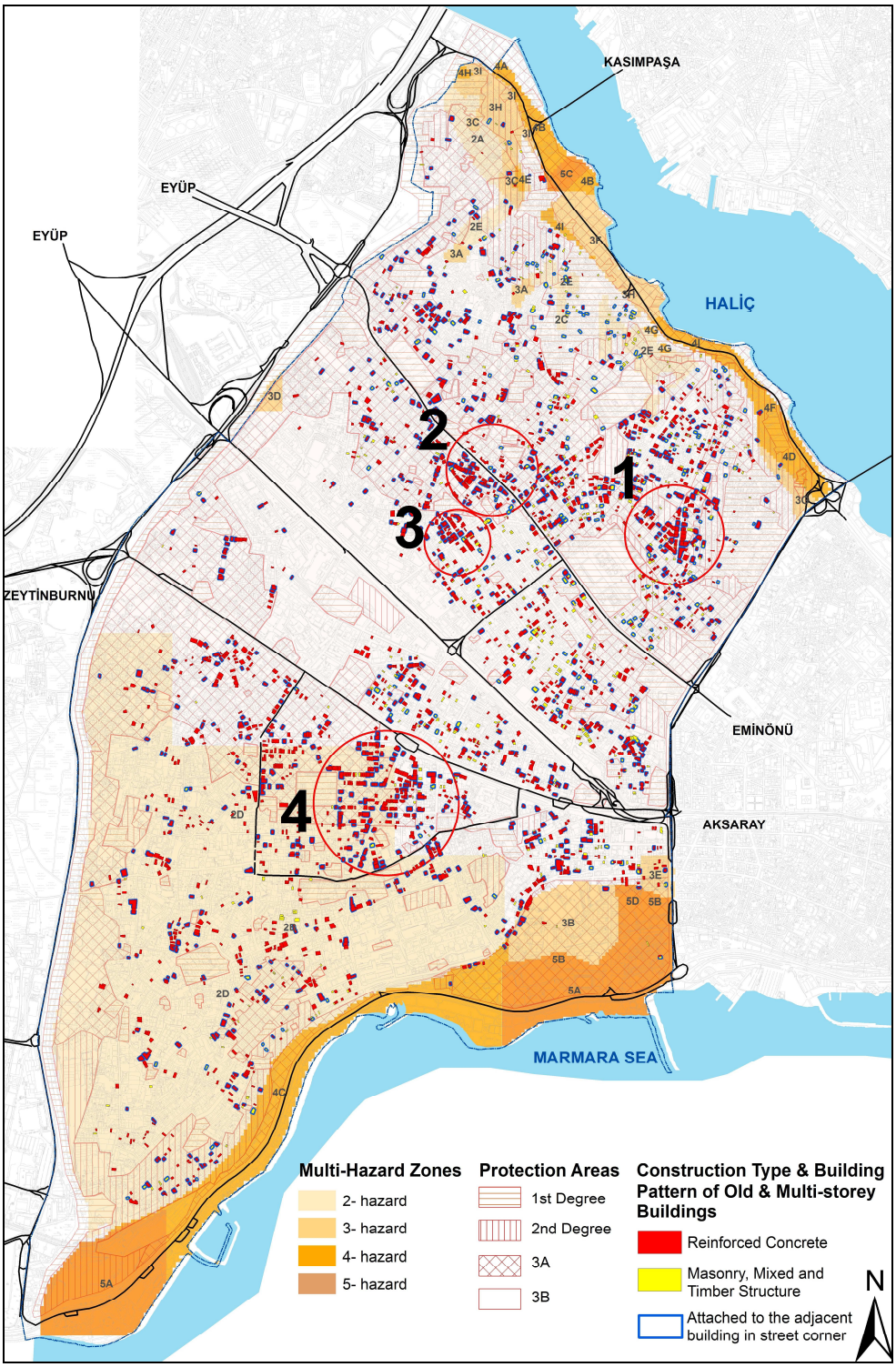


Figure 4.20 Distributions of Old and Multi-storey Buildings in the Fatih District

Table 4.21 Distributions of Old and Multi-storey Buildings in Multi-Hazard Zones

Multi Hazard Zones	**Number of Buildings**	**%**
2-hazard	813	22,72
3-hazard	33	0,92
4-hazard	17	0,47
5-hazard	3	0,08
Non-hazardous	2713	75,81
Total	3579	100,00

Table 4.22 Properties of Old and Multi-storey Buildings and their Distribution according to Protection Areas

Total: 3579 Buildings	**1st Degree Protection Area**		**2nd Degree Protection Area**		**3A Protection Area**		**3B Protection Area**	
	117 buildings (%3)		247 buildings (%7)		1483 buildings (%41)		1732 buildings (%49)	
Average age of buildings	55 years		49 years		46 years		45 years	
Number of stories	5-storey	101	5-storey	195	5-storey	894	5-storey	927
	6-storey	16	6-storey	43	6-storey	495	6-storey	631
	7-storey	-	7-storey	9	7-storey	94	7-storey	174
Usage	Residential	84	Residential	172	Residential	880	Residential	985
	Res. + Commercial	28	Res. + Commercial	72	Res. + Commercial	557	Res. + Commercial	681
	Commercial	5	Commercial	2	Commercial	46	Commercial	66
	Industrial	-	Industrial	1	Industrial	-	Industrial	-
Construction Type	Reinforced concrete	56	Reinforced concrete	153	Reinforced concrete	1261	Reinforced concrete	1460
	Masonry	51	Masonry	61	Masonry	163	Masonry	198
	Mixed	10	Mixed	33	Mixed	58	Mixed	74
	Timber Str.	-	Timber Str.	-	Timber Str.	1	Timber Str.	-
Building Pattern	57 buildings attached to the adjacent building in street corner		109 buildings attached to the adjacent building in street corner		455 buildings attached to the adjacent building in street corner		491 buildings attached to the adjacent building in street corner	

3% of total old and multi-storey buildings are located in 1st Degree Protection Areas, 7% of those are located in 2nd Degree Protection Areas, 41% of those are located in 3A Protection Areas and 49% of those are located in 3B Protection Areas.

In the context of analysis of old and multi-storey buildings; building pattern is also taken into consideration and buildings attached to the adjacent building in the street corner are determined. It is observed that 31% of all 3579 buildings are attached in the corner. It is accepted that buildings older than 40 years and with five and more storey and attached in the corner have higher risk.

COMMERCIAL AND INDUSTRIAL BUILDINGS

2138 of total building stock (26.162) of the Fatih District consist of commercial and industrial buildings. Within the scope of analysis, spatial distribution, construction types, number of stories and age of those buildings are analysed. Regions are determined where industrial and commercial buildings are clustered.

There are 2059 commercial buildings in the district. Moreover, 7189 buildings have corporate usage of residential and commercial (residential+commercial).

Commercial buildings are densely located in main arteries of the district. It is observed that FAR (Floor Area Ratio) values increase in the regions where commercial buildings intensively take place. Fevzi Paşa Street is the main artery where commercial buildings most intensively take place. Commercial buildings very intensively take place on Fevzi Pisa Street as FAR values are beyond 3,5 in this region. Vatan and Millet Streets are other arteries where commercial buildings take place. Moreover, there are commercial buildings on Coast Road. Commercial buildings are also seen in Balat Karabas neighbourhood that takes place on the shore of Halic.

Residential+commercial buildings are densely located in Şeyh Resmi, Kirmasti, Hüsambey neighbourhoods that located at the north of Fevzi Paşa Street and Hat ice Sultan, Muhtesip İskender, Hoca Üveyz, Hasan Halife, Sofular, İskender Pasa

neighbourhoods that located at the south of Fevzi Pasa Street. Yalı, İnebey and Çakırağa neighbourhoods that take place near to Eminönü district boundaries and on Coast Road are regions where commercial and residential+commercial buildings intensively take place. Arabaci Beyazit, Koca Mustafa Paşa, Sancaktar Hayrettin neighbourhoods that take place around Cerrahpaşa and SSK Samatya hospitals are regions where residential+commercial buildings intensively take place (Figure 4.21).

Additionally, there are 79 industrial buildings in the Fatih District and they take place within small clusters in district. Industrial buildings are clustered in Hızır Çavuş, Balat Karabaş, Neslişah, Ali Fakih and Yalı neighbourhoods.

Industrial buildings of the region are: small factories and workshops in Hızır Çavuş neighbourhood, small factories and storages in Balat Karabaş neighbourhood and drug factory in Neslişah neighbourhood.

Construction type, number of storey and building age of commercial, residential +commercial buildings and industrial buildings are presented in the table below (Table 4.23).

Table 4.23 Attributes of Commercial, Residential+ Commercial and Industrial Buildings

Commercial Buildings	**Total: 2059 buildings**	
Average age		34 years
Construction type	Timber structure	20
	Reinforced concrete	1046
	Mixed	202
	Masonry	791
Number of stories	1	684
	2	422
	3	230
	4	184
	5	190
	6	211
	7	138
Residential + Commercial Buildings	**Total: 7189 buildings**	
Average age		33 years
Construction type	Timber structure	7
	Reinforced concrete	5999
	Mixed	265
	Masonry	918
Number of stories	1	23
	2	245
	3	556
	4	1374
	5	2522
	6	1838
	7	631
Industrial Buildings	**Total: 79 buildings**	
Average age		43 years
Construction type	Timber structure	1
	Reinforced concrete	39
	Mixed	4
	Masonry	35
Number of stories	1	32
	2	26
	3	9
	4	9
	5	1
	6	2

Figure 4.21 Distributions of Commercial and Industrial Buildings in the Fatih District

4.3.3. Comparison of the Results of Mitigation Planning Approach and Engineering Surveys in Fatih

After examining the cross-tabulations of construction types, number of stories, age and usage data of buildings and analysing sub-groups, **vulnerable buildings** and **high risk areas** are determined within the scope of urban risk analysis in the existing building stock according to mitigation planning approach.

In this part of the thesis, the consistency between "the results of risk analysis according to the mitigation planning approach" and "the results of the engineering survey of Earthquake Based Urban Renewal Project of Fatih District" is assessed.

Before comparing the two studies, The Screening Procedure of the building stock in Fatih conducted by engineers within the scope of Earthquake Based Urban Renewal Project of the Fatih District is presented in this part. Secondly, the assumed risk criteria and the results of risk analysis according to the mitigation planning approach are presented in detail and the results are compared with results of engineering surveys in terms of consistency of risky buildings.

4.3.3.1. Results of the Screening Procedure of the Building Stock in Fatih by Engineers

Within the scope of building analysis of Earthquake Based Urban Renewal Project of Fatih District, a simple screening procedure for reinforced, masonry and mixed buildings was implemented. This procedure is based on a sidewalk survey of the buildings and it was developed by Sucuoğlu and Yazgan in 2003.

This procedure consists of observing selected building parameters from the street and calculating a performance score for determining the risk priorities for buildings (Sucuoğlu et al, 2007).

Structural parameters used in sidewalk surveys, are;

- number of stories,

- existence of a soft storey,
- existence of heavy overhangs,
- overall apparent building quality.

After obtaining the vulnerability parameters of buildings from sidewalk surveys and determining location of buildings, the performance score is calculated by making some statistical analysis.

“The objective of statistical analysis is to develop a performance score for prioritizing the buildings in the area, based on a set of vulnerability indicators that can be observed visually through a street survey” (Sucuoğlu et al, 2007).

Calculation of performance score also depends on local ground conditions and seismic hazard level.

“The intensity of ground motion at a particular site predominantly depends on the distance to the causative fault and local soil conditions. As there exists a strong correlation between peak ground acceleration (PGV) and the shear wave velocities of local soils (Wald 1999), in this study the PGV is selected as to represent the ground motion intensity. The PGV map in the JICA report has contour increments of 20 cm/s^2. The intensity zones in Istanbul are expressed accordingly, in terms of the associated PGV ranges.”(Özcebe et al, 2006)

Ground classification of the Fatih District is presented in Figure 4.22 and Peak Ground Velocity (PGV) calculated for buildings is presented in Figure 4.23.

In Figure 4.22, it is observed that soft ground (E) takes place on the shores of the Marmara Sea and Haliç. In Fatih, moderate hard ground (D) is dominant and there are more hard ground (B and C) in some regions also.

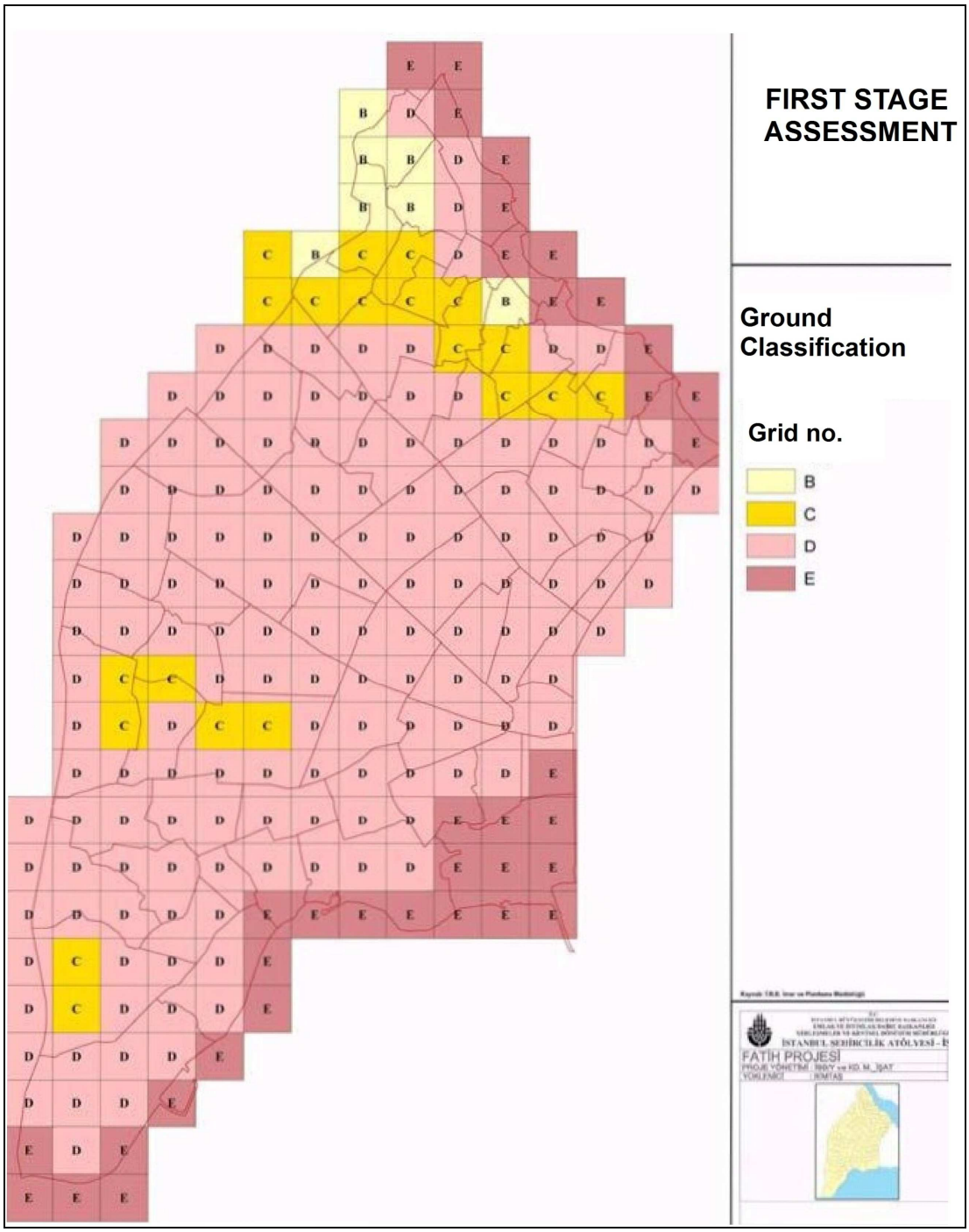


Figure 4.22 Ground Classification of the Fatih District

(Source: Sucuoğlu, 2007:280)

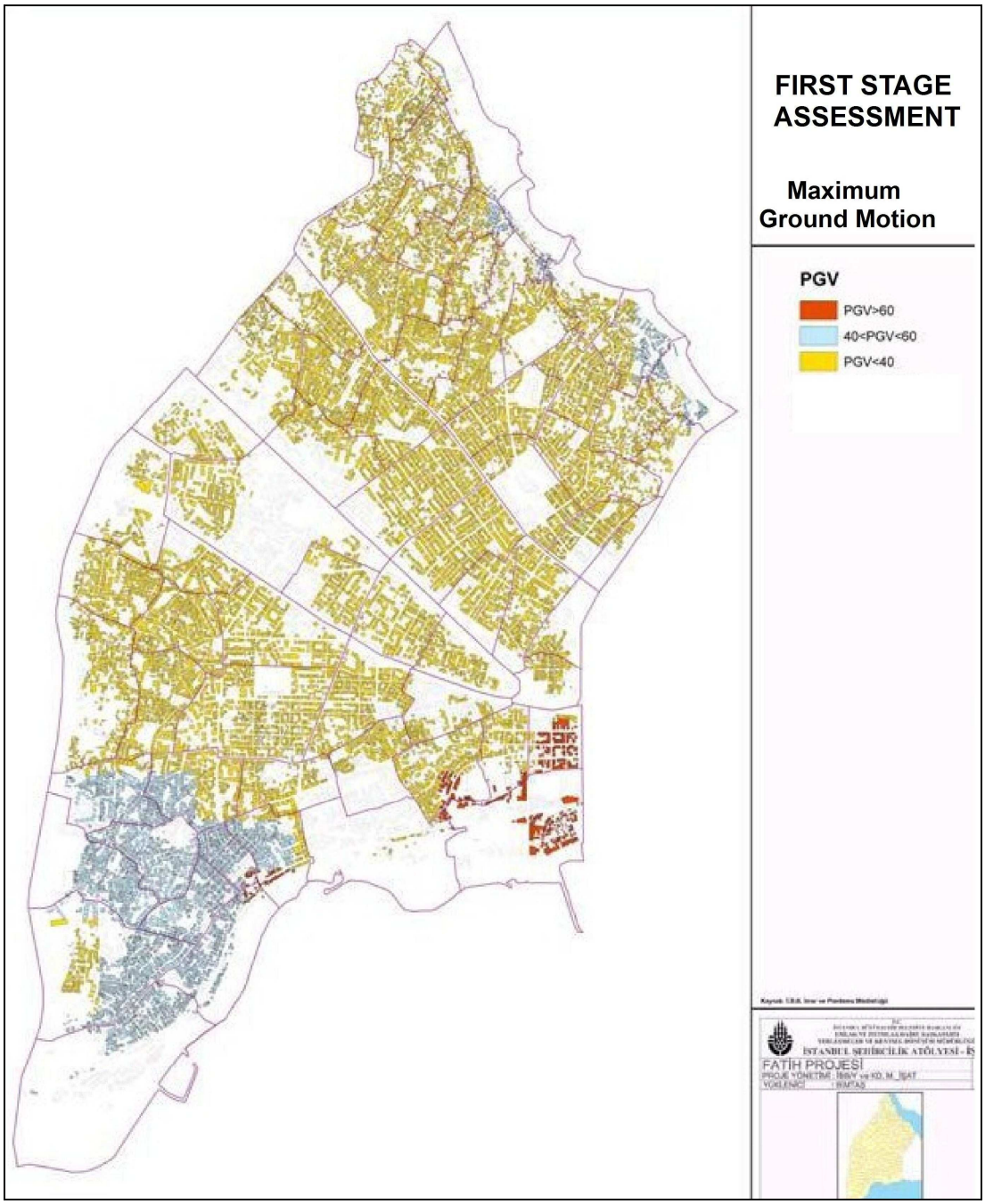


Figure 4.23 Peak Ground Velocity (PGV) Values of Buildings in the Fatih District (Source: Sucuoğlu, 2007:281)

In Figure 4.23, PGV Values range from 0 to 40 cm/s, 40 to 60 cm/s and larger than 60 cm/s. According to Sucuoğlu (Sucuoğlu et al, 2007), “PGV is a superior ground motion-amplitude parameter for indicating light to severe levels of structural damage. Accordingly, PGV is employed to scale ground motion intensity.”

When looking at Figure 4.23, it is observed that on the shore of the Marmara Sea there is a limited area which has PGV value larger than 60 cm/s and in this area ground motion intensity is high. On the shore of Haliç and southern part of the district, there are some areas which have PGV value between 40 and 60 cm/s. In the central part of the district away from the coast, PGV value is moderate (PGV<40 cm/s.).

According to number of stories of buildings and the seismic hazard level at site, a score table is prepared for each building (Table 4.24).

Table 4.24 Score Table of Buildings according to Engineering Survey
(Source: Sucuoğlu, 2007: 279)

Number of Stories	**Base Scores**			**Vulnerability Scores**						
				Individual Building Properties			Location and Storey Level of the Building According to Adjacent Building			
	PGV 60-80	PGV 40-60	PGV 20-40	Soft storey	Apparent quality	Heavy Overhang	Same-middle	Same-edge	Different-middle	Different-edge
1-2	90	125	150	20	9	10	0	10	5	15
3	80	107	138	23	9	23	0	10	5	15
4	73	91	115	22	15	30	0	10	5	15
5-6	64	76	92	24	23	33	0	10	5	15

According to Sucuoğlu (2007), the performance score for each building is calculated by using the equation given below:

Seismic Performance Score = Base Score – (Σ Individual Building Properties x Individual Building Properties Multiplies) – Location and Storey Level of Adjacent Building

After calculating Seismic Performance Score of each building, the buildings are classified as "low risky" or "high risky". Threshold **score is defined as 50** and the buildings which have **score value lower than 50**, are classified as high risky. Results of the calculation of Seismic Performance Score are given in the Figure 4.24.

According to this analysis conducted within the scope of Earthquake Based Urban Renewal Project of Fatih District. 3647 reinforced concrete buildings are determined as risky. 3680 masonry and mixed buildings are also determined risky using a similar method. Totally, 7327 buildings are determined as risky according to results of the secreening procedure which is conducted within the scope of Earthquake Based Urban Renewal Project of Fatih District (Table 4.25 and Figure 4.25).

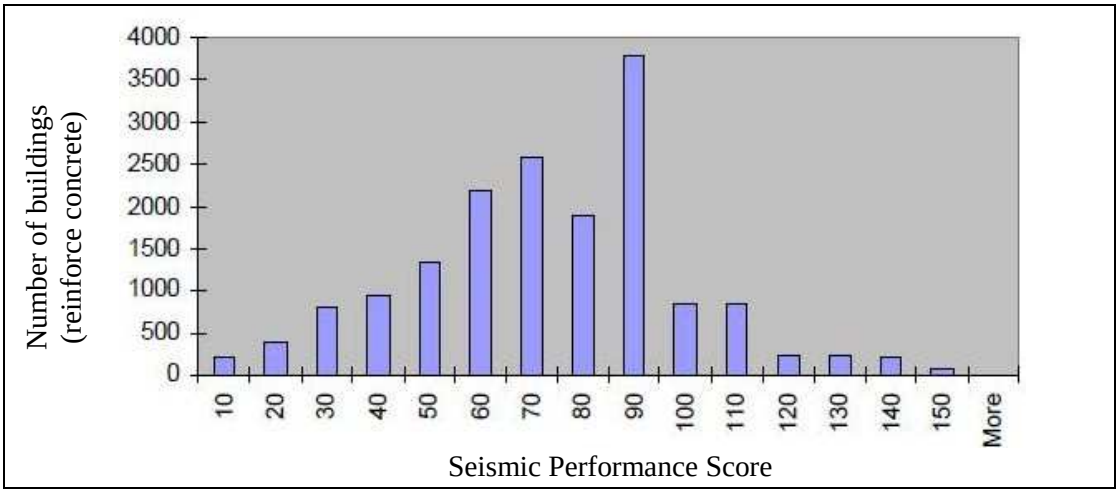


Figure 4.24 Seismic Performance Score of the Buildings (Source: Sucuoğlu, 2007)

Table 4.25 Properties of Risky Buildings According to Engineering Survey

	Total Risky Buildings : 7327	**% within the total risky buildings**
Construction Type		
Timber structure	0	0,00
Reinforced concrete	3647	49,77
Mixed	838	11,44
Masonry	2842	38,79
Building Age (According to Building Code Revisions)		
0 (Built after 2006)	431	5,88
1-10 (Built in 1997-2006)	222	3,03
11-32 (Built in 1975-1996)	1889	25,78
33-39 (Built in 1968-1974)	1102	15,04
40-46 (Built in 1961-1967)	1393	19,02
47-54 (Built in 1953-1960)	749	10,22
55-58 (Built in 1949-1952)	350	4,78
59-67 (Built in 1940-1948)	625	8,53
Older than 67 (Built before 1940)	566	7,72
Average age	29,61	
Number of Stories		
1	205	2,80
2	974	13,29
3	849	11,59
4	1210	16,51
5	2238	30,54
6	1353	18,47
7	498	6,80
Average number of storey	5,68	
Building Pattern		
Detached	284	3,88
Attached	3840	52,41
Attached to the adjacent building in the street corner	3203	43,71
Usage of Buildings		
Residential	3855	52,61
Residential+Commercial	2920	39,86
Commercial	538	7,34
Industrial	14	0,19
Distribution In Regard to Protection Areas		
1st Degree	606	8,27
2nd Degree	934	12,75
3A	2627	35,85
3B	3160	43,13
Distribution In Regard to Multi-hazard Zones		
Non-hazardous	4590	62,64
2- hazard	2291	31,27
3- hazard	249	3,40
4- hazard	115	1,57
5- hazard	82	1,12

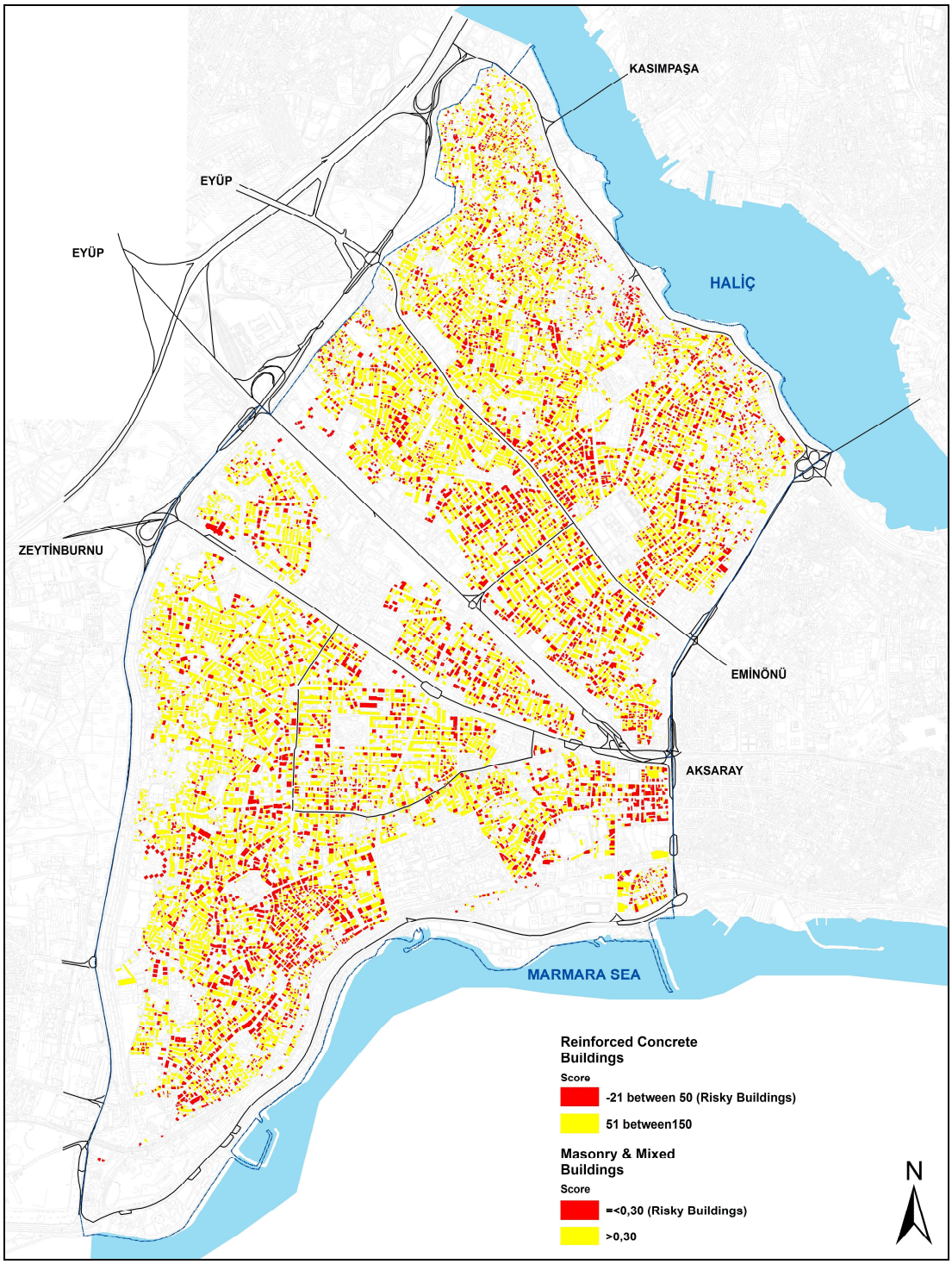


Figure 4.25 Risky Buildings according to the Engineering Survey which is conducted within the scope of Earthquake Based Urban Renewal Project of the Fatih District (Source: BİMTAŞ Database)

4.3.3.2. Risk Analysis Results of Mitigation Planning Approach in Existing Building Stock and Comparison with Engineering Surveys

Depending on examination of the cross-tabulations of construction types, number of stories, age and usage data of buildings and analysis of relatively more vulnerable sub-groups of buildings, three different approaches adopted for risk determination in the building stock and their results examined individually in terms of consistency with engineering surveys. Proportion of overlapping buildings included in both mitigation planning analysis and engineering surveys, are determined according to three different approaches having different assumed risk criteria. This step provides the development of an opinion about parameters that are common in both studies and the effects of the different assumptions of mitigation planning and engineering approach. The criteria assumed in three different approaches are briefly given in the Table 4.26 and results of analysis in terms of overlapping ratio are given Table 4.27.

According to Table 4.26 and Table 4.27; if structural properties and sources of natural hazards are considered as indicator of risk regardless of usage of buildings, number of risky buildings is lower and the ratio of overlapping buildings with risky buildings of engineering survey is lower also (The First Set of Risk Criteria).

If structural properties and sources of natural hazards are considered as an individual indicator of risk, number of risky buildings increases and the ratio of overlapping buildings with risky buildings of engineering survey increases also (The Second Set of Risk Criteria).

If structural properties considered in relation with each natural hazard zone that require different structural robustness, number of risky buildings decreases and the ratio of overlapping buildings with risky buildings of engineering survey decreases too. The third set of criteria more acceptable as considering structural parameters in relation with natural hazard zones, although its results are least consistent with the risky buildings of engineering survey. The reason of the inconsistency is distinction between mitigation approach and engineering approach in terms of consideration of potential natural hazards (The Third Set of Risk Criteria).

Table 4.26 Different Criteria Assumed in Three Different Approaches according to the Mitigation Planning Approach

The First Set of Risk Criteria	No. of buildings	% in 7474	The Second Set of Risk Criteria	No. of buildings	% in 17,834	The Third Set of Risk Criteria	No. of buildings	% in 11,536
1. All buildings located in the 4-hazard and 5-hazard zones.	**490**	6,6	1. All buildings located in the 4 and 5-hazard zones.	**490**	2,7	1. All buildings located in the 4 and 5-hazard zones.	**490**	4,2
2. Buildings that have more than 2 stories and older than 40 years in the 2-hazard and 3-hazard zones.	**1265**	16,9	2. All buildings located in steep hill sides (potential landslide areas), alluvial ground, artificial landfill areas and 50 m. buffer zone of fault lines.	**1933**	10,8	2. All buildings with 3 and more number of stories located in potential landslide areas, alluvial grounds, artificial landfill areas, within 50 m zone of fault lines & areas having high PGA.	**7214**	62,5
3. All timber structure buildings that have more than 2 stories	**47**	0,6	3. All buildings including industrial function which are located in multi-hazard zones and their neighbouring buildings in 50 m. radius zone.	**1257**	7,0	3. All buildings including industrial function which are located in multi-hazard zones and their immediate neighbouring buildings.	**629**	5,5
4. Masonry and mixed buildings that have more than 3 stories and older than 40 years.	**2013**	26,9	4. All buildings in the 100 m. radius zone of gas and lpg stations located in multi-hazard zones.	**221**	1,2	4. All buildings in the 100 m. radius zone of gas and lpg stations located in multi-hazard zones.	**221**	1,9
5. Reinforced concrete buildings that have more than 4 stories and older than 40 years.	**2929**	39,2	5. All timber structure buildings that have more than 2 stories.	**47**	0,3	5. All timber structure buildings with more than 2 stories.	**47**	0,4
6. Timber structure, masonry and mixed buildings attached to adjacent building in street corner.	**3415**	45,7	6. All masonry- mixed buildings that have more than 3 stories.	**2485**	13,9	6. Five and more storey masonry and mixed buildings older than 40 years (built before 1968) in non-hazardous area.	**548**	4,8

Table 4.26 Different Criteria Assumed in Three Different Approaches according to the Mitigation Planning Approach (continued)

			7. All reinforced concrete buildings that have more than 4 stories.	**12740**	71,4	7. Four and more storey masonry and mixed buildings older than 33 years (built before 1975) in 2-hazard zones.	**461**	4,0
			8. Buildings older than 40-years and attached to the adjacent building in the street corner.	**3748**	21,0	8. Four and more storey masonry and mixed buildings in 3-hazard zones.	**57**	0,5
						9. Six and more storey reinforced concrete buildings older than 40 years in non-hazardous areas.	**1206**	10,5
						10. Five and more storey reinforced concrete buildings older than 11 years (built before 1997) in 2-hazard zones.	**3635**	31,5
						11. Five and more storey reinforced concrete buildings in 3-hazard zones.	**98**	0,8
						12. Two and more storey buildings older than 40-years and attached to the adjacent building in the street corner.	**3009**	26,1
Total Risky Buildings*	**7474**		Total Risky Buildings*	**17.834**		Total Risky Buildings*	**11.536**	

* As number of total risky buildings is obtained by avoiding duplications in the different criteria, the sum of number of buildings in each criterion is not equal to total risky buildings. Every building has a unique ID number in the database and, duplicating buildings are eliminated in analysis in ArcGIS programme by using their ID numbers.

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Table 4.27 Results of Three Different Set of risk Criteria according to the Mitigation Planning Approach

	Total Risky Buildings	Overlapping Risky Buildings	Percentage of overlapping buildings in total risky buildings (7327) determined by the engineering survey
Results of the First Assumed Risk Criteria	7474	2946	**40 %**
Results of the Second Assumed Risk Criteria	17.834	5333	**72 %**
Results of the Third Assumed Risk Criteria	11.538	4492	**55 %**

As a result of analysis depending on ***The First Assumed Risk Criteria***, a total 7474 buildings have been determined as risky buildings. When 7474 risky buildings determined in accordance with mitigation planning approach, are compared with 7327 risky buildings determined in accordance with the engineering surveys, it is seen that there are 2946 common buildings that have been included in both sets. Thus, ***40,21%*** of the risky buildings determined in accordance with the engineering surveys overlap with the risky buildings which are determined in accordance with the mitigation planning approach. Depending on the ratio of overlapping buildings in total risky buildings determined by engineering surveys and properties of the residual groups excluded in either of two studies, it can be generally indicated that;

- In the engineering surveys, the ground motion intensity presented by PGV is the only parameter related to natural hazards. On the other hand, in the mitigation planning approach multi-hazard zones including liquefaction, steep hill sides and landslide, artificial landfills, fault lines, geological formations, tsunami impact and drainage basins, are considered.

- Timber structure buildings are not taken into consideration in the engineering surveys.

- In the mitigation planning approach, number of stories as an indicator of risk, is reduced to 4,5 storey for older than 40 years masonry and mixed buildings; 5,6,7 storey for older than 40 years reinforced concrete buildings. However, in engineering surveys number of storey as an indicator of risk is considered only, and multi-storey buildings are determined risky regardless of building age. Thus, multi-storey buildings have a greater ratio in total number of risky buildings of the engineering surveys than the mitigation planning approach.

The result of analysis and the map of risky buildings depending on The First Assumed Risk Criteria are submitted in Appendix A.

In The Second Assumed Risk Criteria, different from previous criteria, usage of buildings and hazardous units are taken into consideration. Also number of storey as an indicator of risk is considered regardless of building age.

As a result of analysis depending on The Second Assumed Risk Criteria, a total 17834 buildings have been determined as risky buildings. When 17834 risky buildings determined in accordance with mitigation planning approach, are compared with 7327 risky buildings determined in accordance with the engineering surveys, it is seen that there are 5333 common buildings that have been included in both sets. Thus, ***72,79%*** of the risky buildings determined in accordance with the engineering surveys, overlap with the risky buildings which are determined in accordance with the mitigation planning approach. According to this analysis results, 68% of total buildings in the Fatih district are risky. After reviewing the properties of the buildings that are risky according to mitigation planning approach but are not risky according to engineering surveys, it can be indicated that structural properties as an indicator of risk, especially number of stories, should be considered related with multi-hazard zones.

The result of analysis and the map of risky buildings depending on The Second Assumed Risk Criteria are submitted in Appendix B.

The Third Assumed Risk Criteria is developed according to previous analysis results depending on other different criteria. After comparing the results of risk analysis depending on The Third Assumed Risk Criteria in terms of overlapping risky buildings in both studies and the residual groups excluded in either of the studies, these criteria are adopted the most consistent criteria with engineering surveys.

The Third Assumed Risk Criteria include;

- ✓ All buildings located in the 4 and 5-hazard zones.
- ✓ Three and more storey buildings located in steep hill sides (potential landslide areas), alluvial ground, artificial landfill areas, 50 meter zone of fault lines and areas having high PGA.
- ✓ All buildings including industrial function which are located in multi-hazard zones and their immediate neighbouring buildings.
- ✓ All buildings in the 100 meter zone of gas and lpg stations located in multi-hazard zones.
- ✓ All timber structure buildings with more than 2 stories.
- ✓ Five and more storey masonry and mixed buildings older than 40 years (built before 1968) in non-hazardous area.
- ✓ Four and more storey masonry and mixed buildings older than 33 years (built before 1975) in 2-hazard zones.
- ✓ Four and more storey masonry and mixed buildings in 3-hazard zones.
- ✓ Six and more storey reinforced concrete buildings older than 40 years in non-hazardous areas.
- ✓ Five and more storey reinforced concrete buildings older than 11 years (built before 1997) in 2-hazard zones.
- ✓ Five and more storey reinforced concrete buildings in 3-hazard zones.
- ✓ Two and more storey buildings older than 40-years and attached to the adjacent building in the street corner.

Different from previous set of criteria, in these criteria, number of stories and building age differently assessed for each construction type according to each natural hazard zone. For reinforced concrete buildings: in non-hazardous areas, six and more storey reinforced concrete buildings older than 40 years (built before 1968); in 2-hazard zones, five and more storey reinforced concrete buildings older than 11 years (built before 1997) and in 3-hazard zones, five and more storey reinforced concrete buildings are defined as risky. For masonry and mixed buildings: in non-hazardous areas, five and more storey masonry and mixed buildings older than 40 years (built before 1968); in 2-hazard zones, four and more storey masonry and mixed buildings older than 33 years (built before 1975); in 3-hazard zones, four and more storey masonry and mixed buildings are defined as risky. All buildings located in 4 and 5-hazard zones have already been defined as risky. As shown above, number of stories is considered in relation with building age. For reinforced concrete buildings located 3-hazard zones, requires more structural robustness, 1997 building code considered essential, as reinforced concrete buildings are classified in the 1997 code as systems of either high or nominal ductility based on the detailing of the components and detailing requirements are more stringent for systems with high ductility. For masonry and mixed buildings located 3-hazard zones, requires more structural robustness, 1975 building code considered essential, as maximum number of stories of masonry buildings is limited regarding earthquake zones of Turkey by the 1975 building code.

Spatial distribution of risky buildings according to risk groups (structural properties, usage and natural hazards) defined with these criteria is given in Figure 4.26.

According to the above criteria, a total 11.536 buildings have been determined as risky buildings. Properties of risky buildings according to construction type, building age, number of stories, building pattern and usage of buildings are stated in detail in Table 4.28. Also, attributes of risky buildings according to the Third Set of Criteria are compared with results of the other two set of criteria and result of the engineering survey in Table 4.29. Attributes of risky buildings according to results of The Third Set of Risk Criteria according to the mitigation planning approach are presented in comparison with engineering survey results in Figure 4.27.

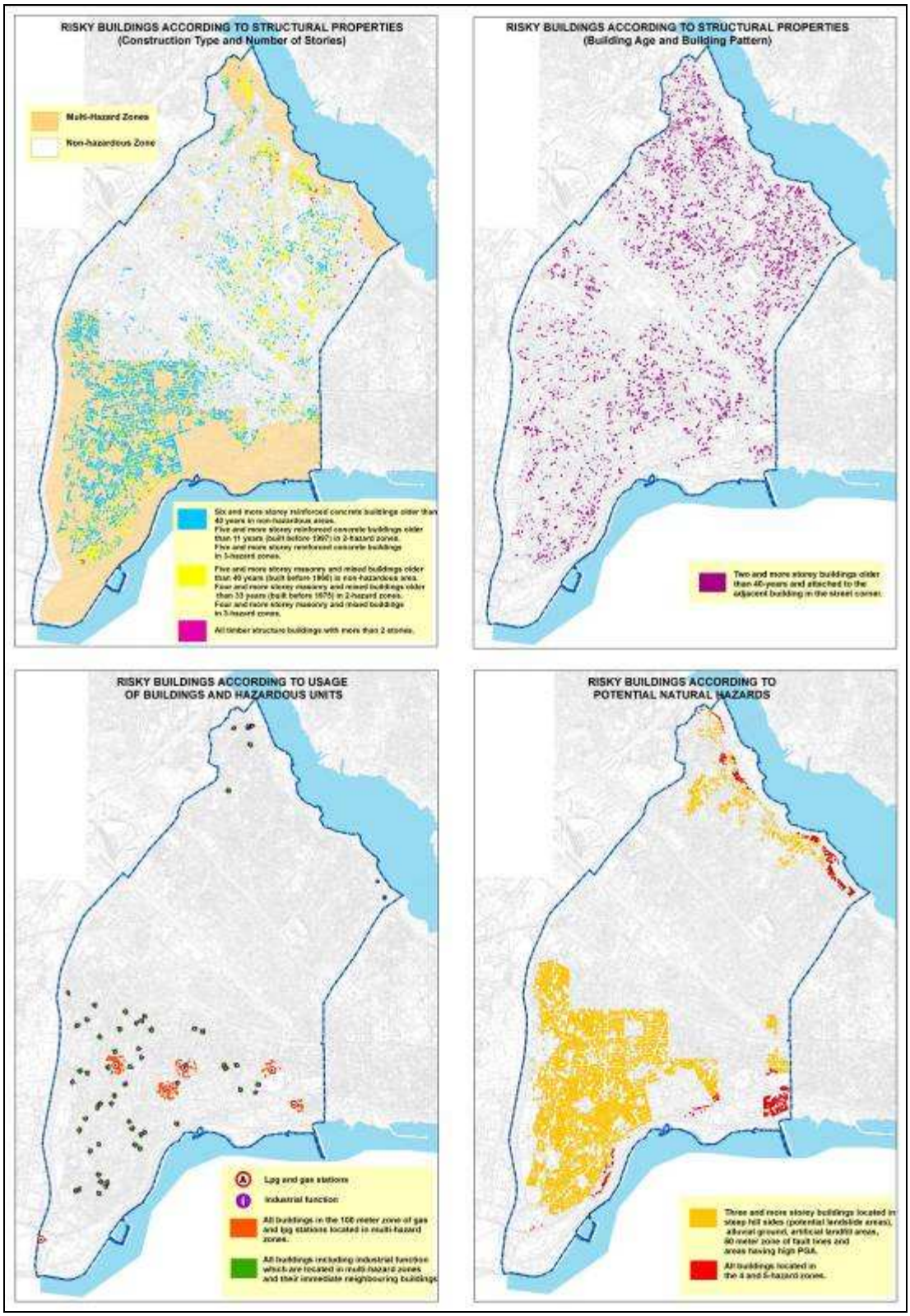

Figure 4.26 Risky Buildings according to Risk Groups defined with the Third Set of Risk Criteria

Table 4.28 Properties of Risky Buildings (The Third Set of Risk Criteria)

	Total Risky Buildings : 11.536	**% within the total risky buildings**
Construction Type		
Timber structure	86	0,75
Reinforced concrete	7810	67,70
Mixed	621	5,38
Masonry	3019	26,17
Building Age (According to Building Code Revisions)		
0 (Built after 2006)	478	4,14
1-10 (Built in 1997-2006)	290	2,51
11-32 (Built in 1975-1996)	2936	25,46
33-39 (Built in 1968-1974)	1664	14,42
40-46 (Built in 1961-1967)	3176	27,54
47-54 (Built in 1953-1960)	1111	9,63
55-58 (Built in 1949-1952)	518	4,49
59-67 (Built in 1940-1948)	758	6,57
Older than 67 (Built before 1940)	605	5,24
Average age	38,55	
Number of Stories		
1	167	1,45
2	836	7,25
3	1655	14,35
4	2206	19,12
5	3783	32,78
6	2384	20,67
7	505	4,38
Average number of stories	4,54	
Building Pattern		
Detached	350	3,03
Attached	6282	54,46
Attached to the adjacent building in the street corner	4904	42,51
Usage of Buildings		
Residential	7434	64,44
Residential+Commercial	3463	30,02
Commercial	617	5,35
Industrial	22	0,19
Distribution In Regard to Protection Areas		
1st Degree	729	6,32
2nd Degree	1537	13,32
3A	3355	29,09
3B	5915	51,27
Distribution In Regard to Multi-hazard Zones		
Non-hazardous	3976	34,47
2- hazard	6696	58,04
3- hazard	374	3,24
4- hazard	315	2,73
5- hazard	175	1,52

Table 4. 29 Attributes of Risky Buildings and Total Building Stock in Fatih

Attributes of the Buildings	Risky Buildings according to Engineering Surveys			Risky Buildings according to Mitigation Planning Approach									Total Buildings in Fatih	
				The First Set of Risk Criteria			The Second Set of Risk Criteria			The Third Set of Risk Criteria				
	No. of buildings **(Total: 7327)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 7474)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 17834)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 11536)**	% in risky buildings	% in Fatih (26162)	No. of buildings & % **(Total: 26162)**	
Construction Type														
Timber structure	0	0,00	0,00	113	1,50	61,41	113	0,62	61,41	86	0,75	46,74	184	0,70
Reinforced concrete	3647	49,77	22,07	3478	46,55	21,05	13572	76,12	82,15	7810	67,70	47,27	16521	63,15
Mixed	838	11,44	61,85	691	9,25	51,00	663	3,72	48,93	621	5,38	45,83	1355	5,18
Masonry	2842	38,79	35,08	3192	42,71	39,40	3486	19,54	43,03	3019	26,17	37,26	8102	30,97
Number of Stories														
1	205	2,80	7,56	608	8,13	22,41	1134	6,36	41,80	167	1,45	6,16	2713	10,37
2	974	13,29	35,43	583	7,80	21,21	1115	6,25	40,56	836	7,25	30,41	2749	10,51
3	849	11,59	29,32	539	7,21	18,61	1175	6,59	40,57	1655	14,35	57,15	2896	11,07
4	1210	16,51	28,44	1961	26,24	46,10	1080	6,05	25,39	2206	19,12	51,86	4254	16,26
5	2238	30,54	31,20	2279	30,49	31,78	7012	39,32	97,77	3783	32,78	52,75	7172	27,41
6	1353	18,47	26,61	1220	16,32	24,00	5030	28,20	98,94	2384	20,67	46,89	5084	19,43
7	498	6,80	38,49	284	3,80	21,95	1288	7,23	99,54	505	4,38	39,03	1294	4,95
Average	5.68			4.27			4.79			4.54			4.18	

Table 4. 29 Attributes of Risky Buildings and Total Building Stock in Fatih (continued)

Attributes of the Buildings	Risky Buildings according to Engineering Surveys			Risky Buildings according to Mitigation Planning Approach									Total Buildings in Fatih	
				The First Set of Risk Criteria			The Second Set of Risk Criteria			The Third Set of Risk Criteria				
	No. of buildings **(Total: 7327)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 7474)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 17834)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 11536)**	% in risky buildings	% in Fatih (26162)	No. of buildings & % **(Total: 26162)**	
Building Age (According to Building Code Revisions)														
0 (built in 2007)	431	5,88	31,41	51	0,68	3,72	681	3,82	49,64	478	4,14	34,84	1372	5,24
1-10 (built in 1997-2006)	222	3,03	23,20	22	0,29	2,30	699	3,92	73,04	290	2,51	30,30	957	3,66
11-32 (built in 1975-1996)	1889	25,78	22,95	209	2,80	2,54	6101	34,22	74,13	2936	25,46	35,67	8230	31,46
33-39 (built in 1968-1974)	1102	15,04	24,55	274	3,67	6,11	3367	18,88	75,02	1664	14,42	37,08	4488	17,15
40-46 (built in 1961-1967)	1393	19,02	28,79	3119	41,73	64,46	3535	19,82	73,05	3176	27,54	65,63	4839	18,50
47-54 (built in 1953-1960)	749	10,22	34,20	1396	18,68	63,74	1265	7,09	57,76	1111	9,63	50,73	2190	8,37
55-58 (built in 1949-1952)	350	4,78	33,21	642	8,59	60,91	587	3,29	55,69	518	4,49	49,15	1054	4,03
59-67 (built in 1940-1948)	625	8,53	37,22	988	13,22	58,84	871	4,88	51,88	758	6,57	45,15	1679	6,42
Older than 67 (built before 1940)	566	7,72	41,83	773	10,34	57,13	728	4,08	53,81	605	5,24	44,72	1353	5,17
Average age	29,61			49,73			35,34			38,55				36,30

Table 4. 29 Attributes of Risky Buildings and Total Building Stock in Fatih (continued)

Attributes of the Buildings	Risky Buildings according to Engineering Surveys			Risky Buildings according to Mitigation Planning Approach									Total Buildings in Fatih	
				The First Set of Risk Criteria			The Second Set of Risk Criteria			The Third Set of Risk Criteria				
	No. of buildings **(Total: 7327)**	% in risky buildings	% in Fatih (26162)	No. of building **(Total: 7474)**	% in risky buildings	% in Fatih (26162)	No. of building **(Total: 17834)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 11536)**	% in risky buildings	% in Fatih (26162)	No. of buildings & % **(Total: 26162)**	
Building Pattern														
Detached	284	3,88	24,13	119	1,59	10,11	525	2,94	44,60	350	3,03	29,74	1177	4,50
Attached	3840	52,41	23,79	4101	54,87	25,40	10087	56,56	62,49	6282	54,46	38,91	16143	61,70
Attached to the adjacent building in the street corner	3203	43,71	36,22	3254	43,50	36,80	7222	40,50	81,68	4904	42,51	55,46	8842	33,80
Usage of Buildings														
Residential	3855	52,61	22,90	4887	65,39	29,03	10936	61,32	64,96	7434	64,44	44,16	16835	64,35
Residential + Commercial	2920	39,86	40,62	2100	28,10	29,21	5708	32,01	79,40	3463	30,02	48,17	7189	27,48
Commercial	538	7,34	26,13	471	6,30	22,88	1136	6,37	55,17	617	5,35	29,97	2059	7,87
Industrial	14	0,19	17,72	16	0,21	20,25	54	0,30	68,35	22	0,19	27,85	79	0,30

Table 4. 29 Attributes of Risky Buildings and Total Building Stock in Fatih (continued)

Attributes of the Buildings	Risky Buildings according to Engineering Surveys			Risky Buildings according to Mitigation Planning Approach									Total Buildings in Fatih	
				The First Set of Risk Criteria			The Second Set of Risk Criteria			The Third Set of Risk Criteria				
	No. of buildings **(Total: 7327)**	% in risky buildings	% in Fatih (26162)	No. of building **(Total: 7474)**	% in risky buildings	% in Fatih (26162)	No. of building **(Total: 17834)**	% in risky buildings	% in Fatih (26162)	No. of buildings **(Total: 11536)**	% in risky buildings	% in Fatih (26162)	No. of buildings & % **(Total: 26162)**	
Distribution in regard to Protection Areas														
1st Degree	606	8,27	32,34	555	7,43	29,62	1095	6,14	58,43	729	6,32	38,90	1874	7,16
2nd Degree	934	12,75	34,29	1054	14,10	38,69	1693	9,50	62,15	1537	13,32	56,42	2724	10,41
3A	2627	35,85	25,42	2888	38,64	27,94	6853	38,42	66,30	3355	29,09	32,46	10336	39,51
3B	3160	43,13	28,14	2977	39,83	26,51	8193	45,94	72,97	5915	51,27	52,68	11228	42,92
Distribution in regard to Multi-hazard Zones														
Non-hazardous	4590	62,64	27,80	4820	64,38	29,20	11356	63,68	68,79	3976	34,47	24,22	16508	63,10
2- hazard	2291	31,27	26,93	1972	26,39	23,18	5590	31,34	65,70	6696	58,04	79,22	8508	32,52
3- hazard	249	3,40	37,96	192	2,57	29,27	398	2,23	60,67	374	3,24	57,01	656	2,51
4- hazard	115	1,57	36,51	315	4,13	100,00	315	1,77	100,00	315	2,73	100,00	315	1,20
5- hazard	82	1,12	46,86	175	2,53	100,00	175	0,98	100,00	175	1,52	100,00	175	0,67

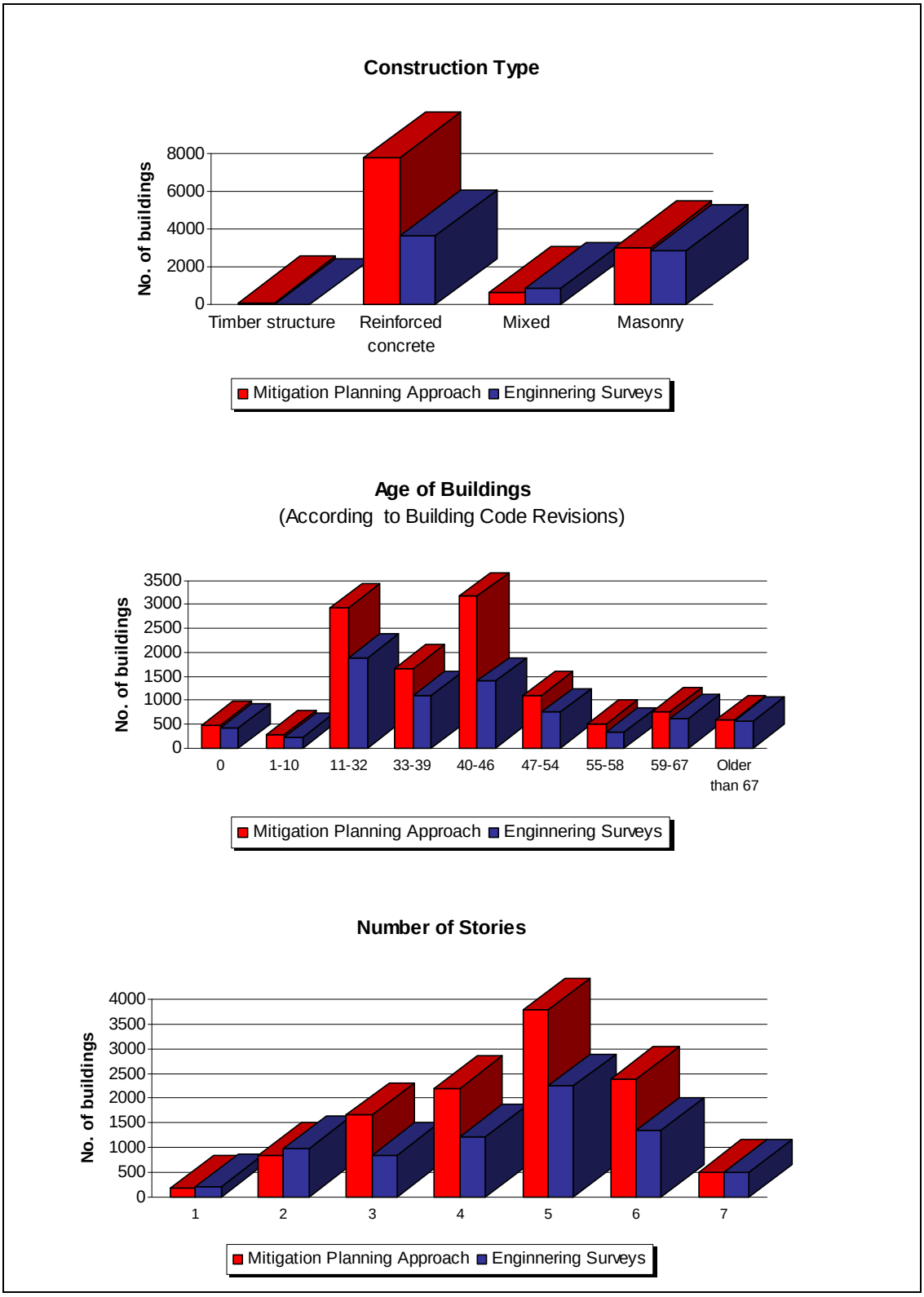

Figure 4.27 Results of the Third Set of Risk Criteria according to Mitigation Planning Approach in comparison with Engineering Survey Results

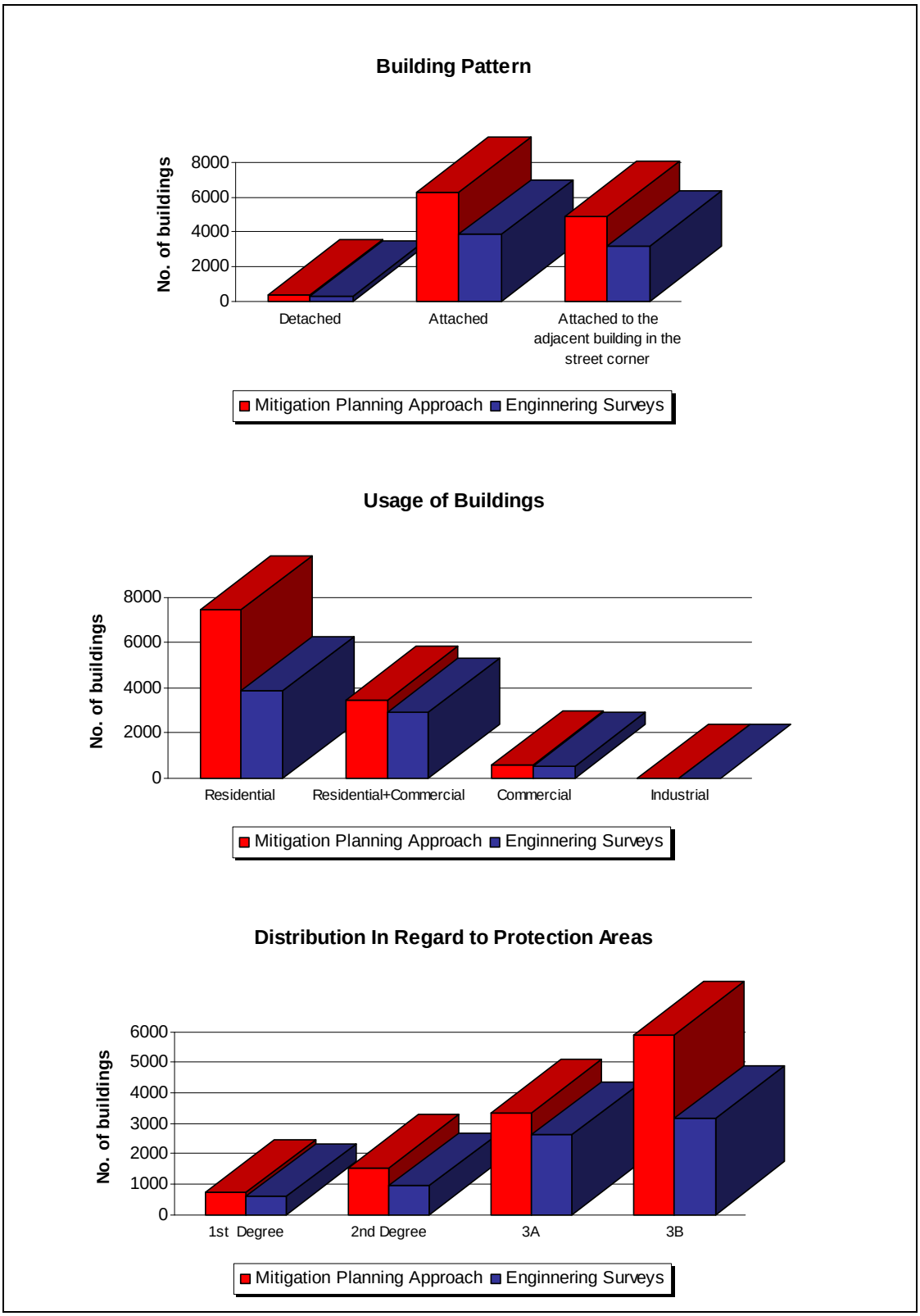

Figure 4.27 Results of the Third Set of Risk Criteria according to Mitigation Planning Approach in comparison with Engineering Survey Results (continued)

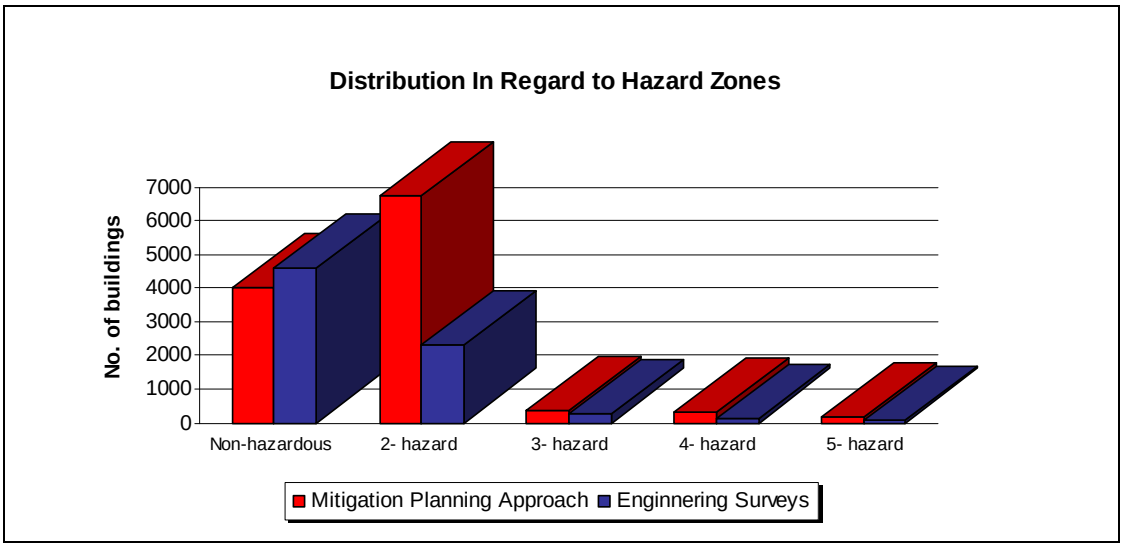

Figure 4.27 Results of the Third Set of Risk Criteria according to Mitigation Planning Approach in comparison with Engineering Survey Results (continued)

If we generally look at structural properties of the risky buildings, 26% of those are masonry and 67% are reinforced concrete; 53% are older than 40 years; 33% have 5 stories and 21% have 6 stories; 42% of those are attached adjacent building in the street corner.

When we look at the usage of risky buildings, it is observed that residential buildings have a majority in total risky buildings with a percentage of 64. These buildings gain more importance in respect to their residential usage. Because it is possible to say that in case of an earthquake, casualties increase because of risky buildings containing residential function.

Analysis results present that about 80% of the risky buildings are located in 3A and 3B Protection Areas. It can be considered an advantage in terms of intervention as short term and long term regenerations are allowed in 3A and 3B Protection Areas according to Historical Peninsula Conservation Plan.

Also analysis results present that 66% of the risky buildings are located in multi-hazard zones. It can be indicated that these buildings need to intervene primarily.

When we look at the spatial distribution of risky buildings, it is observed that risky buildings are densely located especially in;

- ✓ ***Fener-Balat region in northern part of the district,***
- ✓ ***Zeyrek region and along the shore of the Haliç***
- ✓ ***Yalı Mahallesi on the shore of the Marmara Sea in southern part of the district***
- ✓ ***Şehremini-Çukurbostan and Yedikule-Samatya regions at the south of Millet Street.***

Risky buildings are spread in other regions of the district also (Figure 4.28).

When 11.536 risky buildings determined in accordance with mitigation planning approach, are compared with 7327 risky buildings determined in accordance with the engineering surveys, it is seen that there are 3893 common buildings that have been included in both sets.

Thus, ***55%*** of the risky buildings determined in accordance with the engineering surveys, overlap with the risky buildings which are determined in accordance with the mitigation planning approach.

The attributes of overlapping buildings included in both studies and the attributes of the residual groups excluded in either of the studies are presented in Table 4.30 for a more detailed comparison and their spatial distribution in the district is presented in Figure 4.29.

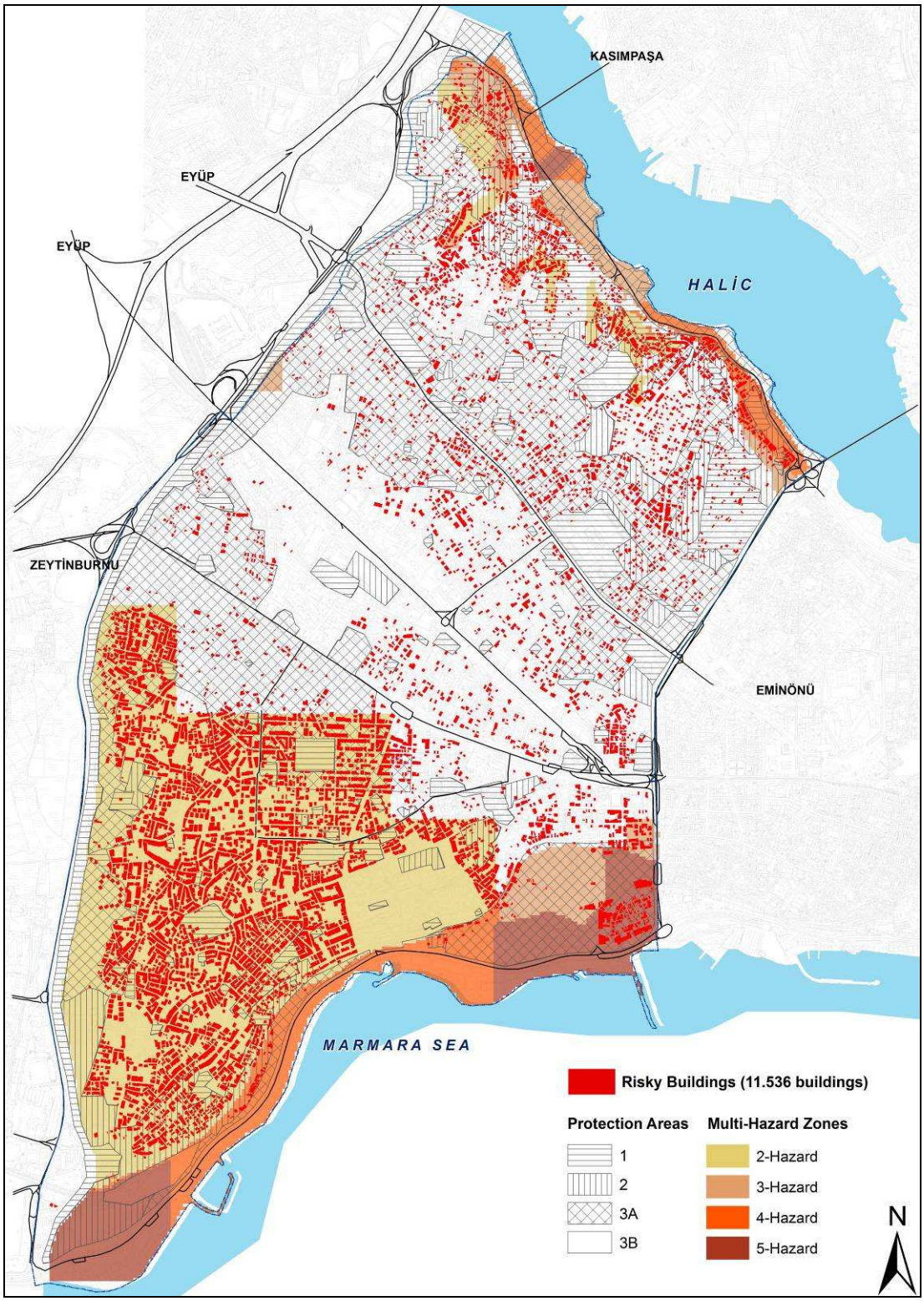

Figure 4.28 Risky Buildings according to The Third Assumed Risk Criteria according to the Mitigation Planning Approach

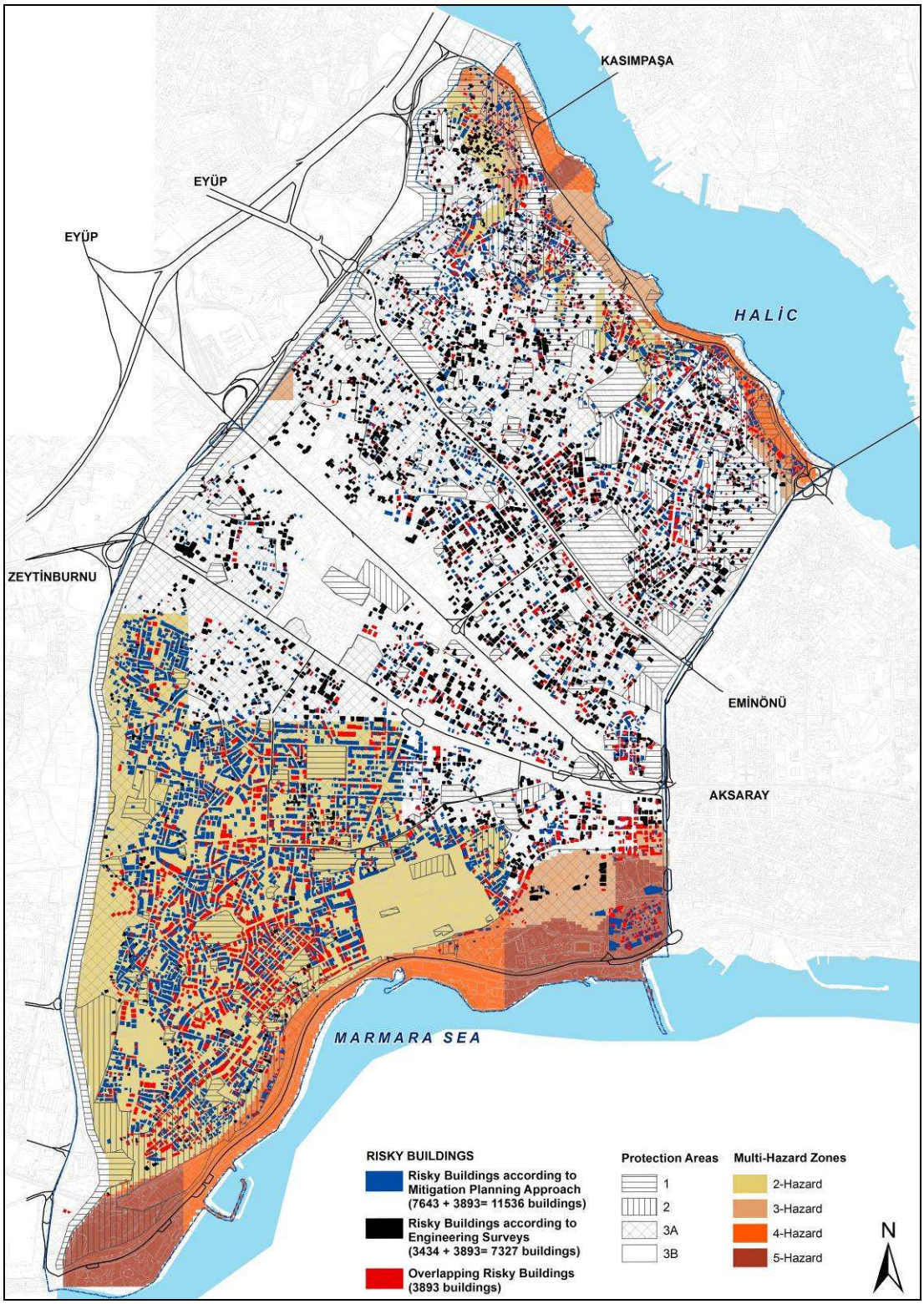

Figure 4.29 Spatial Distribution of Overlapping Risky Buildings in both studies and the Residual Groups excluded in either of the studies

Table 4.30 Attributes of Overlapping Risky Buildings in both studies and the Residual Groups excluded in either of the studies

RESIDUAL RISKY BUILDINGS (Engineering Surveys)			OVERLAPPING RISKY BUILDINGS			RESIDUAL RISKY BUILDINGS (Mitigation Planning Approach)		
CONSTRUCTION TYPE	Number of Buildings	%	**CONSTRUCTION TYPE**	Number of Buildings	%	**CONSTRUCTION TYPE**	Number of Buildings	%
Reinforced concrete	1687	49,13	Reinforced concrete	1960	50,35	Reinforced concrete	5850	76,54
Mixed	397	11,56	Mixed	441	11,33	Mixed	180	2,36
Masonry	1350	39,31	Masonry	1492	38,33	Masonry	1527	19,98
Timber structure	0	0,00	Timber structure	0	0,00	Timber structure	86	1,13
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**
BUILDING AGE According to Building Code Revisions	Number of Buildings	%	**BUILDING AGE**	Number of Buildings	%	**BUILDING AGE**	Number of Buildings	%
0 (Built after 2006)	258	7,51	0 (Built after 2006)	173	4,44	0 (Built after 2006)	305	3,99
1-10 (Built in 1997-2006)	153	4,46	1-10 (Built in 1997-2006)	69	1,77	1-10 (Built in 1997-2006)	221	2,89
11-32 (Built in 1975-1996)	1113	32,41	11-32 (Built in 1975-1996)	776	19,93	11-32 (Built in 1975-1996)	2160	28,26
33-39 (Built in 1968-1974)	654	19,04	33-39 (Built in 1968-1974)	448	11,51	33-39 (Built in 1968-1974)	1216	15,91
40-46 (Built in 1961-1967)	359	10,45	40-46 (Built in 1961-1967)	1034	26,56	40-46 (Built in 1961-1967)	2142	28,03
47-54 (Built in 1953-1960)	280	8,15	47-54 (Built in 1953-1960)	469	12,05	47-54 (Built in 1953-1960)	642	8,40
55-58 (Built in 1949-1952)	129	3,76	55-58 (Built in 1949-1952)	221	5,68	55-58 (Built in 1949-1952)	297	3,89
59-67 (Built in 1940-1948)	245	7,13	59-67 (Built in 1940-1948)	380	9,76	59-67 (Built in 1940-1948)	378	4,95
Older than 67 (Built before 1940)	243	7,08	Older than 67 (Built before 1940)	323	8,30	Older than 67 (Built before 1940)	282	3,69
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**
Average Age			**Average Age**	**41,87**		**Average Age**		

Table 4.30 Attributes of Overlapping Risky Buildings in both studies and the Residual Groups excluded in either of the studies (continued)

RESIDUAL RISKY BUILDINGS (Engineering Surveys)			OVERLAPPING RISKY BUILDINGS			RESIDUAL RISKY BUILDINGS (Mitigation Planning Approach)		
NUMBER OF STOREY	Number of Buildings	%	**NUMBER OF STOREY**	Number of Buildings	%	**NUMBER OF STOREY**	Number of Buildings	%
1	188	5,47	1	17	0,44	1	150	1,96
2	632	18,40	2	342	8,78	2	494	6,46
3	316	9,20	3	533	13,69	3	1122	14,68
4	576	16,77	4	634	16,29	4	1572	20,57
5	801	23,33	5	1437	36,91	5	2346	30,69
6	647	18,84	6	706	18,14	6	1678	21,95
7	274	7,98	7	224	5,75	7	281	3,68
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**
Average no. of Storey			**Average no. of Storey**	**4,58**		**Average no. of Storey**		
BUILDING PATTERN	Number of Buildings	%	**BUILDING PATTERN**	Number of Buildings	%	**BUILDING PATTERN**	Number of Buildings	%
Detached	159	4,63	Detached	125	3,21	Detached	225	2,94
Attached	2118	61,68	Attached	1722	44,23	Attached	4560	59,66
Attached to the adjacent building in the street corner	1157	33,69	Attached to the adjacent building in the street corner	2046	52,56	Attached to the adjacent building in the street corner	2858	37,39
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**

Table 4.30 Attributes of Overlapping Risky Buildings in both studies and the Residual Groups excluded in either of the studies (continued)

RESIDUAL RISKY BUILDINGS (Engineering Surveys)			OVERLAPPING RISKY BUILDINGS			RESIDUAL RISKY BUILDINGS (Mitigation Planning Approach)		
USAGE OF BUILDING	Number of Buildings	%	**USAGE OF BUILDING**	Number of Buildings	%	**USAGE OF BUILDING**	Number of Buildings	%
Residential	1830	53,29	Residential	2025	52,02	Residential	5409	70,77
Residential+Commercial	1305	38,00	Residential+Commercial	1615	41,48	Residential+Commercial	1848	24,18
Commercial	287	8,36	Commercial	251	6,45	Commercial	366	4,79
Industrial	12	0,35	Industrial	2	0,05	Industrial	20	0,26
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**
DISTRIBUTION IN PROTECTION AREAS	Number of Buildings	%	**DISTRIBUTION IN PROTECTION AREAS**	Number of Buildings	%	**DISTRIBUTION IN PROTECTION AREAS**	Number of Buildings	%
1st Degree	303	8,82	1st Degree	303	7,78	1st Degree	426	5,57
2nd Degree	313	9,11	2nd Degree	621	15,95	2nd Degree	916	11,98
3A	1511	44,00	3A	1116	28,67	3A	2239	29,29
3B	1307	38,06	3B	1853	47,60	3B	4062	53,15
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**
DISTRIBUTION IN MULTIHAZARD ZONES	Number of Buildings	%	**DISTRIBUTION IN MULTIHAZARD ZONES**	Number of Buildings	%	**DISTRIBUTION IN MULTIHAZARD ZONES**	Number of Buildings	%
Non-hazardous	3036	88,41	Non-hazardous	1554	39,92	Non-hazardous	2422	31,69
2-hazard Zones	328	9,55	2-hazard Zones	1963	50,42	2-hazard Zones	4733	61,93
3-hazard Zones	70	2,04	3-hazard Zones	179	4,60	3-hazard Zones	195	2,55
4-hazard Zones	0	0,00	4-hazard Zones	115	2,95	4-hazard Zones	200	2,62
5-hazard Zones	0	0,00	5-hazard Zones	82	2,11	5-hazard Zones	93	1,22
Total	**3434**	**100,00**	**Total**	**3893**	**100,00**	**Total**	**7643**	**100,00**

When looking at the results of two studies in general, it is observed that risky buildings of the mitigation planning approach constitute about 44% of total buildings in the Fatih District. However, risky buildings of the engineering survey constitute 27% of total buildings in Fatih. Number of risky buildings according to mitigation planning approach is greater than number of risky buildings determined by engineers.

The main reasons of this distinction are the approach of mitigation planning to the local natural hazards and consideration of hazardous uses as an indicator of risk.

According to urban risk analysis of mitigation planning approach, there are more buildings determined risky due to locating in potential natural hazard zones. In the engineering surveys, the ground motion intensity presented by PGV is the only parameter related to potential natural hazards. However, in the mitigation planning analyses not only ground motion intensity but also liquefaction, steep hill sides and landslide, artificial landfills, fault lines, geological formations, tsunami impact and drainage basins are considered as local natural hazards and multi-hazard map that consists of overlapping of these natural hazard zones, is essential to assess risks in the building stock. For example, all buildings that located in the 4 and 5-hazard zones are determined risky. Also, within the scope of risk analysis of mitigation planning approach, structural properties of buildings are considered regarding to multi-hazard zones for determining risks in the building stock.

According to urban risk analysis of mitigation planning approach, buildings having industrial or manufacturing function and hazardous uses such as lpg and gas stations are a threat factor for neighbouring buildings and their surrounding area as they can cause secondary disasters after an earthquake. On the other hand, in engineering studies the parameter of usage of buildings or hazardous units are not taken into consideration.

When we look at attributes and spatial distribution of overlapping risky buildings; it draws attention that overlapping risky buildings are generally reinforced and masonry, 5 or 6-storey, built before 1968 and attached to the adjacent building in the

street corner. Also it draws attention in spatial distribution of risky buildings, the shore of Haliç and southwest part of the district, which have PGV value is relatively high are the regions where overlapping risky buildings are located intensively.

When we review the attributes and spatial distribution of the buildings that are risky according to mitigation planning approach but are not risky according to engineering surveys, it can be indicated that these buildings are consist of timber structure buildings; buildings containing industrial and manufacturing function and their neighbouring buildings; multi-storey buildings located in multi-hazard zones generally.

If we also review the attributes and spatial distribution of the buildings that are risky according to engineering surveys but are not risky according to mitigation planning approach, it is primarily observed that these buildings are younger than 40 years located in non-hazardous areas.

Consequently, the mitigation planning approach considers not only structural properties of buildings but also potential natural hazards and usage of buildings. However in engineering survey, structural properties of buildings are essential to determine risks in building stock. The engineering approach considers structural properties as an indicator of risk regarding to only ground motion intensity as a potential natural hazard. For instance the mitigation planning approach considers structural parameters in relation with hazard zones and determines risks in the building stock regarding to natural hazard zones that require different structural robustness.

Therefore, urban risk analysis of the mitigation planning approach represents a more comprehensive understanding and treatment of risk. Also, the method of mitigation planning for risk determination in the existing building stock has advantages in terms of processing in shorter periods and with lower costs than the engineering approach.

CHAPTER 5

CONCLUSIONS

The approach to risk assessment, risk reduction, and mitigation planning are deficient, and mitigation planning activities in urban areas are mostly confined to a focus on building-level risk mitigation in Turkey.

Current mitigation efforts aiming to provide the safety of cities are **contended with analysis of robustness of buildings** apart from analysis of different risks in urban areas. Risk identification studies in the existing building stock cover the **evaluation of individual buildings in particular areas, using geophysical and engineering analysis** and **estimating probability of collapse and damage in individual buildings according to their technical properties alone, and the ground motion intensity of ground they are located.**

Such efforts are observed to consider solely the building-retrofitting task. These also assume that **engineering profession** is the only responsible authority, and that their decisions are sufficient for the achievement of safety in cities. This situation is a result of acceptance of the discourse of "it is the buildings that kill people" and the existence of a powerful professional lobby which insists on this current approach and aims prevalently the retrofitting operations.

Besides reducing and degrading 'mitigation planning' activities to building-level risk mitigation, other deficiencies are observed in the current disaster risk management approach of Turkey. The main deficiencies are;

- Conventional disaster management system concentrates on post-disaster activities.

- The conventional disaster policy has two major components: the Disasters Law and the Development Law. The main focus of the Disasters Law deals with the post-disaster operations and relief organizations. The Development Law has almost no reference to natural disasters. There is no interrelation between the two systems.
- The responsibilities and authorizations of administrative units are insufficient as they are traditionally confined to post-disaster SAR and compensation operations. Administrative structure lacks coordination. Tasks of responsible bodies and method of risk reduction studies are undefined.
- Mitigation measures are generally considered as building supervision, insurance functions, professional proficiency and building-retrofitting task.
- The Earthquake Zoning Map of Turkey, provisions of which are directly related to variant building design standards in each zone, do not consider primary factors of risk, social vulnerabilities and other attributes of the building stock and only indicates expected acceleration values of provinces and settlements.
- Urban pattern, land use, neighboring uses, forms of ownership, management, socio-economical structure and local opportunities of cities or settlements are not taken into consideration generally in the determination of risks in the city.
- Although the seismic evaluation of existing buildings and particularly strengthening of public facilities constitutes one of the mitigation activities with implementation examples in Turkey, there is no legal or organizational arrangement related with evaluating earthquake performance of existing urban areas.

However, concepts and methods of urban mitigation planning are entirely different from conventional disaster risk management and building-level risk mitigation approach. Mitigation planning approach and current disaster management approach of Turkey are compared in the Table 5.1.

Table 5.1 Comparison of Mitigation Planning Approach and Current Disaster Management Approach in Turkey

	Mitigation Approach	Existing Approach
Policy	Disaster management system requires a continuous chain of activities that includes pre-disaster (mitigation, preparation) and post-disaster (response, recovery) activities.	Conventional disaster management system concentrates on post-disaster activities.
Strategy	Mitigation Planning requires long-term strategy to reduce disaster risk.	Mitigation measures are generally considered as building supervision, insurance functions, professional proficiency, building-retrofitting task.
Legislation	As mitigation planning can not be implemented separate from urban planning, legislation of disasters and legislation of planning must be interactive. The duties and authorizations of institutions responsible for mitigation activities must be identify in legislation related with disasters and urban planning.	The conventional disaster policy has two major components: the Disasters Law and the Development Law. The main focus of the Disasters Law deals with the post-disaster operations and relief organizations. The Development Law has almost no reference to natural disasters. There is no an interrelation between the two systems.
Organization	Mitigation planning draws the framework for a series of social contracts, indicating to the operations necessary, the responsible bodies and the responsibilities of all administrative units, private bodies, professional/academic disciplines and citizens.	The responsibilities and the authorizations of administrative units are insufficient. Administrative structure lacks coordination. Tasks of responsible bodies and method of risk reduction studies are undefined.
Method	Mitigation planning describes risk sectors in city and evaluates them as a whole.	Mitigation studies solely consider “risks in the building stock” and ignore other risk sectors. Building-retrofitting task is implemented on singular buildings. There is no activity at city scale.
	Mitigation planning consider that cities or settlements may have different risk profiles regarding to their urban pattern, land use, forms of ownership, management, socio-economical structure and local opportunities, so the city level risk variations are relatively different.	Local attributes of cities or settlements are not taken into consideration generally. Also, local governments are not efficient and they have no sufficient responsibility and authorization classified for pre-disaster activities.
	Mitigation studies are based on comprehensive and multidisciplinary studies.	Mitigation studies are performed on a limited basis in terms of pilot projects in particular areas and carried out by some professional disciplines.
	Microzonation maps identify hazards in the city and it is a prerequisite for land-use planning activities at city level.	Geological maps and geological evaluation reports are prepared for individual sites.

A new content for mitigation studies is therefore necessary in existing building stock and in cities. A method for decision-making related with the built environment according to mitigation planning objectives is developed, and a new perspective combining the engineering approach in building stock safety and mitigation planning approach to risk determination in the urban environment is presented in this thesis.

Within the scope of thesis, the existing building stock in the Fatih District is investigated according to mitigation planning objectives. These analyses basically depend on assessment of building's attributes to determine relatively more vulnerable buildings by using data produced by existing data of prior surveys. Findings of the engineering studies related to seismic safety of buildings in the Fatih District have also been used as a basis for comparisons. The aim of comparison between mitigation approach and engineering approach in the seismic risk assessment of existing building stock is to establish the set of attributes that could provide a maximum ratio of concurrence in the building stock.

The results of these two studies, which employ the same population of buildings, but with different risk indicators, are compared. Main difference between the two studies is the consideration of local hazards as bases of risk in the built-up area. In the engineering surveys, the peak ground motion intensity presented by PGV is the only parameter related to local hazards.

On the other hand, in the mitigation analyses not only peak ground motion intensity but also liquefaction, landslide at steep hill sides, artificial landfills, fault lines, geological formations, tsunami impacts, technological hazards and drainage basins are considered as potential local hazards.

Besides this main difference about consideration of local hazards, structural properties of buildings are assessed according to different parameters and different concepts in the two studies. In engineering studies, structural parameters are number of stories, existence of a soft storey, existence of heavy overhangs and overall apparent building quality. These vulnerability parameters are essential for the evaluation of seismic capacity of buildings and their robustness. However these

parameters serve for decisions for retrofitting or removal of individual reinforced concrete buildings. In mitigation planning analyses, structural parameters of buildings are number of stories, construction type and building age and these parameters are used by interrelating them with natural hazard zones to identify relative vulnerabilities in the building stock and urban environment as a whole. As a result of relative vulnerability analysis, more vulnerable sub-groups of the building stock can be defined such as high-rise timber structure buildings and multi-storey old buildings.

Another essential parameter is usage type of buildings. In Fatih there are buildings containing hazardous uses such as basic industrial activities and manufacturing. Such uses in these buildings are a second source of threat factors for the neighboring buildings and their surrounding area in case of an earthquake. However, in engineering studies, the parameter of usage type is not taken into consideration.

The main differences between the mitigation planning approach and the engineering approach as mentioned above, are presented in Table 5.2.

Table 5.2 Differences between the Mitigation Planning Approach and the Engineering Approach

	Mitigation Planning Approach	**Engineering Approach**
Structural Properties of Buildings	1. Construction type 2. Number of stories 3. Age of buildings	1. Number of stories 2. Existence of a soft storey 3. Existence of heavy overhangs 4. Overall apparent building quality.
Potential Natural Local Hazards	1. Ground motion intensity 2. Liquefaction 3. Steep hill sides and landslide 4. Artificial landfills 5. Fault lines 6. Alluvial ground 7. Geological formations 8. Tsunami impact areas 9. Drainage basins	1. Ground motion intensity 2. Soil type
Usage Types of Buildings and Hazardous Uses	Industrial buildings and their immediate neighbouring buildings are defined as risky buildings. Also, gas and lpg stations are taken into consideration and their neighbouring buildings defined as risky buildings.	Usage types of buildings are not considered as an indicator of risk in the building stock.
Method of determining risky buildings	Structural parameters are considered in relation with natural hazard zones and risks in the building stock are determined regarding to natural hazard zones that require different structural robustness.	Structural parameters are essential to determine risks in building stock. Structural properties are considered as an indicator of risk regarding to only ground motion intensity as a potential natural hazard.
Results and Recommendations	Analysis results provides an opportunity of defining and prioritization for high risk areas and making decisions about collective physical rehabilitation of buildings and the upgrading of urban areas.	Analysis results identify seismic capacity of buildings and their robustness. These results serve for decisions for retrofitting or removal of individual buildings.

Mitigation planning analyses and engineering surveys in the existing building stock, both aim earthquake safety in the urban areas, but it is necessary to conduct these two studies interactively. Thus the general screening procedure made by engineers currently can be transformed into purposeful studies that target city-scale, with corresponding useful data. It is indicated that the input data of engineering surveys is gathered with sidewalk survey procedure based on observing structural parameters of the buildings individually. However, input data of mitigation planning approach is already available in any municipality. Such data-base contains information related with construction type, number of stories, building age and usage of buildings, which can be directly obtained from municipalities. Thus mitigation planning approach can determine risks in building stock in shorter periods and with lower costs, and does not require expert engineering services. As a result, urban risk analysis of the mitigation planning approach represents a more comprehensive understanding and treatment of environmental risk depending on the studies of local hazards, relative vulnerabilities of buildings and usage of buildings, together with local social tendencies.

It is obvious that the starting point of mitigation efforts for earthquake safety of cities should introduce a planning vision, with a determination of risk area prioritizations for detailed engineering surveys. Obviously, as the well-stated aphorism goes: "if vision without action is daydreaming, action without vision is nightmare".

In this context, the analysis made within the scope of the case study can be considered as "a rapid assessment process" that could enable more intensive and detailed engineering surveys specifically targeted at high-risk areas determined by planners' efforts.

Consequently, the two approaches imply different modes of responses. The engineering approach relies on the expectation that individual property owners in any building would cooperate to improve the structural system of high-risk buildings, which relies on market interactions. Comprehensive approach of mitigation studies provides on the other hand, an opportunity of defining and prioritization for high-risk areas, and the possibility of making decisions about collective physical rehabilitation

of buildings and the upgrading of urban areas. This mode of operations is available within powers of local authorities by law. In this context, depending on results of urban risk analysis in the existing building stock in Fatih, areas where risky buildings are densely located should be designated as “project areas”. The project areas and forms of intervention can be determined according to following recommendations for groups of risky buildings.

5.2. Recommendations according to the urban risk analysis of Mitigation Planning Approach

1. ***Buildings located in multi hazard zones especially 4-hazard and 5-hazard zones***, should have higher safety standards. The required properties for those regions should have a safer level through building regulations, usage types and environment standards. Typical application models should be developed for typical conditions in those regions.

2. ***In areas where timber structure buildings are densely located***, usage types should be restricted in order to protect traditional timber structure buildings. Moreover, neighbouring buildings and their usages, open land ratios in parcel and access ways should be taken into consideration.

3. It should be considered that relatively older buildings are more vulnerable particularly multi-storey ones, even the reinforced concrete buildings. These buildings require independent engineering analyses and suggestions. Those located in multi hazard zones should be considered as threat factors for their surrounding area and necessary measures should be taken. Additionally, different principles should be defined for the ***old and multi-storey buildings*** located in the different Protection Areas. If these buildings are also located in multi- hazard zones, these areas should be considered as special project areas.

4. ***For relatively older buildings***, usage permissions should be restricted and stricter measures should be taken particularly in multi hazard zones.

5. ***Industrial buildings in 1st Degree Protection Areas or in neighbouring areas*** (e.g. Ali Fakih Neighbourhood) should be detected in detail. These buildings should be controlled, expropriated and removed if it is required, and they should be transformed to comply with protection aims of the Historical Peninsula.

6. ***In areas where industrial buildings are located together with other usages*** (e.g. Hızırçavuş Neighbourhood), removal, retrofit or transformation opportunities of industrial buildings should be identified in detail and, projects prepared by taking into consideration their manufacturing type, accessibility and sizes.

7. ***Commercial usage of buildings*** should be controlled and opportunities of constructing new 2 or 3-storey commercial buildings should be considered within the scope of urban design projects.

5.2. Further Lines of Investigation

This study is an attempt of inquiry on the basic and primary step of identification of various types of risks in the building stock and its environment, the mitigation problems in the safety of buildings and the city. Within the scope of an empirical study of the existing building stock in Fatih District in Istanbul, structural properties of buildings, usage types of buildings and potential natural hazards are considered to develop a method for decision making within a comprehensive urban planning context.

Apart from these attributes of buildings as well as urban pattern, land values, forms of ownership, rates of unauthorized buildings, population density and social conditions and behavioral tendencies could be effective in the determination of risks in the existing building stock.

This study could be further advanced with the contribution of other urban risk sectors and other lines of investigations, to establish an optimal representation of engineering findings with a set of simple parameters as proposed in this study. The final verdict will be available of course by means of observations after the earthquake we all are in the least expectation to occur, though inevitable.

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APPENDIX A

RISK ANALYSIS RESULTS ACCORDING TO THE FIRST SET OF CRITERIA ACCORDING TO THE MITIGATION PLANNING APPROACH

Table A.1 Properties of Risky Buildings according to the First Assumed Criteria

	Total Risky Buildings : 7474	**% within the total risky buildings**
Construction Type		
Timber structure	113	1,50
Reinforced concrete	3478	46,55
Mixed	691	9,25
Masonry	3192	42,71
Building Age (According to Building Code Revisions)		
0 (Built after 2006)	51	0,68
1-10 (Built in 1997-2006)	22	0,29
11-32 (Built in 1975-1996)	209	2,80
33-39 (Built in 1968-1974)	274	3,67
40-46 (Built in 1961-1967)	3119	41,73
47-54 (Built in 1953-1960)	1396	18,68
55-58 (Built in 1949-1952)	642	8,59
59-67 (Built in 1940-1948)	988	13,22
Older than 67 (Built before 1940)	773	10,34
Number of Stories		
1	608	8,13
2	583	7,80
3	539	7,21
4	1961	26,24
5	2279	30,49
6	1220	16,32
7	284	3,80

Table A.1 Properties of Risky Buildings according to the First Assumed Criteria (continued)

Building Pattern		
Detached	119	1,59
Attached	4101	54,87
Attached to the adjacent building in the street corner	3254	43,50
Usage of Buildings		
Residential	4887	65,39
Residential+Commercial	2100	28,10
Commercial	471	6,30
Industrial	16	0,21
Distribution In Regard to Protection Areas		
1st Degree	555	7,43
2nd Degree	1054	14,10
3A	2888	38,64
3B	2977	39,83
Distribution In Regard to Multi-hazard Zones		
Non-hazardous	4857	64,99
2- hazard	2017	26,99
3- hazard	192	2,57
4- hazard	244	3,26
5- hazard	164	2,19

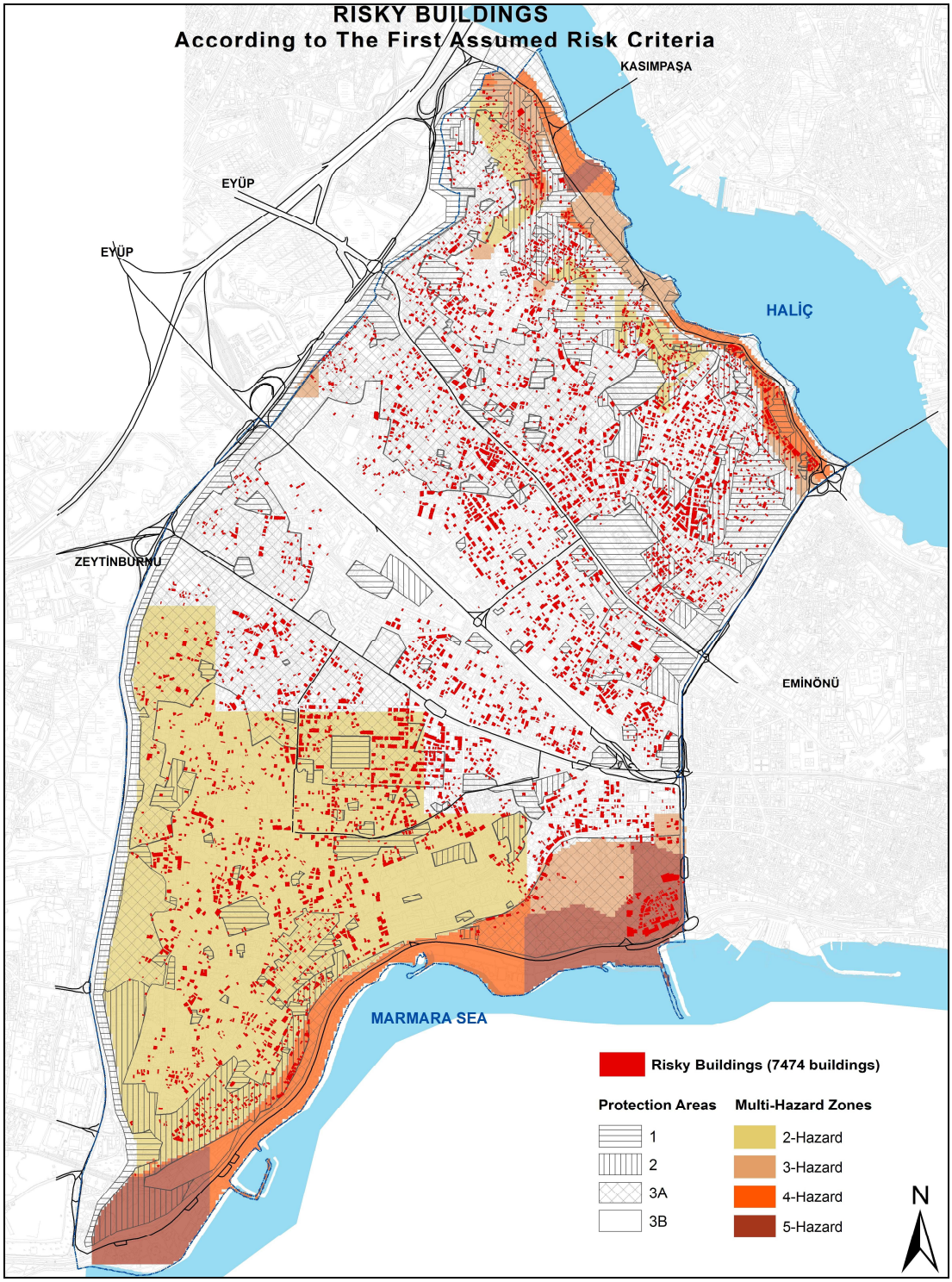

Figure A.1 Risky Buildings according to the First Assumed Risk Criteria according to the Mitigation Planning Approach

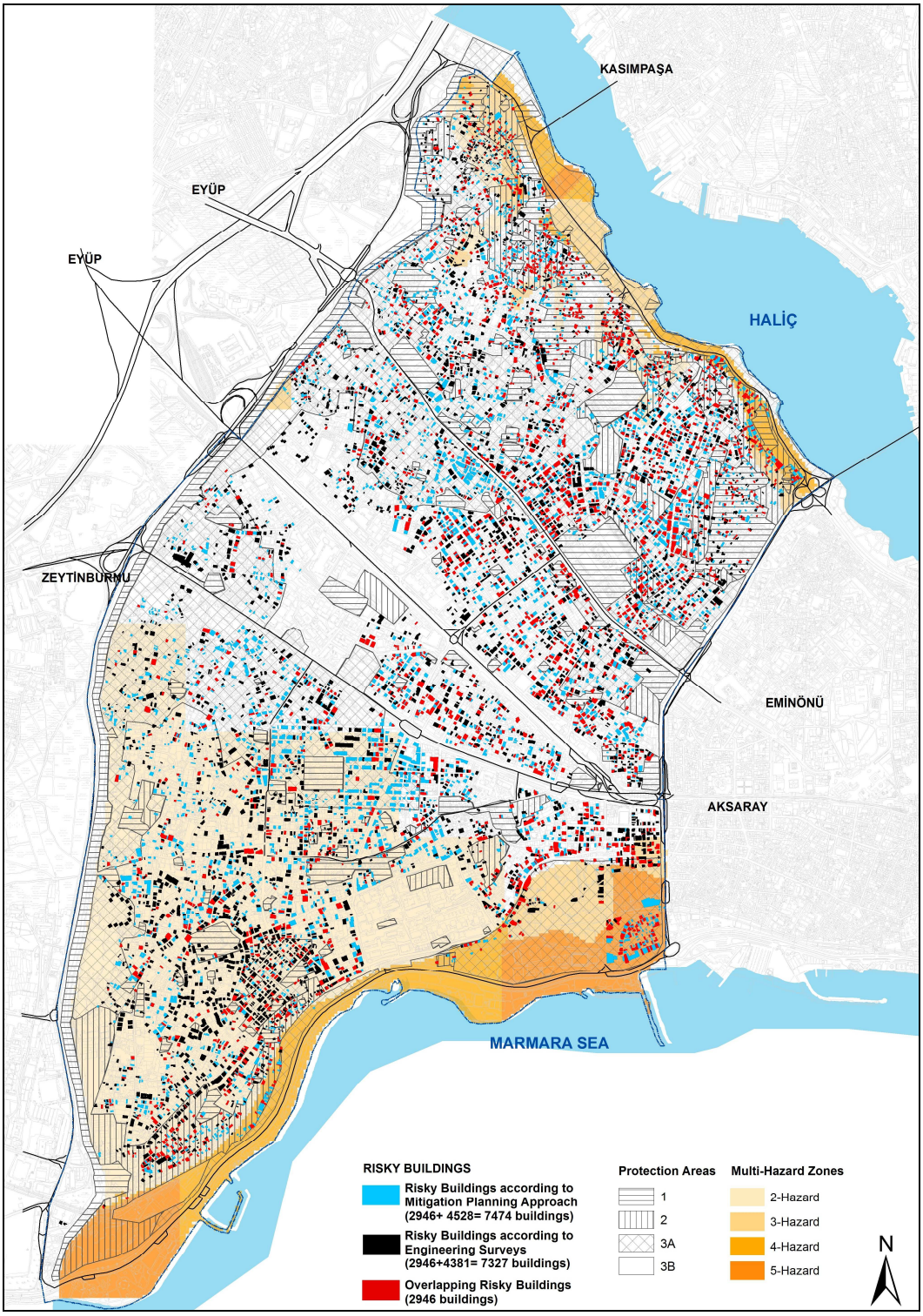

Figure A.2 Spatial Distribution of Overlapping Risky Buildings in both studies (Mitigation Approach/the First Set of Criteria & Engineering Survey) and the Residual Groups excluded in either of the studies

APPENDIX B

RISK ANALYSIS RESULTS ACCORDING TO THE SECOND SET OF CRITERIA ACCORDING TO THE MITIGATION PLANNING APPROACH

Table B.1 Properties of Risky Buildings according to the Second Assumed Criteria

	Total Risky Buildings : 17834	**% within the total risky buildings**
Construction Type		
Timber structure	113	0,62
Reinforced concrete	13572	76,12
Mixed	663	3,72
Masonry	3486	19,54
Building Age (According to Building Code Revisions)		
0 (Built after 2006)	681	3,82
1-10 (Built in 1997-2006)	699	3,92
11-32 (Built in 1975-1996)	6101	34,22
33-39 (Built in 1968-1974)	3367	18,88
40-46 (Built in 1961-1967)	3535	19,82
47-54 (Built in 1953-1960)	1265	7,09
55-58 (Built in 1949-1952)	587	3,29
59-67 (Built in 1940-1948)	871	4,88
Older than 67 (Built before 1940)	728	4,08
Number of Stories		
1	1134	6,36
2	1115	6,25
3	1175	6,59
4	1080	6,05
5	7012	39,32
6	5030	28,20
7	1288	7,23

Table B.1 Properties of Risky Buildings according to the Second Assumed Criteria (continued)

Building Pattern		
Detached	525	2,94
Attached	10087	56,56
Attached to the adjacent building in the street corner	7222	40,50
Usage of Buildings		
Residential	10936	61,32
Residential+Commercial	5708	32,01
Commercial	1136	6,37
Industrial	54	0,30
Distribution In Regard to Protection Areas		
1st Degree	1095	6,14
2nd Degree	1693	9,50
3A	6853	38,42
3B	8193	45,94
Distribution In Regard to Multi-hazard Zones		
Non-hazardous	11350	63,65
2- hazard	5590	31,34
3- hazard	398	2,23
4- hazard	320	1,79
5- hazard	176	0,99

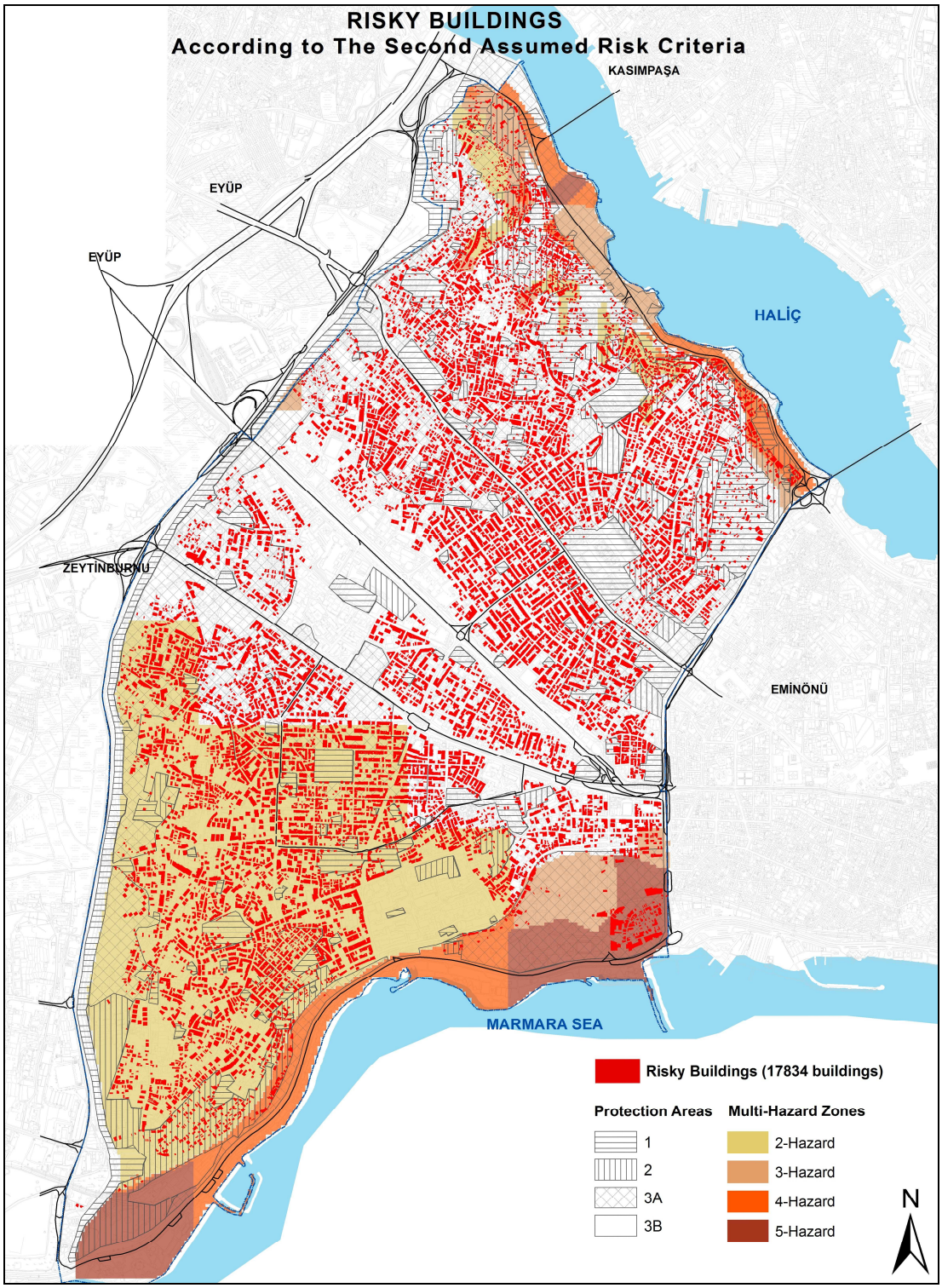

Figure B.1 Risky Buildings according to the Second Assumed Risk Criteria according to the Mitigation Planning Approach

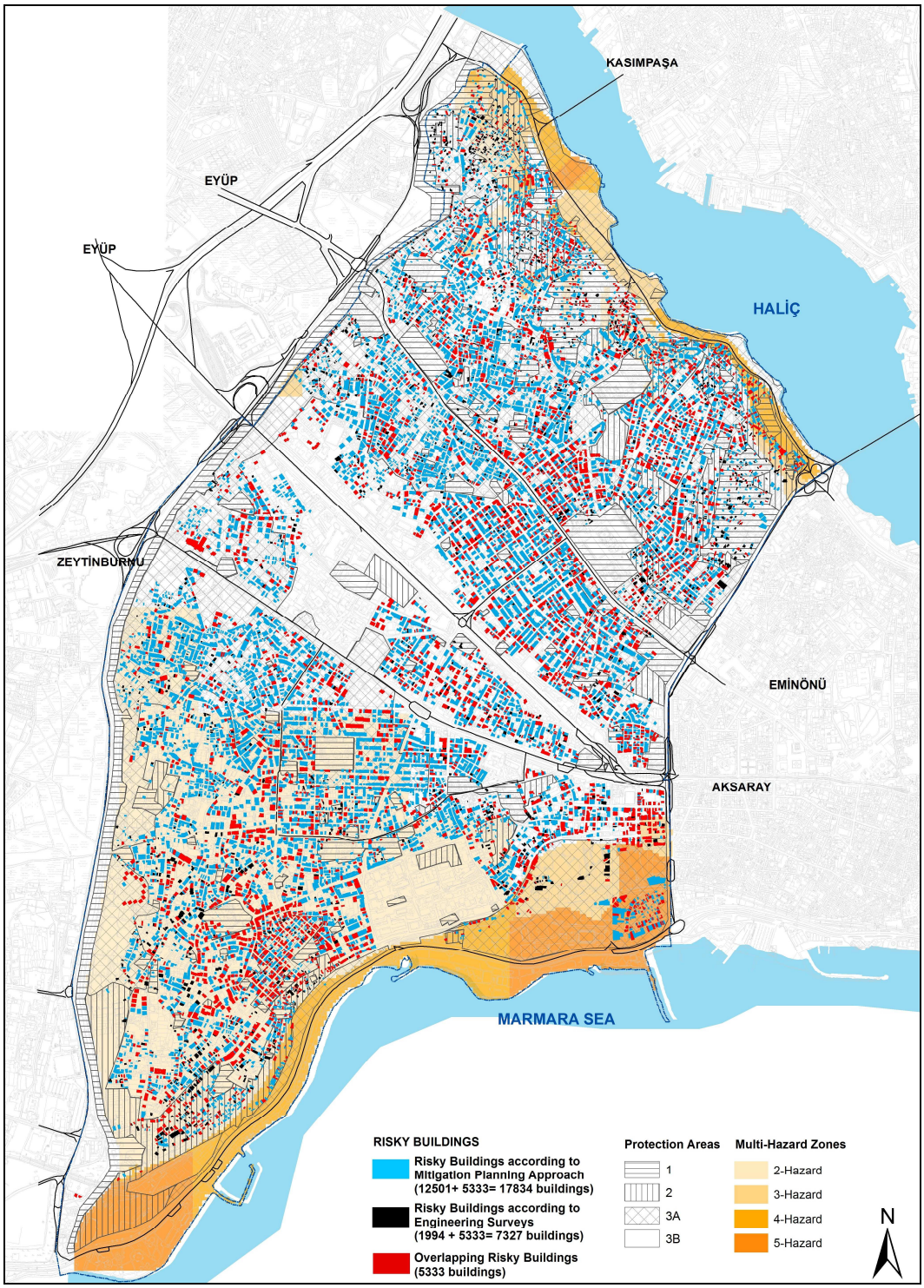

Figure B.2 Spatial Distribution of Overlapping Risky Buildings in both studies (Mitigation Approach/the Second Set of Criteria & Engineering Survey) and the Residual Groups excluded in either of the studies