EARTHQUAKE CONSCIOUS URBAN TRANSFORMATION AND REDEVELOPMENT: REPERCUSSIONS OF İZMİR RADIUS PROJECT ON FİKRİ ALTAY DISTRICT

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ABSTRACT

Earthquakes are one of the most destructive natural occurrences. They strike without warning and they may result various damages to urban environment and human life. The technology to predict their specific time, location and magnitude has not developed yet. It is possible to reduce the harmful effects of earthquakes and to create urban surroundings resistant to earthquakes by comprehensive projects stated as “risk mitigation activities”.

Turkey is exposed to earthquake risk due to fact that it is on an active seismic zone and that most of the buildings are not in conformity with earthquake safe design codes. İzmir also has high earthquake risk as determined in the content of İzmir RADIUS Project that is conducted by United Nations.

This thesis is mainly about to ensure safety of urban environment that is expose to earthquake risk. The thesis has three principle purposes: to produce a guide about the projects done for mitigating İzmir’s earthquake risk, to explain the strategies, process and methods for urban safety and to develop planning and design principles of earthquake conscious urban design.

Risk assessment process of the existing buildings and urban environment is the part of the urban safety process. In this context risk management, risk assessment process and the methods for risk assessment is clarified. Especially the methods for vulnerability assessment of existing urban pattern and of buildings are explained. Strategies for designing earthquake safe cities are discussed. Urban transformation is proposed as a solution of urban safety. As a matter of this, a case study is undertaken on Fikri Altay District in İzmir comprising a vulnerability assessment and an urban transformation project.

Different methods used in the content of the survey. İzmir’s scenario earthquake produced in the content of RADIUS Project is adopted for hazard assessment. Istanbul Earthquake Master Plans’ observed vulnerability assessment method is modified for the case study area and RADIUS computer software is used for damage estimation.

Consequently, a redevelopment plan and principles for earthquake conscious urban transformation is proposed.

ÖZET

Özellikle gelişmiş ve gelişmekte olan kentlerde deprem riski gittikçe artmaktadır. Depremin olması önlenemeyeceği ve önceden tahmin edilemeyeceği için, deprem hasarlarının azaltılması ve bunun için gerekli tedbirlerin alınması gerekmektedir. Deprem zararlarını azaltmak için yapılmış projeler ve yapılması gerekenler bu tezin araştırma konusudur.

Türkiye, gerek aktif bir sismik bölgede bulunmasından gerek Türkiye ‘deki yapıların deprem yönetmeliğine uymamasından dolayı riske maruz bir ülkedir. İzmir de deprem riski yüksek olan bir kenttir. Bu Birleşmiş Milletlerin yürüttüğü RADIUS Projesi kapsamında da belirlenmiştir. Bu tez İzmir’de yapılmış zarar azaltma çalışmalarının üzerinde yoğunlaşmıştır. Aynı zamanda İstanbul Deprem Planı ve diğer ülkelerdeki deprem zararını azaltma çalışmaları, İzmir’ de yapılacak çalışmalara rehber olması açısından incelenmiştir.

Bu çalışmaların kentsel güvenlik, risk yönetimi risk analizi ve değerlendirmesi konularına yaklaşımı ve önerileri açıklanmıştır. Özellikle yapıların hasar görebilirliğinin tespiti üzerinde çalışılmıştır. Yapıların sokaktan gözlenebilen özelliklerine göre yapısal özellikleri deprem riski açısından değerlendirilmiştir. Olası bir depremde, bilimsel olarak hazırlanmış senaryo depreminde, bu yapıların ve kentsel çevrenin göreceği zarar RADIUS projesi kapsamında önerilen bir bilgisayar programı aracılığıyla hesaplanmıştır.

Bu tez kapsamında deprem riski yüksek olan alanlarda kentsel dönüşümün gerçekleştirilmesi gerektiği ve bununla ilgili bir imar planı önerilmiştir. İleride yapılacak çalışmalara altlık oluşturması açısından kentsel tasarım ilkeleri önerilmiştir. Bütün çalışmalar Fikri Altay Mahallesi örneğinde tartışılmıştır.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1. Problem Definition

Earthquakes are one of the most destructive natural occurrences that turn into disasters by man-made effects. Earthquake disaster has major impacts on the urban environment. These negative consequences evince themselves by the infrastructures, property damage, economical losses, serious casualties and death. The scale of death and casualties are increasing due to the urbanization factors and other man made effects. Earthquake risk is intimately connected to processes of human development. At the same time, the development choices made by individuals, communities and nations can increase the earthquake risk.

Urbanization, the exodus from rural areas to cities, will be a major demographic phenomenon of the 21st century, according to experts. Whereas in 1950 only about 30 percent of the world's population lived in cities, the United Nations Human Settlements Program (WEB_9, 2005) currently puts that figure at %50. It is expected to rise to more than %60 by 2030. Due to this, earthquakes are more destructive when they strike large cities, given the growing trend of high urban-population densities. However, preventing or limiting the damage caused by earthquakes, floods and fires requires that earthquake risk should be reduced and strategies should be tailored for the specific risks that urban settlements face.

Earthquakes can not be prevented. However, the harmful effects can be minimized. Among the cities of the well developed and developing countries, it is possible to create urban surroundings resistant to earthquakes by comprehensive mitigation activities.

Turkey also is exposed to various kinds of natural hazards, especially earthquakes, due to fact that it is on an active seismic zone and that most of the buildings are not in conformity with earthquake safe design codes, although %99 of its land is on high-risk zone according to Turkey Earthquake map. Izmir, being the third biggest city of Turkey on west coast is one of the high-risk cities of Turkey.

Several organized activities have taken place worldwide to mitigate the earthquake risk. In this context, UN Secretariat has lunched RADIUS Project (Risk Assessment Tools for Diagnosis of Urban Areas) and selected nine case-study cities over 58 applicant cities. İzmir is chosen as one of these nine cities. Metropolitan Municipality of Izmir has signed a protocol with Bogazici University to execute the RADIUS Project. Consequently, Bogazici University has prepared the Earthquake Master Plan of Izmir that is also forming the RADIUS Project's data collection phase. Earthquake Master Plan of İzmir, and contents, proposals of RADIUS Project have been introduced and scrutinized in the scope of the thesis.

RADIUS Project and Earthquake Master Plan are an opportunity for to built safer urban environment but they either incomplete or some are missing. Public Authorities do not imbibe these projects enough. Therefore, project's proposals are not developed and realized.

1.2. Aim of the Study

The thesis on the problems of Turkey's and İzmir's existing situation has three principle purposes: to produce a guide about the projects done for mitigating İzmir's earthquake risk; to explain the strategies, process and methods for earthquake safety; and to develop planning and design principles of earthquake conscious urban design

The thesis aims to realize its purposes in four phases:

- The constitution of the conceptual, historical, and legal aspects of the earthquake mitigation activities;
- Defining the processes and methods for assessing the risk,
- Mitigating the defined risk;
- Discussion and a final evaluation of the findings, principles and the solutions

The study also aims to argue and seek for solutions to the problems of İzmir with a critical approach to develop a system to build for earthquake safety. The study claims that implementation of RADIUS Project in İzmir and Earthquake Master Plan has serious shortcomings in terms of spatial studies. The problems are just mentioned or referred to but the solutions are not provided. Within these projects it is remarked to implement earthquake mitigation projects, but up to now, this has not been realized even has not taken into consideration. As RADIUS Project and Earthquake Master Plan revealed the high earthquake risk in , it is aimed to focus on a specific area, which is aimed to be one of the high-risk areas that RADIUS Project indicates.

Within this study, it is investigated to propose a model for urban safety for earthquake prone areas that are developed without planning through a specific area. Risk assessment process of the existing buildings and urban environment is the part of the urban safety process. As a matter of this, a field survey is undertaken in the content of thesis. Within this survey existing buildings' risk assessment process and the methods searched and critically evaluated.

At the end of this survey, in case of presuming buildings' earthquake performance as low that means high risk, the priorities are aimed to define for urban transformation project aiming the urban safety. In the content of the site survey, it is intended to:

- To acquire the statistical data about housings, population and open areas
- To acquire the statistical data about building structure
- To identify the earthquake risk level of the buildings
- To estimate the losses
- To develop urban transformation strategies

1.3. Limits of the Study

Due to the comprehensive mitigation activities that executed in such as RADIUS Project comprising Earthquake Master Plan, and the high earthquake risk the city has, is selected as the case study city of this thesis.

The scope and the principles of the mitigation activities that have been done in , and the execution of them, are the subjects of the thesis. Therefore, the projects and activities within the other cities of the world, of Turkey, especially Istanbul, are researched and analyzed to be a guide for 's earthquake mitigation strategies.

Due to the earthquake risk it has, as indicated RADIUS Project, and the potential's for urban transformation, Fikri Altay District in Karsıyaka is chosen to be a case study area. The district is divided into 3 sub-zones. Out of these three sub zones, project area is chosen for proposed earthquake conscious urban transformation.

1.4. Methods of the Study

Methods of the study consisted of three steps as theoretical, analytical and pragmatical. The first step of the method involved the establishment of a conceptual and theoretical foundation necessary for further explanations and discussions in the following parts of the study. The second step of the method is to set the criteria for the evaluation of İzmir's mitigation activities analytically. Finally, third one included a pragmatical approach to propose a problem solving system for Fikri Altay District. Sources are the district itself, as buildings and urban pattern, people living in, interviews, and other visual sources as maps and photographs.

Theoretical Step; Literature Survey, Research; The theoretical foundation is tried to be given in two parts: first, the strategies of the researched activities are explained, and then the techniques that are needed to realize the strategies are particularized.

Literature survey is carried out to provide theoretical background about the definition and explanation of earthquake mitigation activities around the world and in Turkey. In addition to accustomed sources like books, articles, periodicals and academic publications, web sites are used for getting up-to-date information from experienced examples and recently accomplished studies.

Analytical approach: Interviews with professionals are used to get information about the RADIUS Project and to get information about the earthquake risk in Turkey and also to be aware of the public reaction and tendency. Field survey is done for the selected site, including all the natural and environmental features. Street observations, interviews with local people and oral history about the area helped to get needed information. Theoretical, empirical, and observational analyses are used in getting information in general and about the case study.

Pragmatical Approach: Finally, the third step included a pragmatical approach to propose a problem solving system for Fikri Altay District. The pragmatical approach consisted of four steps. The first is included the analyses of the district as a whole and dividing the district into sub zones. The second is choosing the project area out of these sub-regions based on the principles of being high risk and having the potential for urban transformation. The third is analyzing the chosen project area in detail for risk assessment process. The vulnerability assessment and damage assessment are being made based on risk assessment strategies given in the content of the thesis. In the fourth, the risk assessment results are evaluated and urban safety strategy of the area is chosen. In the content of fourth step, design and planning criteria are proposed for earthquake safety of the project area and in general.

Different methods used in the content of this study. These methods are all explained in the related chapters. Here, bases of the methods are introduced briefly:

Risk Assessment Process

Izmir's scenario earthquake produced in the content of RADIUS Project is adopted for hazard assessment.

Istanbul Earthquake Master Plans' observed vulnerability assessment method is modified for the case study area.

RADIUS computer software method is aimed to be used for damage estimation.

Urban Transformation for Urban Safety

Public participation should be provided to realize urban transformation. Therefore, it is required supplying the essential number of dwelling to persuade the people to be in the transformation process voluntarily. Three models are developed to redistribute the required dwelling units, which are explained in the content of fifth chapter.

1.5. Content of the Study

In Chapter 1 the introduction part explaining the problem, aim, limits, methods and the content of the study is given.

Chapter 2 aims to provide a conceptual framework of disasters and to point out the basic outlines of earthquake risk. In this chapter conceptual framework of disaster, disaster types, earthquake risk on urban areas and especially in the city of İzmir is discussed. Moreover, the challenges, opportunities and effects of the earthquake are put forwarded.

In the first section of the Chapter 2, disaster issue is defined. Source and the classification of disasters, relationship between natural hazard and disasters are examined. Second section concentrates especially on earthquake hazard especially. Its effect on urban areas, firstly physical effects and then social effects are stated and the factors, increasing the effects and the opportunities of earthquake disaster are discussed.

Lastly, in the third section, City of Izmir is described in order to be able to understand the earthquake risk of the city. İzmir's geographical properties, past earthquakes are defined and its urban pattern risk is discussed considering the urban development process.

Chapter 2, comprise earthquake risk on urban environment. Chapter 3 will help to understand the worldwide and national "mitigation activities" for reducing the effects of earthquakes.

In Chapter 3, earthquake mitigation activities around the world, in Turkey and in İzmir are investigated. RADIUS Project is briefly discussed and critically evaluated to find out if this project would be successful to prevent and reduce the damages of earthquakes. The process of the project and its implementation in the case cities around the world is put forward. National activities about risk reduction are scrutinized especially in İstanbul. Earthquake Master Plan of İstanbul carried out by İstanbul Metropolitan Municipality is also introduced. Zeytinburnu Pilot Project that is proposed to be a case within the master plan is also the first serious work about Urban Transformation Project done in Turkey. That's why those works are taken into consideration as a guide for İzmir.

In this chapter, general outlook of mitigation activities is put forward. An attempt has been made to understand the strategically approach for mitigation activities. (The techniques for risk mitigation are studied in the content of Chapter 4).

The strategies of the activities for determining the earthquake risk within the urban environment is focused on to be used for the risk assessment process which is the initial phase of mitigation project. Related with these studies, urban safety, risk management, risk assessment process and the methods for risk assessment will be clarified in the content of Chapter 4. Consequently, strategies for urban safety will be discussed. As a solution of safer urban environment, earthquake conscious urban transformation is proposed and its components are discussed.

In Chapter 4 different methods of risk assessment process, which are, utilized both at urban level and building level is presented. This Chapter also includes a general evaluation of urban transformation process in the name of mitigating the risk. Strategies for designing earthquake safe cities and circumstances for realization of an urban transformation project are discussed in this chapter

An attempt is also made to clarify how to organize an earthquake conscious urban transformation project. For the applicability of an urban transformation project the problems and terms are defined.

Earthquake conscious urban transformation is an interdisciplinary issue. An applicable urban transformation model should also include financial, administrative, legal corporate governance models, and strategic communication model. These issues should be held within further studies.

As a case study, Fikri Altay District in Karşıyaka is selected. General information about Karşıyaka and Fikri Altay is given. The analyses of the area have been made. The strategies and techniques that are discussed in the previous chapters are executed, on Fikri Altay District to mitigate the earthquake risk**.**

In Chapter 5, general information about Karşıyaka and Fikri Altay District is given. Karsıyaka's past residential development is mentioned briefly. In the content of Chapter 5, vulnerability of the project area in Fikri Altay District is assessed using the methods defined in Chapter 4. Earthquake performance of the buildings' is determined using these methods. The vulnerability map of the area is obtained to be used for determining the transformation strategy of the area. Finally a transformation project is proposed for reducing the risk of Fikri Altay District.

CHAPTER 2

THE EARTHQUAKE RISK

2.1. Disaster Risk

2.1.1. Definition of Disaster

Hazard & Risk

Some of the natural occurrences may turn into *natural hazards*. These natural hazards carry *risk* to be a *disaster***.** Risk is sometimes taken as synonymous with hazard. Hazard is an ever-present, inescapable part of life. An earthquake or an accident can happen at any time, but a risk has the additional implication of the chance of a particular hazard actually occurring. For example; if earthquake is the hazard, death and loss is the risk and a destructive physical event, resulting with loss of life, injury, property damage, is disaster.

It can be conveyed that *hazard* is the potential to cause harm; and *risk* on the other hand is the likelihood of harm (in defined circumstances, and usually qualified by some statement of the severity of the harm). Oxford Dictionary defines "risk" (noun) in terms of a hazard, chance, bad consequences, loss, etc., exposure to mischance; and it defines risk (verb) in terms of: to expose to chance of injury or loss, venture on, accept the chance of.

Risk is the relative degree of probability that a hazardous event will occur. The probability of harmful consequences or expected losses (deaths, injuries, livelihoods, disruption of economic activity or environmental damage) resulting from inter-actions between natural or human-induced hazards and vulnerable conditions. Based on mathematical calculations, risk is the product of hazard and vulnerability. Conventionally, risk is expressed by the notation: (WEB_6, 2005)

Risk = (Hazards x Vulnerability)

Natural events are considered as hazards if they cause death or damage to humans. Single natural events may cause compound hazards by the effect of human location and population. The differentiation between natural hazards and natural event is seen in the Figure 2.1**.** (Smith 1992)

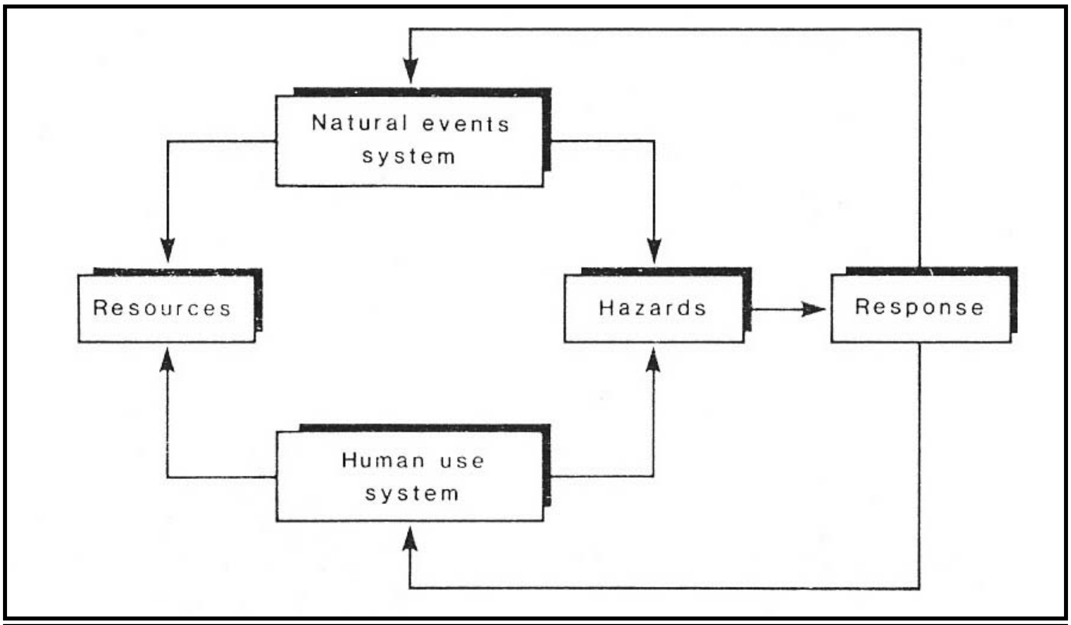


Figure 2.2. Natural Events and Natural Hazards

The risk from a specific hazard may vary according to changes in physical exposure or human vulnerability**.** Keith Smith points in his book the combination of natural hazards as:

"1. Physical exposure- reflecting the range of natural and technological events and their statistical variability at a particular location and

2. Human vulnerability- reflecting the breadth of social and economic tolerance available at the same site." (Smith 1992, p. 11)

Any manageable definition of environmental hazards will be both arbitrary and contentious. Keith Smith defines common features despite their diverse sources.

- *The origin of the damaging event is clear and produces characteristic effects, e.g. a flood causes death by drowning*
- *The warning time is normally short, i.e. the hazards are often known as rapid-onset events, although drought is an important exception*
- *Most of the losses whether to life or property, are suffered very shortly after the event.*
- *The risk of exposure is largely involuntary, normally due to the location of people in a hazardous area.*

▪ *The resulting disaster occurs with an intensity and scale that justifies an emergency response.* (Smith 1992, p:14)

Environmental problems which are also influenced by human activity are sometimes regarded as hazards. Such as deforestation, desertification, depletion of the stratospheric ozone layer and rising sea levels resulting from the greenhouse effect, environmental pollution.

Disaster

The term is defined briefly as "an event that has occurred unexpectedly with destructive consequences". (Procter et al. 1995). A disaster is a sudden, devastating physical phenomenon that seriously disrupts the functioning of a community or society and causes human, material, economic or environmental losses that exceed the community's or society's ability to cope with using its own resources. (WEB_6, 2005)

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. (WEB_8, 2005)

Disasters become super disasters as occurrence of secondary disasters and the multiplication of loss caused by lack of preparation. (Coburn and Spence 2002)

Urban areas are not disaster-prone by nature; rather, the structural processes of accelerated rapid urbanization, population movement and population concentration substantially increase the disaster vulnerability. UN General Secretary Kofi Annan acknowledges the trends that are increasingly affecting human vulnerability to natural disaster in an editorial to mark the end of the International Decade for Natural Disaster Reduction in 1999:

"We know that human communities will always have to face natural hazards, whether floods, droughts, storms or earthquakes. However, today's disasters owe as much to human activities as to the forces of nature. Indeed the term 'natural' is an increasingly misleading one. A wide variation in the number and intensity of natural hazards is normal and to be expected. What we have witnessed over the past decades, however, is not nature's variation but a clear upward trend caused by human activities". (WEB_7, 2005)

The factors most often blamed for the increase in natural disasters are environmental degradation, climate change, population growth (in particular, unplanned urban growth), and the negative results of economic globalization. (WEB_6, 2005)

2.1.2. Classification of Disasters

Though often caused by nature, disasters can have human origins. The term environmental hazard includes natural and social components. The spectrum of hazard types is indicated in Figure 2.2. (Smith 1992)

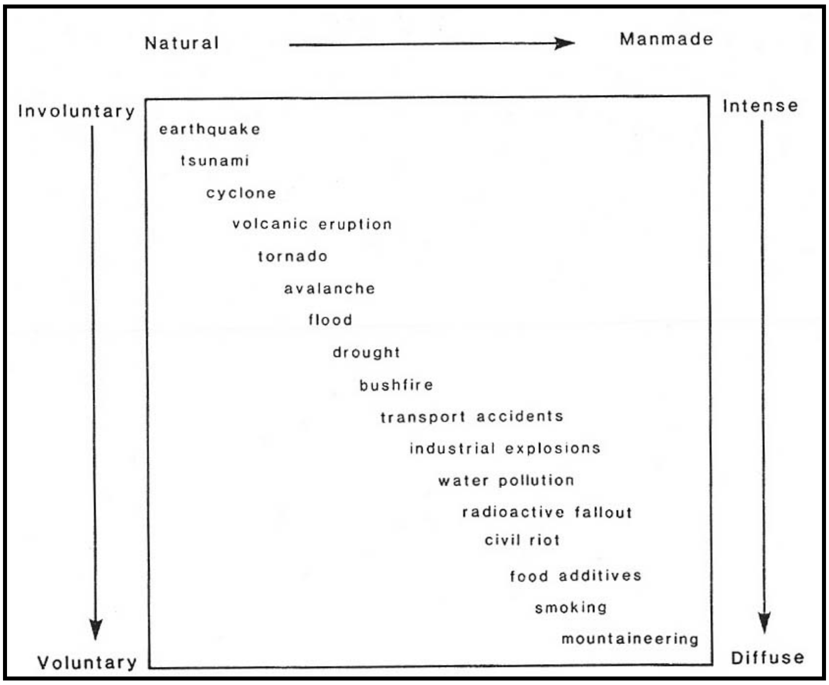


Figure 3.2. The Spectrum of Hazard Types

Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency and probability. (WEB_8, 2005)

Alternatively, natural hazards can be divided into those of endogenous origin (earthquakes, and volcanic hazards), those of exogenous origin (floods, droughts, avalanches)

Some of the disasters are localized and seasonal (wildfires, floods, landslides, epidemics), whereas others are incidental (earthquakes) (Stanojevska and Milutinovic 1999)

Hazards arise from compound or synergistic effects as when wind combines with snow to produce blizzard or earthquakes set off landslides in step terrain. The volcanic eruption may lead earthquakes, ash falls landslides floods and wild fires. (Smith 1992)

Natural hazards are classified according to their sources as in the Table 2.1.

Table 2.1. Classification of Hazardous Environmental Process

POTENTIALLY HAZARDOUS ENVIRONMENTAL PROCESSES					
Atmospheric	Hydrological	Geologic-Seismic	Biologic	Technologic	Social
*Wind storms, *Thunderstorms *Tornadoes *Hurricanes *Blizzards *Whiteout *Drought	*Flooding *Lake and sea-shore wave action *Waterlogging sea-ice and icebergs *Runoff drought	*Landslides *Erosion *Silting *Earthquakes *Volcanic eruptions *Shifting sands	*Sever epidemics in humans, in plants and in domestic and wild animals *Animal and plan invasions (e.g.locuts) *Forest and grassland fires	*Transport accidents *Industrial explosions and fires accidental *Releases of toxic gas *Nuclear power plant failures *Failures of public buildings or other structures *Germ or nuclear warfare	*Famine *War/conflict *Terror Attacks * Poor health/general sickness

The source of the natural hazards is defined in the table. As it is mentioned before these hazards may become disasters with the effect of urbanization or because of the intensity and scale of the disaster. Concerned with these sources disasters also can classified into two

- Natural Disasters
- Man-made Disasters

Natural Disasters

Natural disasters can be divided into three specific groups: hydro-meteorological disasters, geophysical disasters and biological disasters. (WEB_6, 2005)

Hydro-meteorological disasters are natural processes or phenomena of atmospheric, hydrological or oceanographic nature. These include floods and wave surges, storms, landslides, avalanches, and droughts and related disasters (extreme temperatures and Forest/scrub fires).

Geophysical disasters are natural earth processes or phenomena that may cause loss of life or injury, property damage, social and economic disruption or environmental degradation. These include earthquakes, tsunamis and volcanic eruptions.

Biological disasters are processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic microorganisms, toxins and bioactive substances; these include epidemics and insect infestations.

Man - Made Disasters

Man- Made effects increased the intensity of all disasters both natural sourced and social sourced. But there are events that are caused by only human beings and turns into disasters. They are categorized as man-made disasters such as

- Technical Disasters
- Fire
- Death/poor health/general sickness
- War/conflict/terrorism
- Workplace violence

Technical Disasters are originates from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities. Technical disasters include:

- Power cuts and communication failure
- Explosions involving domestic, industrial and non industrial buildings or structures
- Oil spills and chemical spills
- Nuclear-reactor failures, chemical mishaps
- Breakdown of computer networks
- Gas leaks
- Poisoning of atmosphere or water courses due to industrial sources
- Cooling/heating/ventilation system failure

2.2. Earthquake Hazard

It is possible to explain how and why earthquakes occur. It can be also determined which areas are more prone to earthquakes than others are. However, at the present state of knowledge and in spite of the most highly developed technology, it is almost impossible to predict exactly when and where an earthquake will take place and how big it will be. While other natural disasters, like floods and tornados are much more predictable, an earthquake may strike where people are not alerted to the imminent danger.

The direct disaster of the ground shaking caused by earthquakes is called "Earthquake Hazard". (WEB_3, 2005) Earthquakes are among the most deadly and destructive natural hazards. In 1976, 242,000 people died in the Tangshan Earthquake in China, creating US$ 5, 6 billion in economic losses. They often create secondary natural disasters such as tsunamis, fires and landslides. They kill around 1, 5 million people between 1900 and 1990. (WEB_10, 2005)

Turkey is under constant threat of earthquakes. UN reports that a large percentage of the Turkish population resides in high-risk areas and is increasingly vulnerable. (WEB_7, 2005) It has experienced many earthquakes during the last 15 years. These are Erzincan (1992), Dinar (1995) and Adana-Ceyhan (1998) and Marmara earthquakes (1999). %61 of the natural disasters consists of earthquakes. There have been nearly 130 damageable earthquakes during the period 1903-1998. These earthquakes caused the death of 72 thousands persons, injured some 130 thousand, and destroyed about 500 thousand dwelling units and other building structures. (Ergünay 1999).

2.2.1. Effects on Urban Environment

It is obvious that earthquake effect is a physical effect caused naturally. J.P.Bardet categorizes the physical effects as "direct" and "secondary" effects on physical environment (J.P.Bardet 1990). These physical effects may affect built urban environment and cause damages or losses where people live. These losses or damages also can be categorized as "direct losses" or "indirect losses".

<u>Physical Effects</u>

Direct Effects

Direct effects are solely those related to the deformation of the ground near the earthquake fault itself. Thus direct effects are limited to the area of the exposed fault rupture. Many earthquake faults never break the surface, ruling out direct effects. (J.P.Bardet 1990)

Secondary Effects

Most of the damage done by earthquakes is due to their ***secondary effects***, those not directly caused by fault movement, but resulting instead from the propagation of seismic waves away from the fault rupture. Secondary effects occur over very large regions, causing widespread damage. Such effects include landslides; liquefaction; fires and the triggering of aftershocks and additional earthquakes**.** (J.P.Bardet 1990)

Losses

Direct Losses: Physical Losses

Direct losses occur immediately after the event. Direct losses such as deaths and damages, are caused by the throwing down of buildings and lifelines in an earthquake. They are caused by the immediate damage done to humans, goods and the environment.

The damage caused by an earthquake can be magnified in areas where:

- People are concentrated;
- Economic and political functions are concentrated;
- Buildings and infrastructure have been built to inadequate standards of design; and
- In slums and squatter settlements that many low-income people live. (WEB_3, 2005)

Earthquake Hazard can inflict damage on a wide variety of structures, can be devastating to people as individuals, to families, to social organizations at every level, and to economic life. The damage to buildings is the most obvious and important damage. The main cause of deaths during earthquakes is *building collapse.* About 160,000 buildings collapse or damaged and 15,000 lives are lost in the case of the 1999 Marmara earthquake in Turkey. (WEB_10, 2005)

Earthquake hazard also affects *lifeline facilities* such as railroads, highways, bridges and water, sewage, electric power and gas networks. Lifeline damages can significantly impede recovery efforts aimed at the damaged area.

Indirect Losses: Socio-Economic Losses

Indirect losses arise mainly through the second-order consequences of disaster, such as the disruption of economic and social activities in a community or the onset of ill-health amongst disaster victims. These effects often outlast those of the direct losses by months or even years and can be intangible. Indirect losses include the costs of both medical expenses and lost productivity arising from the increased incidence of disease, injury and death. (Smith 1992)

The socio-economical and cultural impacts of earthquake are *migration* and *changes in social activities.* People leave the city after the earthquake. In Turkey, after Dinar earthquake, according to research that Nuray Karanci did, one third of the Dinar population left the city. Karanci claims that the earthquake and following post-disaster decisions related to temporary housing has a massive impact on the dislocation of the community. So it is important to provide people qualified urban environment so that they do not leave where they live. (Karancı and Akşit 1999)

Financial difficulties and *changes in social activities* after the earthquake can be observed on society. Because of the destruction of work places and due to the financial losses, there may be changes in status at work after the earthquake. The most important difficulty is loss of jobs and financial hardships. (Karancı and Akşit 1999)

Earthquakes are closely linked to *poverty* that can be stated as a result and risk factor of an earthquake. Poor people, in developing countries are particularly vulnerable to disasters because of where they live; and the economic losses cause poverty. Research shows that they are more likely to occupy dangerous locations, prone to earthquakes and other natural hazards, such as flood plains, riverbanks, steep slopes, reclaimed land and highly populated settlements of shanty homes. Bam earthquake makes a good example of this: In 2003, the earthquake, which struck the Iranian town Bam in December of that year, demolishes approximately 25,000 houses, according to UN figures. More than 40,000 people die because their housing is not designed to handle a major tremor. Most houses in the region were built with mud bricks accounting for the extreme vulnerability of the settlement to the earthquake. (WEB_6, 2005)

2.2.2. Risk Increasing Factors

The effects of any earthquake depend on a number of widely varying factors. These factors are:

Intrinsic to the earthquake: its magnitude, type, location, or depth;

Geologic conditions where effects are felt: distance from the epicenter, path of the seismic waves, types of soil, water saturation of soil; and

Social conditions reacting to the earthquake: quality of construction, preparedness of community, ability in emergency response, time of day or year (J.P.Bardet 1990)

Major social conditions contributing to the configuration of earthquake risk in cities are unqualified built environment, population growth, adverse political developments in the region, etc. (Stanojevska and Milutinovic 1999)

- Lack of planning and resources to accommodate rapid urban growth
- Lack of appropriate building and land-use codes or lack of mechanisms to enforce them,
- Inadequate engineering,
- Inadequate design reviews,
- Incorrect construction practices,
- Inadequate design reviews**,** causes unqualified built environment.

Population growth

Overall number of people affected by earthquakes is increasing through the world by the population growth. The fastest rates of growth are seen in less developed countries especially in the poorest sections of the community. Those people are least able to protect themselves and consequently influenced more by the harmful effects of the earthquakes. (Smith 1992)

Population growth makes people find self-solutions to their housing problem to live on if housing is not provided for them. In less developed countries self-built urban slums, squatters and illegal developed areas within high-risk zones such put emphasis on the potential for earthquake. (Smith 1999)

The urbanization process leads to the concentration of populations within cities. Urbanization can modify hazard patterns. Through process of urban expansion, cities transform their surrounding environment and generate new risks. As human influence has spread over the globe earthquake hazard is exacerbated by the human effect both deliberate and inadvertent. (Smith 1999)

Development both increases and reduces the effect of an earthquake. The vulnerability level of a country is related with its development level. The World Conference on Natural Disaster Reduction held in Yokohama, Japan, in May 1994, stated that “disasters are the unresolved consequences of development choices that governments, private organizations and individuals make every day.”(WEB_5, 2005)

Earthquakes tend to have a greater effect in Less Economically Developed Countries (LEDCs) than More Economically Developed Countries (MEDCs). Buildings in MEDC are more likely to withstand an earthquake. They may have seismic isolators (e.g. Japan) or deep foundations (e.g. USA). In 1995 an earthquake measuring 7.2 on the Richter scale hit the Japanese city of Kobe. Only 5000 people were killed. (WEB_7, 2005)

Earthquakes are usually assessed on some quantitative criteria of death and property damage. These consequences are important to be a threshold for categorizing the earthquake rather than defining the scale of it. This type of definition confined to losses has important weakness. Because a country's level of development has a direct impact on the damage that natural hazards inflict on populations. The intensity of the same magnitude disaster may be more for less-developed countries than industrialized wealthy nations. Their weak infrastructure and limited capacity for prevention makes them more. (Smith 1992)

2.2.3. Possible Positive Effects and Opportunities of an Earthquake

Earthquake-prone areas are often neglected areas especially within the undeveloped and developing countries. The rate of the illiteracy may be high, transport, communications may be poor, and the distribution system for goods and commodities may be inadequate. For such societies earthquake may be an opportunity to loosen the grip that poverty has on such societies. (Alexander 1990)

Within the aftermath of an earthquake, the reconstruction of the damaged community presents a chance to make the urban environment safer against a possible repetition of the disaster some time in the future. Better development policies can be incorporated to disaster-risk reduction strategies. Post-earthquake operations are an opportunity to make societies more resilient to the impact of future earthquakes and also other natural hazards. (Coburn and Spence 2002)

Rehabilitation and reconstruction efforts increase the activity in the construction industry. Gross indirect costs are also partly offset by the positive downstream effects of the construction works. (Smith 1992)

An earthquake tends to focus attention on the area and to produce and disseminate new information about it. Linkages may be fostered with the international aid community and lead to more frequent transactions with the outside world and central government. (Alexander 1990)

2.3. Earthquake Hazard & Izmir-Built up Zone

2.3.1. Geographical and Demographic Features

Izmir is exposed the earthquake hazard. As belonging to the first-degree hazard zone in the official Earthquake Hazard Map of Turkey, Izmir's earthquake risk is increasing due to its urbanization process. In this section, Izmir's properties will be explained and its earthquake risk will be discussed.

Izmir is a city on the western coast of Turkey having a population about 3 millions and spreading about 90 000 ha of land. Izmir is the third big city in population in Turkey. It has important activities in industry, trade, tourism, health, education and culture. (WEB_2, 2005)

The metropolitan municipality of Izmir, spreading on 71 400 ha, comprises town of Balçova, Bornova, Buca, Çiğli, Gaziemir, Güzelbahçe, Karşıyaka, Konak and Narlıdere. (WEB_2, 2005)

Figure 2.3 Izmir, on the west coast of Turkey
Source (Google Earth software)

In 1990, Izmir province has a population of 2.694.770 where the provincial center of 1.758.780; and in 2000, the province has a population of 3.370.866 and provincial center of 2.250.150. Between 1990 and 2000 census, annual growth rate of provincial population is 2.24 % (of greater municipality is 2.38 %), of urban population is % 2.446 and of rural population is %1.36. The annual growth rate is %3. (WEB_11, 2005)

Izmir is a strategically important city. It is a settlement where regional and interregional transportation axes intersect. It provides a linkage to other regions through railways and sea transportation.

Geographical

Most of the urban areas of Izmir are situated on the fertile agricultural land. The residential area is located on the southern edge of the Menemen deltaic plain, the Bornova plain and piedmont of Inciraltı, Narlıdere and Güzelbahçe. (WEB_2, 2005)

Izmir is one of the active parts of the Aegean Plate. It shows a very complex active moving and rapidly changing tectonic pattern due to the relative motions of the surrounding tectonic plates. (WEB_2, 2005)

There are alluvial flat parts that delta precipitates constitute in the districts such as Konak, Alsancak, Karşıyaka, Çiğli, Bostanlı, Sahilevleri, Salhane, Manavkuyu, and Bornova. In these districts, there are also regions (Kordon, Sahil Bulvarı) that filled afterward in seashores. Delta precipitates of Gediz River in Menemen plain and thick alluvial plats of Meles Stream in Bornova constitute seashore settlements ground type. (Oflozer 2005)

The areas having high underground water level, and the areas of young precipitates, which formed of loose-soft thick alluvial layers, are generally known as the areas where earthquake waves slow down and increase the earthquake intensity. Because of this, built environment in this area, due to the ground characteristics may greatly suffer damage even in earthquakes like 6, 0 mg – 7, 0 mg as a result of soil amplification. In these conditions, the high-risk regions can be shown as Çiğli, Naldöken, Cumaovası, Karşıyaka and west Bornova. Relatively, on the other hand more safe regions can be expressed such as Güzelbahçe, Seferihisar and Karaburun. (Akçığ and Pınar 2005)

As it is mentioned above Izmir‘s ground situation is not safe enough against earthquake risk. According to the research, that Zafer Akçığ did and Izmir Earthquake Master Plan indication, the level of vulnerability will be high, at the time of an earthquake occurrence. (Akçığ and Pınar 2005)

It is not solely the ground properties that increase the effects of earthquake. Unconsciously construction with disregarded ground properties increase earthquake influences. Ground characteristics of Izmir should be defined deeply. Potential disaster maps have to be prepared which can be formed due to the ground characteristics. (Oflozer 2005)

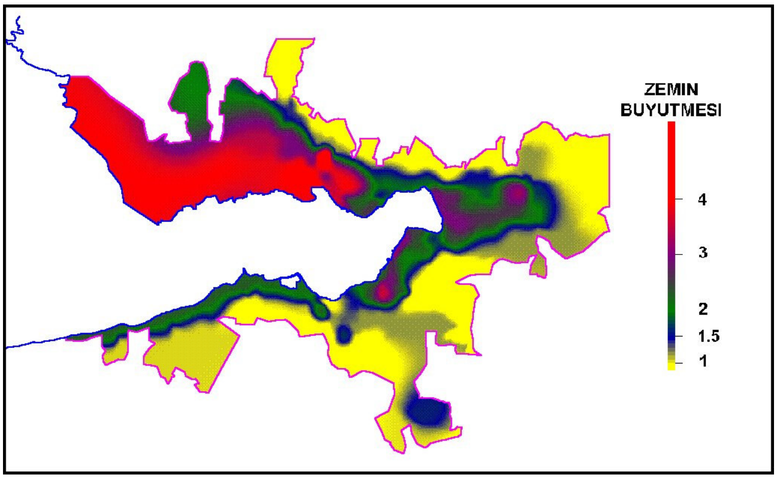


Figure 2.4. Izmir's Soil Amplification Map
(Source: Izmir Earthquake Master Plan)

2.3.2. Earthquakes in the past

Izmir has a perpetual restructuring process. It has been greatly affected by some disasters especially earthquakes and fires which led permanent amendments in the city's physical structure. Because of the disasters, the historical structure of the city is demolished and did not survive until today. (Serçe et al.2003)

According to history readers, earthquakes have been the most damaging natural disasters that have affected the Izmir built up zone. They are documented in the Earthquake Master Plan. Here, it is given a brief summary of the historical earthquakes. There have been at least 20 disastrous earthquakes with magnitudes greater than 6 reported in literature. It has been documented that historical cities in and around Izmir were destroyed in AD 17, 47, 105 and 178. Also in the last century, there have been major devastating earthquakes in Izmir. 1688 Izmir Bay, 1778 Izmir, 1880 Izmir, 1928 Torbali, 1949 Karaburun, 1953 Yenice-Gönen, 1969 Alaşehir, 1974 Izmir, 1992 Seferihisar earthquakes are the ones that mostly affect the southern part of Izmir. (WEB_2, 2005)

Lots of fire, depending on an earthquake or as a mere event, occurred in Izmir. In each time, the city managed to repair itself and regained its importance. The fire that followed the 1688 earthquake led to a major destruction. The city was almost destroyed and in addition to the loss of life and property, commercial activities declined. The fire of 1742 also brought a destruction that necessitated the city‘s completely reconstruction. In addition to these examples, during the two centuries between 1763 and 1861, twelve great fires took place. The great fire that broke down in September 1922 destroyed almost half of the city. The reconstruction of the fire stricken zone continued until the 1940's. Among the boulevards and avenues that are opened, a new urban issue consisting of two to three storied detached houses with gardens, emerges. The coastline between Alsancak and Güzelyalı is occupied by similar detached houses. (Serçe et all. 2003)

2.3.3. Urban Development Process

In addition to the risk potentials causing by the natural properties of the city especially its soil geology, Izmir has such an urban pattern, which makes the city exposed to earthquake risk.

As the third most populated city of Turkey, and the only metropolis of Aegean Region, Izmir has been witnessing considerable demographic changes and a dynamic social structure since the immense migration flows starting in the 1960s. It has a rapid population growth, which is 3 percent annually. It has been under the pressure of a migration above Turkey's average. (WEB_11, 2005) Especially, after 1980s Izmir's urban pattern started to change because of the rapid urbanization. The changes in urban pattern and several other changes in the social structure all contribute to the formation of a new urban morphology within the city and its region. (Çıkış 2005)

Accompanying the population growth there has been a growth in housing demand. The housing policies can not be integrated with that of housing demand and the housing subsidies can not serve the low-income groups. (Özdemir 2005)

Although some national policies are adopted to supply huge housing needs of newcomers, development of illegal buildings and squatters on publicly owned lands or privately owned land are be prevented. During 1950-1980, a number of construction amnesty / exemption acts are adopted related with legalization of illegal buildings and prevention of new squatter developments. Depending on these regulations, squatters and other illegal buildings are legalized and with the help of "improvements plans", their land ownership conflicts are solved. According to the arrangements in improvement plans, publicly owned lands are sold to squatter owners at low prices. During 1985 – 1998, improvement plans are prepared for 3.200 ha area by municipalities in Izmir. (Özdemir 2005)

Due to this development process, nearly %40 of the population is living in squatters in İzmir. (Özdemir 2005) The legalization of illegal building does not improve the quality of urban environment. These areas remain unhealthy residential districts within the city because of insufficient provisions of technical and social infrastructure and because of buildings that are not ensuring compliance with planning act and building codes.

İzmir's urban pattern can be analyzed by categorizing like this:

- Developed Areas (Planned)
- Historic Urban Fabric
- Unplanned and uncontrolled Urban Development

Developed Areas (Planned)

Attached Development

These areas are located mostly in city center as being the first developed urban areas of İzmir. The city center becomes overpopulated parallel to the urban growth. The demands of new residential and business areas increased. As a result the development spread from the center to the outside of the city boundaries and new housing areas of Hatay, Balçova, Narlıdere and new arteries are constructed and being settled during the time between 1970 and 1980. In addition, historical sites and coastal area such as Kordon, Yalı, MıthatPaşa, EşrefPaşa, and Karşıyaka and nearby towns are destructed with the effect of this trigger. Multi-floored housing blocks that built during this decade were generally 7-8 floors and attached. (Çıkış 2005)

The features of the area, such as high building density, low percent green area, narrow roads, increases the vulnerability of the area. In addition to that, because of being attached, and being constructed on different dates, the buildings floor level may be different which also increase the risk. Attached and high-density housing development pattern causes open area inadequacy and imbalance of proportion of open and closed area. (See section 4.3.2). Population density is 1000-1500 ha.

Figure 2.5. Attached Urban Development (Planned); Karşıyaka-Alaybey
(Source: Izmir Metropolitan Municipality, air photo 2002)

Detached Development

This pattern exists usually in two types; the first one is high-rise, high-density detached apartments and the second one is low density detached houses. The areas are usually located out of the city centers which are built about 1980-1990s. Within this pattern, the green area percentage is high comparing other urban patterns. Building quality may differ according to the construction dates but because they are detached, this is not a risk-increasing factor. Mostly located on the development axes of the city the accessibility is enough in this urban pattern. Population density is about 500-700 ha. Balçova, Narlıdere, Gaziemir, north of Karşıyaka (Sayar and Süer 2004)

Figure 2.6. Detached Urban Development (Planned): Narlıdere
(Source: Izmir Metropolitan Municipality, air photo 2002)

High-Rise, High-Density Housing

Starting from 1980's boundaries of the city enlarged toward the hillsides located around the city such as Çiğli, Evka, Bornova, Buca, Narlıdere etc. The dominant housing model become public housing, which is financially, supported both by the government and local municipalities. The new housing projects are realized outside the city because of the lack of urban land in the central districts. (Sayar and Süer 2004)

Another trigger for development of high-rise high-density housing is the increasing construction trigger of big shopping centers after 1990. Around these centers housing development also increased such as Mavişehir, Atakent, and Gaziemir. (Sayar and Süer 2004)

These urban patterns are usually located out of the city center. Because of the qualified urban environment such as enough road capacity, high green area and urban services earthquake risk is low in that kind of urban pattern.

Figure 2.7. High-Rise, High-Density Urban Development: Karşıyaka-Atakent
(Source: Izmir Metropolitan Municipality, air photo 2002)

Historic Urban Fabric

These areas are located in the city centre such as Kemeraltı, Alsancak, Eşrefpaşa, and Kadifekale. Physical depreciation and obsolescence resulting by the previous earthquakes and fires the increase earthquake risk. It can be said that within the historical pattern the utilization of the buildings differs such as dwelling, small factories or commercial, which also increase the risk. High building density also may cause obstacle after the earthquake.

Figure 2.8. Historic Urban Fabric: Konak: Kemeraltı
(Source: Izmir Metropolitan Municipality, air photo 2002)

Unplanned and uncontrolled Urban Development

Squatters and illegal developed areas have high earthquake risk. Utilities and services are neither provided nor anticipated initially in these areas. The improvement stagnation of the urban environment is procured by community from the city using the water, sewerage electricity and other services. Structural risks causing by irregular and unplanned structuring; accessibility problem; inadequate urban facilities such as parks, car parks, children playground areas, and recreational facilities; high building and population density; and different construction dates are the main factors that increase the earthquake risk. (See section 4.1.2.2)

Figure 2.9 Unplanned Urban Development: Karşıyaka- Yalı district
(Source: Izmir Metropolitan Municipality, air photo 2002)

2.4. Concluding Remarks

In this chapter conceptual definition of disaster, disaster types, earthquake risk on urban areas and especially in the city of Izmir is discussed. The challenges, opportunities and effects of the earthquake are put forwarded.

In the first section of the Chapter 2 disaster issue is defined. Source of the disasters, classification of disasters, relationship between natural hazard and disasters are examined. Second section concentrates on earthquake hazard especially. Its effect on urban areas, firstly physical effects and then social effects is defined. The factors, increasing the effects and the opportunities of earthquake disaster are discussed.

Lastly in the third section, City of Izmir is described to be able to understand the earthquake risk on the city. Izmir's geographical features, past earthquakes are defined and its urban pattern risk is discussed considering the urban development process.

In Chapter 2, earthquake risk on urban environment is defined. Chapter 3 will help to understand the worldwide and national "mitigation activities" for reducing the effects of earthquakes.

CHAPTER 3

EARTHQUAKE RISK MITIGATION ACTIVITIES

3.1. Mitigation Process

The word “mitigation” is generally used as the means of lessening or reducing the seriousness or extent of a disaster. Earthquake disaster risk should be mitigated for urban safety. Mitigation activities should be coordinated through a collaborative work of different disciplines via the activities organized before and after the earthquake. The process for urban safety is an interdisciplinary work. As an interdisciplinary work risk mitigation activities comprise economical, educational, governmental, administrative, social and financial, etc issues related to human life. Risk mitigation process is a long term planning and rational coordination of execution in developing or less developed countries. (Karaesmen 2005)

Mitigation concept reveals, when an earthquake hazard turns into disaster because of man - made effects. The necessity for mitigation comes to point when an earthquake strikes. In fact, mitigation is a closed loop process requiring feed backing because the phases might overlap.

Urban planning and urban design tools and processes can be adjusted for mitigating the earthquake risks in physical level. To execute risk mitigation efforts to the existing planning and design processes is a necessity. Urban level mitigation activities will provide a livable and safe environment in cities. (Balamir 2005a)

Planning activities concerned with mitigation have been practiced mainly organized in two categories. Mitigation encompasses post-earthquake activities stated “Crisis Planning” and pre-earthquake activities stated, “Contingency Planning” and “Resilience Plans”. Crisis planning is related to all preparations and planning concerned with the occurrence of an earthquake. On the other contingency planning, comprise all activities and organized efforts to risk avoidance and reduction. (Balamir 2001)

3.1.1. Post-Earthquake Activities

Crisis Planning involves identification of responsibilities in the case of emergencies, training and preparation, emergency intervention, relief operations and immediate accommodation, compensations and rehabilitation work

The Post-earthquake activities concerned with Crisis Planning have been practiced mainly in three periods:

- *The immediate relief period, emergency period; generally lasting a few days*
- *The rehabilitation period, from the end of the relief period for a number of months*
- *The reconstruction period, lasting a number of years, even tens of years in some cases.* (Coburn and Spence 2002, p:141)

During the relief period**,** emergency preparedness plans are engaged just at the time of occurrence of an earthquake. The organization of the period is very particular charge where communicative; control and command capabilities must easily function. The emergency period is not usually the best time to make crucial decisions concerning the long-term future of a city.

Being the first stage of the aftermath the relief period, in which the emergency plan is in operation, and emergency actions, such as search and rescue, take precedence. Normal social and economic activities are suspended or greatly modified while the situation is sorted out with regard to casualties, survivors and destruction. In this period clearance of the rubble and wreckage, usually delay the emergency actions. They may obstruct search and rescue operations. If there is an emergency preparedness plan this obstruction does not impede the planning activities (Coburn and Spence 2002)

Preparedness planning should establish the longer-term aims of a mitigation program in general, so that in the event of a major earthquake, the reconstruction can be channeled towards well established aims rather than having to improvise a new strategy plan.

The rehabilitation period is characterized by repairs to utilities and to commercial, industrial and residential structures. Buildings that can not be salvaged will be demolished and efforts will be made to turn others back to normal uses. Survivors who have left the disaster area return during this period. In societies with a large resource, base restoration may only take a few months. However, to ensure that transportation and utilities are functioning will be a complex and laborious process, especially damage has been widespread. (Coburn and Spence 2002)

Within the reconstruction period, people are relocated. Safer settlement patterns are generated with higher urban space standards.

Cities should attempt to prepare a reconstruction plan before earthquakes strikes. The more readily the realities of destruction and damage are faced, the more abundant the opportunities to reduce suffering and benefit from creativity in the reconstruction process. (Alexander 1990)

David Alexander argues in his book that Robert W. Kates & David Pijawka‘s dispute about reconstruction phases. According to them, the reconstruction process typically occurs in four stages as an emergency period, a restoration phase, a replacement-reconstruction period and one of developmental reconstruction. In addition to first two known classification he emphases on the importance of the latter two:

- *A replacement reconstruction period*
- *Developmental reconstruction (Alexander 1990 p: 445)*

The reconstruction- replacement period is one in which capital stocks are re-built and the economy of the area recovers to pre-disaster levels. This may take some years, and the phase ends when population has returned to its former levels and losses in jobs, housing and services have been rectified.” (Coburn and Spence 2002)

However, once the emergency phase of earthquake response is over and rehabilitation starts, most strategies aim at restoring a society’s pre-disaster state. Infrastructure is rebuilt as it stood before the earthquake.

Developmental Reconstruction

Where a city or damaged region already has an existing plan for growth or long-term strategic objectives, the earthquake reconstruction should follow those plans and use them as the guiding principles for its own plans. The reconstruction then builds on existing studies and plans developed under less demanding circumstances. (Coburn and Spence 2002)

The pattern of earthquake damage will naturally affect the master plan to some degree, but should not affect the overall strategic objectives. Its main effect will be to determine the locations and facilities where the implementation can take place during the recovery period. (Coburn and Spence 2002)

There are at least five important considerations that affect reconstruction planning and the policies that are likely to be most effective in bringing about future safety. A. Coburn conveys them as below:

- *The return period of the earthquake*
- *Pre-existing plans for the future development of the city- including seismic risk studies for future protection.*
- *Profile of the communities affected, including the economic basis and cultural preferences of the various groups affected.*
- *The scale of the disaster*
- *The resources available for reconstruction* (Coburn and Spence 2002 p:335)

Reconstruction is planned sectorally. The program for reconstructing schools buildings, for example, will be planned and costed separately from that for repairing damaged roads and rebuilding bridges. Sectoral approach is useful because groups of facilities are the responsibilities of different agencies and require different skills to understand the reconstruction needs.

All sectors are to some degree interdependent; food processing factories need rebuilding at the same time as agricultural production is revitalized; commerce, industry and the service sector need to be helped to recover at the same time as rebuilding housing. (Coburn and Spence 2002)

The reconstruction also provides opportunities: the opportunity for a new start and to make improvements on the situation that existed before the earthquake. The physical planning of the reconstruction of a town, particularly one with high levels of damage, represents an opportunity for change: a change to design a better town.

Reconstruction should be considered as the part of contingency plan for sustainable and earthquake resistant cities. The reconstruction of a city after the earthquake and designing a new settlement is a new chance to have safer cities.

3.1.2. Pre-Earthquake Activities

A major Contingency planning offers the opportunity to introduce comprehensive mitigation measures into the ongoing processes of planning, administration and construction. It also provides the impetus to channel financial resources where they are needed and prompts a political willingness to implement policies. (TMMOB, 2005)

Social and economic recovery of the affected communities and the reduction of the overall vulnerability of the city to the effect of future earthquakes require comprehensive policies covering a wide range of activities. As it is mentioned above contingency planning takes the role in this point.

Contingency planning entails the structuring or information bases and communications, micro-zonation, risk analyses, determination of urban vulnerabilities, land-use planning decisions, building control, retrofitting work, and proficiency of responsible agents undertaking such work. Contingency Plans are not so widespread especially in less developed countries. Existing approaches to urban mitigation are not only loss estimations and therefore have a diagnostic emphasis, but also rely on expert opinion and mostly manifest authoritative forms of action. (Balamir 2001)

Resilience Plans are of a macro –character, necessary for the strategic achievement of an overall sustainable robustness in social and material development. Resilience is the social and economic ability of the society to withstand impact of an extreme event. Mitigation in this sense is all forms of action taken to ensure loss reduction and achieve a level of resilience. An overall strategy to restructure administrative bodies and authorities concerned with disaster management. (Balamir 2005a)

Table 3.7. Progress from Crisis Planning to Contingency Planning (Balamir 2005a)

FATALIST SOCIETY	Disorganized information	Information System	RESILIENCE SOCIETY
	Political operation	Technical Issue	
	Umbrella funds	Specialized Funds	
Saving Strategy	Post-disaster intervention	Pre- Disaster Conduct	Protection Strategy
	Extraordinary responses	Routine Procedures	
Healing Discourse	Risk Minimization/Sharing	Risk Avoidance	Preparedness Discourse
Crisis Planning	Centrally Monitored	Locally Managed	Contingency Planning

Resilience is a measure of the rate of recovery from a stressful experience. It can be defined as a measure of a system's or part of a system's, capacity to absorb and recover from the occurrence of a hazardous event. Resilience has been the main weapon against hazard in the less developed countries where disaster is often accepted as a recurrent fact of life. (Smith 1992)

3.2. Mitigation Activities

3.2.1. Worldwide

International institutions and other related groups about disaster mitigation started taking precautions after 1990 against natural disasters in order to reduce the harmful as a pre-condition of development. The milestones of the issue are:

- UN International Decade for Natural Disaster Reduction (IDNR) (1990-2000)
- Yokohama Strategy and Action Plan for a safer world (1994)
- Kobe Conference and Hyogo Declaration (2005)
- Hyogo Action framework for Developing the resistance of Nations and societies against Natural Disasters (2005-2015)
- RADIUS project 1997-1999 (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters)

3.2.2. RADIUS Project

3.2.2.1. Outline of the project

United Nations emphasized in the Yokohama Strategy that determined in the International Decade for Natural Disaster Reduction Program (IDNDR 1990-2000) and also in HABITAT Istanbul meeting, that there should be politics about prevention of the natural hazards. The IDNDR Secretariat therefore has launched the RADIUS project to realize the concept of the IDNDR and the "Yokohama Strategy and Plan of Action." It aims to promote worldwide activities for mitigation the risk of seismic disasters in urban areas, particularly in developing countries. The primary goal of RADIUS is to help people understanding the seismic risk and raise public awareness at the city level, in the form of long-term, institutionalized programs to manage earthquake risk. It will develop common methodologies for seismic risk assessment of the urban areas in order to raise public awareness and provide guidelines for disaster mitigation. (WEB_3, 2005)

Table 3.8. RADIUS Timetable (Web_3)

TIMETABLE	
1996	Planning of the initiative
1997	Invitation for the case-study cities Pre-selection of the 20 cities Establishment of the STC subcommittee for RADIUS Selection of the three international institutes
1998	Selection of the nine case-study cities (January) Implementation of the case studies (1.5 years from February) Kick-off meetings and earthquake damage scenario workshops were held Training seminars in Japan (May/June) Comparative study on "understanding urban seismic risk in the world" (1 year from April) RADIUS Workshop at the International Conference in Yerevan, Armenia (September)
1999	Implementation of the case studies (continued) Action plan workshops were held Comparative study on "understanding urban seismic risk in the world" (continued) Development of practical tools RADIUS Workshop in the IDNDR Program Forum in Geneva (July) International RADIUS Symposium in Tijuana, Mexico (October)
2000	Publications Evaluation of the case studies

3.2.2.2. Objectives

The direct objectives of RADIUS are: (WEB_ 3, 2005)

- To develop earthquake damage scenarios and action plans in nine case-study cities selected worldwide;
- To develop practical tools for seismic risk management, which can be applied to any earthquake-prone city in the world;
- To conduct a comparative study to understand urban seismic risk around the world;
- To promote information exchange for seismic risk mitigation at city level

3.2.2.3. Case-Study Cities

Nine case-study cities are selected, namely, Addis Ababa (Ethiopia), Antofagasta (Chile), Bandung (Indonesia), Guayaquil (Ecuador), Izmir (Turkey), Skopje (The former Yugoslav Republic of Macedonia), Tashkent (Uzbekistan), Tijuana (Mexico), and Zigong (China) from 58 applicant cities. The case studies are carried out for 18-months to develop earthquake damage scenarios and to prepare a risk management plan and propose an action plan for earthquake disaster mitigation. To reduce seismic risk the case cities involve decision makers, local scientists, local government officers, representatives of the communities, and mass media. (WEB_ 3, 2005)

The case studies also aim:

- To raise the awareness of decision makers and the public to seismic risk;
- To transfer appropriate technologies to the cities;
- To set up a local infrastructure for a sustainable plan for earthquake disaster mitigation;
- To promote multidisciplinary collaboration within the local governments as well as between government officers and scientists; and
- To promote worldwide interaction with other earthquake-prone cities.

In order to develop earthquake damage scenarios, the physical damage to buildings and infrastructure, human losses in the city, as well as the effects on urban functions and activities are first estimated. The earthquake damage scenario describes the various stages of the city's damage during and after a probable earthquake. Human loss is estimated, based on the damage of buildings and infrastructure, the efficiency of relief activities, and outbreaks of fires. (See 4.1.1.3.) A risk management plan is prepared, based on the scenario. It contains the following aspects:

- Improvement plan for the existing urban structures such as reinforcement of vulnerable buildings and infrastructures, securing of open spaces and emergency roads, and designation of areas for evacuation;
- Emergency activities such as life saving, fire fighting, emergency transportation, and assistance to suffering people;
- Individual countermeasures for important facilities; and
- Dissemination of information to, and training of, the public and private sectors.

Finally, an "Action Plan" is proposed. It prioritizes the necessary actions so that they can be implemented soon after the project. Therefore, the action plan has to be practical. It is a first step for the city. The scenario and action plan are disseminated to relevant organizations and the public. (WEB_ 3, 2005)

Selection of the case-study cities

In early 1997, the IDNDR secretariat sent invitation letters for participation in the RADIUS initiative as case-study cities, to major cities prone to earthquakes all over the world. By the end of July 1997, the IDNDR secretariat accepts applications for the case studies from 58 cities worldwide, mainly from developing countries. Cities that that applied for RADIUS are listed as below: (58 cities) (United Nations 2005)

In September 1997, the IDNDR secretariat pre-selects twenty (20) cities from the 58 cities, based on the objective criteria and on the information in the application forms, taking into consideration the regional distribution. (United Nations 2005)

Taking into consideration the evaluation reports from the experts who visited the candidate cities and more information collected by the questionnaires filled by the cities, the IDNDR secretariat selects nine (9) cities in January 1998, in consultation with the STC (Scientific and Technical Committee for IDNDR) subcommittee for RADIUS. (United Nations 2005)

Table 9.3. Fifty Eight Applicant Cities (WEB_3, 2005)

Asia	Almaty (Kazakhstan), Amman (Jordan), Ashgabat (Turkmenistan), Bandung (Indonesia), Baoji (China), Bishkek (Kyrghistan), Calcutta (India), Damascus (Syria), Daqing (China), Dushanbe (Tajikistan), Hefei (China), Istanbul (Turkey), Izmir (Turkey), Kathmandu (Nepal), Mandalay (Myanmar), Metropolitan Manila (Philippines), Mumbai (India), Shiraz (Iran), Tabriz (Iran), Tangshan (China), Tashkent (Uzbekistan), Tbilisi (Georgia), Tehran (Iran), Urumqi (China), Yangon (Myanmar), Yerevan (Armenia), Zigong
Europe and Africa	Accra (Ghana), Addis Ababa (Ethiopia), Algiers (Algeria), Belgrade (Yugoslavia), Bucharest (Romania), Conakry (Guinea), Dodoma (Tanzania), Giza (Egypt), Petropavlovsk Kamchatsky (Russian Federation), Skopje (The former Yugoslav Republic of Macedonia), Sofia (Bulgaria), Tirana (Albania),
Latin America	Ambato (Ecuador), Antofagasta (Chile), Cali (Colombia), Cumana (Venezuela), Guayaquil (Ecuador), Kingston (Jamaica), La Paz (Bolivia), Lima (Peru), Manizales (Colombia), Medellin (Colombia), Pasto (Colombia), Pereira (Colombia), Popayan (Colombia), Quito (Ecuador), San Juan (Argentina), Santiago (Chile), Santo Domingo (Dominican Republic), Tijuana (Mexico), Toluca (Mexico).

Table 3.10. Pre-Selected 20 Cities (WEB_3, 2005)

Asia	Bandung (Indonesia), Baoji (China), Kathmandu (Nepal), Mandalay (Myanmar), Tashkent (Uzbekistan), Tbilisi (Georgia), Zigong (China)
Europe, Middle East and Africa	Addis Ababa (Ethiopia), Bucharest (Romania), Giza, (Egypt), Izmir (Turkey), Skopje (The former Yugoslav Republic of Macedonia), Sofia (Bulgaria)
Latin America	Antofagasta (Chile), Guayaquil (Ecuador), Manizales (Colombia), Quito (Ecuador), Santo Domingo (Dominican Republic), Tijuana (Mexico), San Juan (Argentina)

Table 3.11. Nine Case-Study Cities (WEB_3, 2005)

Full case study (five cities)	Addis Ababa (Ethiopia), Guayaquil (Ecuador), Tashkent (Uzbekistan), Tijuana (Mexico), Zigong (China)
Auxiliary case study (four cities)	Antofagasta (Chile), Bandung (Indonesia), Izmir (Turkey), Skopje (The former Yugoslav Republic of Macedonia)

Assistance to the case-study cities

Full case studies are conducted with intensive external assistance in five cities where a similar project has not been carried out. Auxiliary case studies are carried out in four cities, to fulfill part of the objectives of the case studies, or to follow up or complement a similar study that has been or is being carried out in the city. What is done as an auxiliary case study varied, depending on the situation of the city. Financial aid is provided for the all case studies. (United Nations 2005)

It is supposed that the selected case-study cities would need not only financial assistance but also external technical assistance to carry out the project effectively in such a short time. The IDNDR secretariat identifies three international institutes in three regions, namely, Asia, Europe/the Middle East/Africa, and America. Regional cooperation is expected to be more efficient and effective as local institutes have the best knowledge about their regions. (United Nations 2005)

The role of the international institutes is to supervise and coordinate the case studies. In order to guide the case studies technically, they are requested to visit a case-study city several times.

Three international institutes are:

- For Asia (Bandung, Tashkent, Zigong)
  OYO Group and International Center for Disaster-Mitigation Engineering (INCEDE), Japan
  Fumio Kaneko, Rajib Shaw, Shukyo Segawa, Jichun Sun, Ken Sudo
- For Europe, Middle East and Africa (Addis Ababa, Izmir, Skopje)
  Bureau de Recherches Géologiques et Minières (BRGM), France
  Philippe Masure, Pierre Mouroux, Christophe Martin
- For Latin America (Antofagasta, Guayaquil, Tijuana)
  GeoHazards International (GHI), United States
  Carlos Villacis, Cynthia Cardona (United Nations 2005)

3.2.2.4. Interactions between the Cities

The IDNDR Secretariat has started a comparative study on "Understanding Urban Seismic Risk around the World," (UUSRAW) which aims to identify and compare the project results of different cities. This will provide an opportunity to exchange information more directly with each other. (United Nations 2005)

These city representatives gathered the information necessary to develop a systematic comparison of earthquake that is “The Earthquake Disaster Risk Index” (EDRI). It provides a framework for the UUSRAW project. The EDRI compares metropolitan areas according to the magnitude and nature of their earthquake disaster risk, which is analyzed using five main factors, namely, "Hazard", "Vulnerability", "Exposure", "External Context", and "Emergency Response and Recovery". (United Nations 2005)

Technical training seminars, seminars for city government officials, workshops on Earthquake damage scenarios and on action plan are organized within the RADIUS project to assist the case cities. (United Nations 2005)

The comparison of the 9 case study cities are given in the table 3.6 at the next page.

3.2.2.5. Evaluation

RADIUS participants actively discuss the experiences of RADIUS in the International RADIUS Symposium held in Tijuana, Mexico, in October 1999. The outcome of RADIUS is presented publicly at the press conference in November 1999 and is being published in early 2000. (WEB_3, 2005)

Seismic risk reduction is a long-term undertaking. It will take dozens of years to make cities safe against earthquakes. It is difficult to strengthen existing vulnerable buildings, or change their location in short term. Even in the nine case-study cities, unless they take immediate actions, the earthquake risk of the cities will continue to grow. But, the RADIUS approach should help raise public awareness among the communities. It would eventually help fix land use planning priorities, conform to building regulations, retrofit existing structures and especially promote preventive management of earthquake damage. RADIUS, if correctly implemented, will help save lives and property.

Table 3.12. Comparison of the Nine Case Studies (WEB_3, 2005)

City	**Addis Ababa**	**Antofagasta**	**Bandung**	**Guayaquil**	**Izmir**	**Skopje**	**Tashkent**	**Tijuana**	**Zigong**
Location	Situated on the western margin of the Ethiopian rift system	Situated at Bahia Morena to the south of the Mejillones peninsula	Situated in the Western Java Province	Situated on the west bank of Guayas River	Situated on the western coast of Turkey	Situated on the banks of Vardar River	Situated in the Tashkent Oasis of Central Asia	Situated along the coast of the Pacific Ocean, 35 km south of the border of USA	Situated in the Sichuan Province (south of China)
Area	54 km2	90 km2	168 km2	340 km2	90 km2	1,860 km2	326 km2	250 km2	4,373 Km2
Population (million)	2.90	0.22	2.06	2.10	3.00	0.55	2.08	1.25	3.13
Annual Population growth	3.80%	3.00%	3.48%	3.20%	3.00%	8.00%	2.00%	6.00%	0.74%
Characteristic	Capital of Ethiopia	Capital of Antofagasta region, port and main city in the Great Northern Chile	Provincial capital, business and trading centre of the region, founded about 100 years ago	Main industrial and commercial city of Ecuador	Industrial, commercial, health, educational and cultural centre	Capital of Macedonia, political, economic, industrial, commercial and cultural centre	Capital of Uzbekistan, Scientific, industrial and educational centre	Relatively young city founded about a century ago	Industrial
Contribution to the country's economy		6.5% of the country's GNP and 31% of its exports	9.13% (regional GDP)	20% of the country's GNP and 60% of its exports			21% (country's GDP)	3.8% of the country's GNP	7.6% (regional GDP)
Recent earthquake	1961 Kara Kore Mg 7	30 June 1995, Mg 7.3	No record of damaging earthquake since its foundation	13 May 1942 Mg 7.9	6 and 12 November 1992 Mg 6	26 July 1963 Mg 6.1	26 April 1966 Mg5.3	No experience of a destructive earthquake since its foundation	29/03/1985 Mg 5.0

3.2.3. National Activities

3.2.3.1. Activities in Istanbul

Istanbul Metropolitan Municipality (IMM) has been engaged in the development of an “Earthquake Master Plan” for Istanbul in an effort to mitigate potential losses from a future possible earthquake event within the next several years. Istanbul Earthquake Master Plan (IEMP) is procured by IMM in November 2002 and completed in July 2003. (WEB_1, 2005)

The Earthquake Master Plan serve as the principal guide for all earthquake risk mitigation actions undertaken by IMM. Earthquake Master Plan involves a multi-disciplinary team of earth scientists, social scientists, engineers, urban planners, and other specialists from Turkey’s four leading university. IMM has contracts with the four universities to undertake a comprehensive study and to develop the elements of the Master Plan and an approach for its implementation. One team consists of Middle East Technical University (METU) and Istanbul Technical University (ITU), and the other team consists of Bogazici University (BU) and Yildiz Technical University (YTU). The two teams works independently. The teams are obligated to report their findings and recommendations on a single report. (WEB_1, 2005)

The investigators provide an in-depth assessment of the current situation, and identify and investigate several elements related to the Master Plan, including Seismic Risk Assessment, Urban Planning, Information Infrastructure, Education, Social Environment, and Disaster Management. The current earthquake risk factors and the aftermath of the 1999 Marmara earthquake are also documented in the master plan. (WEB_1, 2005)

IMM benefits also from the support of several other national and international organizations and the Japanese International Cooperation Agency (JICA). In particular, in 2001, (JICA) funds an in-depth earthquake risk analysis for Istanbul, providing valuable information on the spatial and sectorial distribution of the risk to Istanbul. At the same time, Turkish academic institutions develop valuable scientific and technical knowledge on the risk parameters to the city and investigate options for risk reduction. (WEB_1, 2005)

IEMP is procured to provide a comprehensive framework for the technical, social, institutional, legal and financial parameters of a citywide mitigation program, as well as the action plans, processes and strategy for implementation. It also develops comprehensive strategy for earthquake risk mitigation, enhances internal and external resources for implementation, and offers opportunities for capacity enhancement. (WEB_1, 2005)

The Master Plan study is a far-reaching benchmark study, in Turkey. It is a major contribution to the effort of earthquake risk reduction in the city. It is a critical endeavor for Istanbul and for many other cities that are prone to earthquake.

Components of IEMP (WEB_1, 2005)

The IEMP chapters are organized as follows:

Chapter 1 provides an "Introduction" that reiterates the scope of the study, its objectives and some fundamental criteria adopted by the research team.

Chapter 2 provides a "Current Situation" analysis that summarizes the previous studies and provides a comprehensive summary of the risk parameters to the population, buildings, transportation systems, and lifelines as well as to the potential impact on essential facilities, services and emergency response.

Chapter 3 deals with the risk assessment and evaluation of existing buildings. Several methods are proposed for the assessment of the buildings. A discussion is provided related to legal issues pertaining to the collection information on the building characteristics.

Chapter 4 is entitled Urban Planning, Legal Issues, Administration and Finance. It provides essentially two approaches for integration of risk mitigation in planning of Istanbul. It discusses the legal and institutional arrangements and proposes new organizational structures to facilitate the implementation of the master plan. It also discusses various financial instruments for funding.

Chapter 5 deals with the software, hardware and data structures related to information management.

Chapter 6 explains the educational and social issues and proposes various earthquake preparedness programs, with an emphasis on community education and social networking.

Chapter 7 reviews some basis principles of disaster management and suggests a framework for emergency management for Turkey that provides a role to the provincial and local governments.

Zeytinburnu Pilot Project

The district municipalities of Istanbul to develop zonation studies and to undertake surveys of buildings also undertake several local studies. Zeytinburnu is selected as pilot study area for the implementation of IEMP.

"Zeytinburnu Pilot Study" is an important experiment in terms of verifying the approaches and methodologies suggested in the IEMP and of achieving scientific consensus on a common framework for risk assessment and mitigation strategies implementation. It is critical that Zeytinburnu Pilot Study encompasses an exercise of risk assessment of buildings. It allows testing and verifying the innovative contribution of urban planning to risk mitigation; furthermore, it attempts to incorporate the urban renovation and urban transformation recommendations suggested in the IEMP. Zeytinburnu Pilot Study is undertaken within the full context of the IEMP to serve as an actual test of the suggested framework, approaches, methods and recommendations of the IEMP.

Methods for Risk Assessment

IEMP offers a comprehensive risk assessment for urban environment including the building stock. The risk assessment comprises engineering, architectural and planning methods. The related methods and processes will be explained in the content of following section. (See 4.1).

Hazard Assessment

A Scenario Earthquake that is defined in JICA report is used as the base of mitigation activities.

Vulnerability Assessment: (See 4.1.2.2.2)

Damage Assessment: In the content of IEMP HAZUS 99 is used for loss and damage estimation. (See 4.1.2.3.1)

3.2.3.2. Izmir RADIUS Project

In Izmir, Metropolitan Municipality undertakes a comprehensive mitigation activity. Due to the application of the municipality for RADIUS Project, the city is chosen as one of the case studies.

3.2.3.2.1. Process

Izmir Chamber of Civil Engineers arranges a panel about earthquake scenario in 1996. In this panel RADIUS initiative is introduced to mayor and the technical committee. The chamber supported Izmir's participating to RADIUS initiative. (Tunçağ 1999)

Earthquake mitigation activities start with the initiative of Izmir's Metropolitan Municipality's applying to RADIUS Project. UN, IDNDR secretariat chooses Izmir as one of the nine case cities that the project is executed. (Tunçağ 1999)

A local steering committee is constituted within Metropolitan Municipality to the responsibility for the implementation of the case study. The committee consists of two co-chairmen from municipality, one from the chamber of civil engineering, and the other from Dokuz Eylul University Geology Engineering Department. They are responsible for all the activities of the case study, including authorization of expenditure of the United Nations grant and preparation of periodical reports to the IDNDR secretariat. Under the steering committee, 4 working groups are set up to carry out the case study efficiently. The working groups are gathered under these titles: (Tunçağ 1999)

- Risk assessment group
- Building and infrastructure assessment group
- Social and economic condition assessment group
- Rescue works relief activities and rehabilitation group

Workgroups gather and work during a year. They ensure the collection of city data, give direction to the studies, prepare the scenario text, the action plan, and ensure the coordination between the institutions. The project process can be defined as:

- Data collection
- Risk assessment
- Damage estimation
- Earthquake scenario text
- An action plan proposal
- Dissemination to related government organization

The agreement signed with IDNDR secretariat stipulated to start on 01.02.1998 and resulted on 31.07.1999. This final report transmitted to United Nations IDNDR secretariat and presented in Tijuana Symposium that is held on 11-14 October 1999 in Mexico.

3.2.3.2.2. Preparation and Data Collection & Earthquake Master Plan

In the case of Izmir, the Metropolitan Municipality has developed contacts with the scientists (Prof. Dr. Aykut Barka, Prof. Dr. Atilla Ansal, Prof. Dr. Mustafa Erdik, Prof. Dr. Nuray Aydınoglu, and Prof. Dr. Ozal Yüzügüllü) from Bogazici University and from Istanbul Technical University, to prepare the "Earthquake Master Plan of Izmir. (WEB_2, 2005)

The municipality has signed a protocol with these universities, aiming to estimate the building damage in the occurrence of a probable future earthquake and to propose precautions for mitigating these damages. Preparing an earthquake scenario is also aimed in the content of the master plan, which is a wide study of research, compilation, assessment and consultancy service. (WEB_2, 2005)

The data required for RADIUS project is collected in the content of Earthquake Master Plan of Izmir. With the participation of the members of the working groups, the team accumulates large amount of data, which is never accomplished in Izmir before. After interviews with the related institutions, the maps, the position of the essential facilities, the design drawings are digitized. (WEB_2, 2005)

The data is achieved from the Directorate of Highway Department, the Directorate of Waterworks and Dams, the Metropolitan Subway (metro) Project, the Directorate of Clean and Waste Water System, the Directorate of National Electricity Distribution, The Turkish Telecom, The Directorate of Airports and Seaports, The Directorate of Security Forces, The Directorate of National Railways, The Municipal Fire Brigade, the Directorate of Mining Research. (WEB_2, 2005)

The data collected in the content of Izmir Earthquake master plan for the risk assessment process of RADIUS project is summarized as below: (WEB_2, 2005)

- General Information about Izmir's geological structure and ground drilling data done up to now, is collected from the soil laboratory of the Chamber of Civil Engineers. The data from the Directorate of Mining Research (MTA) provide information regarding the geological structure of the city, the positioning of the main faults and places of potential landslides. From these documents, soil classification of the city is estimated and analyzed.

- All underground data such as , metro construction , highways and viaducts, petrol stations, railways, harbor, airports, communication systems, drinking water systems, energy transformation line, transformers and big channel project are obtained with the help of institutions taking place in the committee and are sent to Boğaziçi University to be assessed.
- The teams from the Chamber of Civil Engineering organize a survey for the buildings in Izmir. Building inventory obtained from the observational data is transmitted to Bogazici University. In the content of this study statistical data about approximately 220.000 buildings, including the public housing is acquired. The ortho photomaps that are prepared by Metropolitan Municipality are used for this study.
- City Civil Defense, Security and City Health Directorships' disaster organization maps are used for preparing the scenario text.
- The Chamber of Commerce and the Chamber of Industrialists have provided information regarding the addresses and work force of the establishments that were member of their respective chambers.
- In parallel to the collection of the technical data, data is retrieved for social and demographic structure of the city. The population densities, the family structure (the number of elderly people, women, children, the size of the family etc) have been obtained by the Geography Faculty of the Aegean University, and the Directorate of Public Health.
- About one third of the village headmen ("muhtars"), elected leaders of each community, have provided basic information on their communities. "Muhtars" provides the approximate formation date of the neighborhood, the average estimated family size and whether it is affected by a disaster.

3.2.3.2.3. Risk Assessment Process

Hazard Assessment

The earthquake scenario text is prepared using all the data. According to the scenario on 18th of November in 2013 at 17.25 there will be an earthquake Ms 6,5 which will last 24 second. Izmir Fault Line In this scenario all the details are given about the city’s atmosphere after 5 minutes, half an hour, an hour, first night, first day, two days and a week and a month of the earthquake. (WEB_2, 2005)

Vulnerability Assessment

Comprising all the buildings in the borders of Metropolitan Municipality a wide building inventory study is done in the content of master plan as an input data of vulnerability assessment. At the end of this study the buildings are classified according to their structural properties, construction date, project and construction quality and functional properties.

The city is divided into 25 cells. In turn these cells were again divided into 25 sub-cells. The teams organized by the Chamber of Civil Engineers made on-site observations and filled forms specially prepared for this project. The questionnaire contained information on the following subjects: (WEB_2, 2005)

- The classification of the building i.e. whether it is a dwelling, a pharmacy, a hospital, a police station, a cinema, a shop etc.,
- The structural classification of the building i.e. whether it is reinforced concrete, masonry etc.,
- The number of floors of the building,
- The approximate date of its construction i.e. whether it was built before the national seismic codes (1975) or after,
- The appearance of the building i.e. whether it is good, fair or bad,
- The number of similar buildings in that street.

The data from the on-site observations on about 220 000 buildings is then sent to Bogazici University for damage estimation.

Damage Estimation

The result of the vulnerability assessment is used for estimating the damage under Izmir scenario earthquake. In fact this is not an accurate estimation. It is a prediction of the possible damages and losses sourced the theoretical earthquake.

The damage is estimated using HAZUS, ATC-25 and GIS methods (see 4.1.2.3.1). According to the results the possible damage of infrastructures and lifeline systems in Izmir such as highways and bridges, railroads, airports, marine facilities, subway system, telecommunication systems, electrical transmission and distribution Systems, clean water and waste water systems, dams, and building contents, is predicted. The results obtained from the investigations are presented in master plan (WEB_2, 2005)

Using these data Earthquake scenario is prepared as the base of action plan.

3.2.3.2.4. Action Plan

Damage scenario and risk management plan is the bases of action plan.

The Scenarios and Action Plans are disseminated to relevant organizations and the public. The main objective of these actions is to raise awareness of government officials, citizens, business leaders, owners of buildings and houses, and insurance and reinsurance companies. (United Nations 2005)

The main objectives of the action plan are:

- Strengthening of the strategic buildings such as hospitals, crisis centers, the Municipal Building, the Governor's office etc
- Making collaboration with chamber of professions about projects and building inspection
- Education and planning for emergency activities
- Planning of the open space areas to be used for emergency activities, planning the evacuation axes, and determining temporary settlement places in the city
- Dissemination of emergency rescue and instruction units in fire departments
- Education of the citizens and children about how to behave during earthquakes,
- Providing funds and financial aid for rehabilitation and reconstruction, work
- Preparation of a Mass Media Program for the public information and awareness
- The creation of a Risk Mitigation Unit within the municipality

3.2.3.2.5. Results of the Project

Because of the limited time and possibilities and the problems in disaster management law in Turkey RADIUS Project could not be completed in Izmir. Depending on these deficiencies some part of the project, mentioned as below, **can not be realized:** (Selvitopu 2003)

▪ Offsetting the different knowledge from headman of the village and village clinics about demographic structure of the city. They should be joined and saved with the help of GIS and made part of the City Information System.

▪ The industrial and commercial structure of the city could not be evaluated exactly. Although commercial and industrial working units address information obtained it could not be classified according to their working area.

▪ Coordination of the rescue works done by different institutions could not be equalized although each institution's rescue schema were obtained

▪ Education of the citizens: Only an earthquake brochure was prepared to inform and educate the citizens and children. The communication is not being realized with instructors, unionists, tradesman, artisans, and head of the villages, sociologist and psychologist to ascertain what to do about this subject.

▪ The project could not be transferred to press, disseminated and presented enough.

▪ Disaster management unit can not be realized. All the data collected by RADIUS steering committee should have been transmitted to this unit which is supposed to coordinate the civil society institutions such as official foundations, universities, and head of the villages, syndicates, clubs, and chamber of professions.

The activities that are **realized in the content** of the project are: (Selvitopu 2003)

▪ Within the Agenda 21 meetings are organized to provide the communication and coordination of the institutes in Izmir.

▪ The precautions are proposed for mitigating the damage that is determined in the content of master plan. The institutes are informed about the results and asked for taking the essential precautions. (WEB_2, 2005)

▪ Governorship determines the spaces to be used for emergency. Disaster map of Izmir is prepared. Earthquake Drills are done. New crisis management center is founded in the content of governorship.

▪ Chamber of Architects organized seminars about earthquake resistant construction techniques. 4000-construction worker are participated.

▪ Metropolitan Municipality revises the building codes.

▪ Geological maps of Izmir on a scale 1/25.000 is prepared and 1/5000 scaled maps are being prepared to be used in more detailed maps on a 1/1000 scale.

- The translation of the book that comprises the RADIUS guideline and the studies about Izmir is prepared to be ready for publishing.

3.2.3.2.6. Evaluation

This project should not be considered as the result of the all questions about earthquake problem in Izmir. This is the only an initiative to accelerate the future work. As it is aimed, the earthquake damage scenario and disaster management plan including the action plan is prepared.

RADIUS Project lasts two years. Owing to RADIUS project, Izmir succeeds the beginning work for mitigating the earthquake risk. The city has a big knowledge and experience saving for future projects. Local institutionalization of the efforts is very important for the sustainability of these efforts.

Physical projects such as architectural, urban design and planning should be proposed for execution in the district scale. RADIUS does not propose the methods for reinforcement of the buildings and renewal of the high risk areas. Models should be developed in order to applicable of these architectural and planning or urban design problems:

- Recommendations (general principles and criteria, methods) for repair and strengthening of buildings
- Seismic regulations for new buildings
- Guidelines for design and construction of individual houses and small buildings

3.3. Concluding Remarks

Within this chapter, general outlook of mitigation activities is put forward. An attempt has been made to understand the strategically approach for mitigation activities. The techniques for risk mitigation will be studied in Chapter 4.

It is focused on the role of pre-earthquake and post-earthquake activities within the first section to be able to understand the mitigation process.

The worldwide and national mitigation activities are examined within the second section. RADIUS Project is defined and criticized. The process of the project and its execution in the case cities around the world is put forward.

National activities about risk reduction are searched focusing on Istanbul and Izmir. Istanbul Earthquake Master Plan is presented briefly considering as a guide for Izmir case. Then Izmir RADIUS Project comprising Izmir Earthquake Master Plan is scrutinized.

The strategies of the activities for determining the earthquake risk within the urban environment is focused to be used for the risk assessment process. Related with these studies, urban safety, risk management, risk assessment process will be clarified in the content of Chapter 4. Consequently, strategies for urban safety will be discussed. As a solution of safer urban environment, earthquake conscious urban transformation will be proposed and its components will be discussed.

CHAPTER 4

URBAN SAFETY: EARTHQUAKE CONSCIOUS URBAN TRANSFORMATION

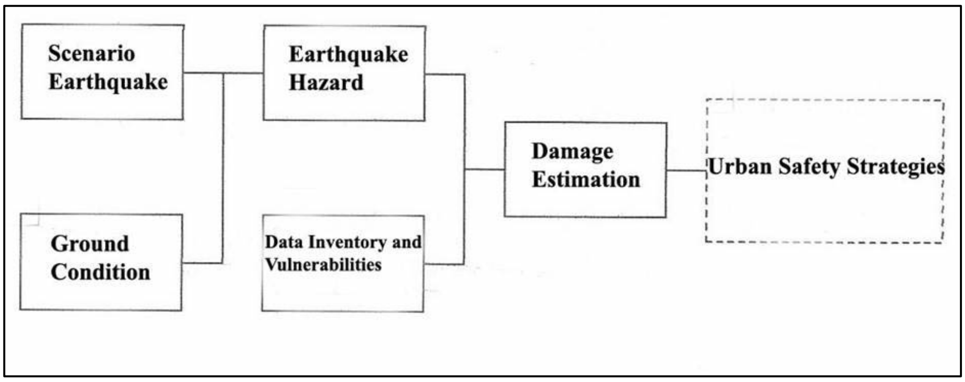
4.1. Risk Assessment

4.1.1. Process

Urban safety is important for a sustainable development. Effects of earthquakes should be mitigated through a comprehensive risk management plan to ensure the urban safety. Earthquake risk of the city should be assessed to realize the risk management plan. Result of the risk assessment is used to prepare an earthquake scenario. Using the earthquake scenario an action plan is constructed that if implemented, will reduce the earthquake risk of the city.

Risk assessment is determining and estimating the effects of earthquake in the city. Risk assessment comprises hazard assessment, vulnerability assessment and damage estimation. Risk assessment aims constructing an earthquake scenario. This is done through the collection of existing data and the estimation of the potential damage caused by a hypothetical earthquake. The evaluation of these factors reveals the earthquake scenario, which will guide the realization of action plan that is necessary for risk mitigation.

Table 4.1. Risk Assessment Process



Below it is defined how a risk assessment process should be :

- Hazard Assessment and scenario earthquake
- Vulnerability Assessment
- Damage Estimation and earthquake scenarios (United Nations 2005)

4.1.1.1. Hazard Assessment

Hazard assessment is the preparation of the hypothetical earthquake, which is also stated as "scenario earthquake" that has a fair chance of occurrence during lifetime. Based on geological and seismologic information, scenario earthquakes are generally prescribed in terms of their size, mechanism and rupture characteristics. The scenarios define the intense of the probable earthquake and its effect on urban environment.

Historical earthquake inventories, geological and seismological data, and the evaluation of the earthquake risk with methods (Probabilistic or Deterministic methods: WEB_2, 2005) prediction of the land movements depending on the circumstances and knowledge of the microzoning are necessary to estimate the earthquake risk.

The main objectives of hazard assessment can be articled as:

- To select the hypothetical earthquake to be adopted for use in the project
- To estimate the distribution of seismic intensities for the adopted earthquake
- To estimate the effects of collateral hazards (United Nations 2005)

These estimates will form the basis of the damage estimations. For hazard assessment these information is required:

- Historical seismicity
- Damage reports from past earthquakes
- Information on main seismic sources
- Soil conditions
- Topography
- Previous hazard assessment studies
- Landslide potential
- Liquefaction potential
- Tsunami potential
- Flood potential (e.g., failure of vulnerable dams)

▪ Additional collateral hazard potential (e.g., nuclear power plant failure) (United Nations 2005)

4.1.1.2. Vulnerability Assessment

Vulnerability is defined as the degree of loss to a given element at risk or set of such elements resulting from a given level of hazard in urban areas, buildings, population, lifeline systems and socio-economic activities constitute the "element at risk". Vulnerability assessment of urban pattern and buildings is an essential component of following damage and loss estimation methodology. (Coburn and Spence 1992).

The vulnerability is commonly expressed by matrices, that can be obtained by statistical studies of damaged structures in previous earthquake-stricken areas (observed vulnerability) or by simulations using numerical models of structures or engineering calculations (predicted or calculated vulnerability) as a function of some parameter describing the earthquake size. Observed vulnerability is valid in a broad probabilistic sense. Calculated vulnerability is available only for a fraction of the existing building. (United Nations 2005)

Process

The recommended process of vulnerability assessment is ,firstly, to identify all the existing structural and infrastructural types of the city and then select representative ones. Next, existing vulnerability for the selected types should be calibrated using data of past-observed damage as well as the opinions and/or studies of local experts. Within the Istanbul Master Plan calibrated data is obtained from 1999 Marmara earthquake. The Damage level of the buildings in Marmara earthquake are evaluated by statistical methods and the scores are defined for each vulnerability parameter. In the Izmir case, A statistical evaluation of a previous earthquake's real damage results is not used. The results are calibrated with observed vulnerability. (WEB_1, 2005)

Essential buildings and facilities require individual evaluations (airport, hospitals, important bridges, government buildings, historical monuments, harbors, army bases). The vulnerability assessment of these structures cannot be considered through the use of vulnerability functions, which are used to obtain a general, average description of damage. (United Nations 2005)

Vulnerability assessment can be realized incrementally. City scale vulnerability assessment comprises all the components of physical environment. Properties due to the cities current system and spatial and physical distributions of the units have to be determined. The risk has to be put forward through determining urban vulnerability. A City-scale vulnerability assessment is taken up within Istanbul Earthquake Master Plan with the headings below: (WEB_1, 2005)

- Macro-form Analysis (Ground condition, seashores, forests, water basins)
- Urban Pattern Analysis (Parcels/Roads/Density)
- Open Space Analysis
- Building Stock Analysis (Project and Production mistakes)
- Land utilization Analysis (incongruity)
- Dangerous uses (LPG, Fuel oil stations)
- Special Areas (close to fault zone, seashores)
- Special buildings, environments (Historically, culturally and aesthetically and special buildings and urban environment)
- Infrastructural deficiencies (network/itinerary/material /capacity /production
- Safety and Location Analysis of Important buildings for emergency (Hospitals, fire department, schools, ports, main roads, energy transfer lines, bridges, water cisterns)
- Administration/ Management/inspection deficiencies

In this wide scope of city-scale issues, building stock risk analysis will be explained in the following part, 4.1.2.2.2, using the method used in Istanbul Master Plan.

Urban Pattern Vulnerability Assessment

Urban pattern is a property of the manner that the urban physical elements come together. Urban patterns that reveal different physical and ownership properties can carry risks as a matter of characteristics below: (WEB_1, 2005)

- Properties of the road system and vehicle ownership: (Evacuation or difficulties of access)
- Difficulties due to the probable building demolishes during the earthquake
- Physical conditions like plot form, construction, filled building plot
- Disharmony of usage with building stocks
- Insufficiency of urban equipments (car park, green, playground, etc.)
- Topography and pattern risks from the point of micro-regions

- Night-day population
- Ownership

Determining Urban Pattern Risks

Urban pattern risks can be defined by determining elements formed the urban pattern such as building units, building plot (properties like form, size, density and etc.), green area, road, car park, natural data and ground conditions. These data are combined with the findings of engineering researches related to the building resistance, and vulnerability map of the urban pattern is prepared. The vulnerability maps are used to determine the approaches of urban transformation to reduce the hazards and lost because of a probable earthquake. (See 4.2.1)

Natural Features

Ground conditions and topographic features are the major natural characteristics effective in urban pattern analysis. Similarly, formed two different pattern samples just because of the slope differences can carry distinctive risk characteristics. Besides, attitudes of grounds during earthquake, and the relationship between the building and the ground have to be examined. Resonance period of the ground earthquake has to be harmonious with the resonance period of the building. Otherwise, both will increase the risk by passing to the resonance situation. (Akçığ and Pınar 2005)

Road / Transportation System Features

An important data group in analyzing the risks due to the urban pattern is the information of transport planning, the relation of road system with the general system and car parking location.

- Road system characteristics (grid, hierarchical, Cul-de-sac Street, etc.)
- Relations with the main transport network (distance of link, single/double direction, urgent case transportation plan data effects)
- Road section (road extensive/ building height proportions)
- Street/ car parking relations, upper road park, and open/closed car parking locations are the headings that will be taken in hand in this group.

Urban Pattern and Building Features

- Total building number, total house number
- Building base area/ plot area, total storey area/ plot area, and such values,
- Size of the building stock areas
- Proportion of green area
- The way that the buildings formed the pattern come together

- Usage and function properties of the buildings
- Building Quality (Observed quality of the building, subjects not compliant to the earthquake regulations)
- Structural disorder of the building, interference to the building,
- Building age
- Ownership
- Due to the quantitative and qualitative values above, risk level tables are formed.

4.1.1.3. Damage Estimation

The objective of the damage estimation is to estimate the theoretical potential damage caused by the scenario earthquake.

Assessing the magnitude of potential damage should not be thought of as the final goal of the damage estimation process, but rather as the beginning of the earthquake disaster management planning. Required information and the process is defined in the content of RADIUS Project as below: (United Nations 2005)

Required information

- Inventory of buildings (using GIS in order to include location of buildings)
- Inventory of infrastructure
- Population information
- Intensity distribution (including collateral hazard effects)
- Vulnerability of the buildings, infrastructure, and human and economic impact

Process

In carrying out the damage estimation, there are several steps which should be followed:

- The date and time of the earthquake should be decided on since they will determine weather conditions and building occupancy
- The area unit for which the damage will be estimated (e.g., urban block or neighborhood) should be decided
- Hazard and vulnerability assessment's result should be combined in order to estimate potential damage and impact. Estimated damage should be mapped for efficient presentation

▪ Recovery times for the city's services and human and economic impacts should be estimated using the methods. (HAZUS method and RADIUS method will be explained within part 4.1.2)

As it is mentioned before one of the objectives of risk assessment is to have an earthquake scenario of the city. Depending on this scenario action plan is implemented as the base of mitigation the earthquake risk. Here earthquake scenario will be defined briefly.

Earthquake Scenario

The scenario consequences illustrate a regional damage pattern that is likely to result from the specific scenario earthquake.

The objective of the creation of the earthquake scenario is to describe the results of the damage estimation in a comprehensive and easy to understand manner.

In developing the earthquake scenario, the following process is recommended:

- Obtaining damage estimation through risk assessment process
- Summarizing the main findings on map
- Sending mapped results and summarizing to city system managers for their review,

Preparing final version of preliminary damage estimations and mapped results (United Nations 2005)

Preliminary estimates of the city's losses; emergency response capacity; and recovery capability, are obtained due to the adopted earthquake. The result of the creation of the earthquake scenario include realistic and corrected descriptions of the damage and impact that the adopted earthquake will have on the city, as well as realistic and corrected estimates of the recovery capability of the city.

4.1.2. Methods for Risk Assessment

RADIUS Project gives a guideline about risk assessment as it is briefly summarized in 4.4.1. Within RADIUS Project a special method for vulnerability assessment of buildings and urban pattern and life lines is not proposed. Each case city is responsible for the vulnerability assessment of existing building stock. A tool, which is a simplified computer program, is proposed for the damage estimation. (See 4.1.2.3.2)

Risk assessment process of Izmir RADIUS project is realized within the Izmir Earthquake Master Plan. (See 3.2.3.2)

In the content of Izmir Earthquake Master Plan the damage and losses are estimated using HAZUS 99 methodology.

The methods that are possible to be used within risk assessment process is be defined within this section. Different methods used for the components of risk assessment process. In the content of this section, these methods will be mentioned about:

- Hazard Assessment: Joyner & Boore, Campbell, or Fukushima & Tanaka
- Vulnerability Assessment: Istanbul Master Plan,
- Damage Assessment: HAZUS, RADIUS software program

4.1.2.1. Hazard Assessment

For the scenario earthquake, the reoccurrence of a past damaging earthquake or an active fault earthquake is commonly adopted. Although hypothetical earthquakes can be used as the scenario earthquake, it is important to be careful that the hypothetical earthquake model is valid from a seismological point of view. For example, the magnitude should not exceed 8.5. However, since the degree of damage is the function of the magnitude of the event and distance of the target area from the epicenter, it is meaningless to use an excessively small magnitude event or a large distance from the epicenter. (United Nations 2005)

Magnitude, epicenter, depth and occurrence time (hour during the day or night when the event strikes) of the hazard are the input data of hazard assessment. Distance from the epicenter can be calculated with the locations of the epicenter and target area. Magnitude (MMI) and Peak Ground Acceleration PGA are measured by formulas. PGA is calculated by one of three most popular formula such as Joyner & Boore (1981), Campbell (1981) or Fukushima & Tanaka (1990); and converted to MMI using empirical formula such as empirical formula of Trifunac & Brady (1975). Relation between Epicenter& Acceleration and MMI & PGA are shown in the table 4.2 and 4.3 (United Nations 2005)

Table 4.2. Epicenter & Acceleration

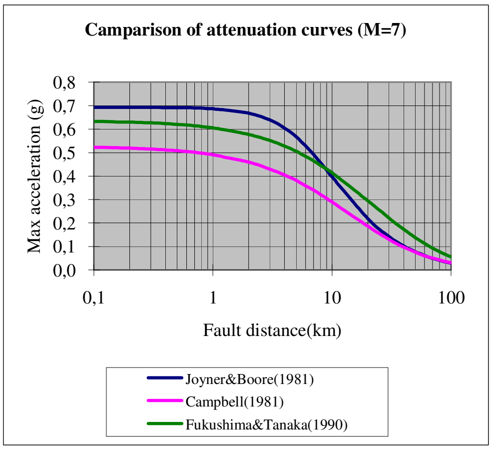
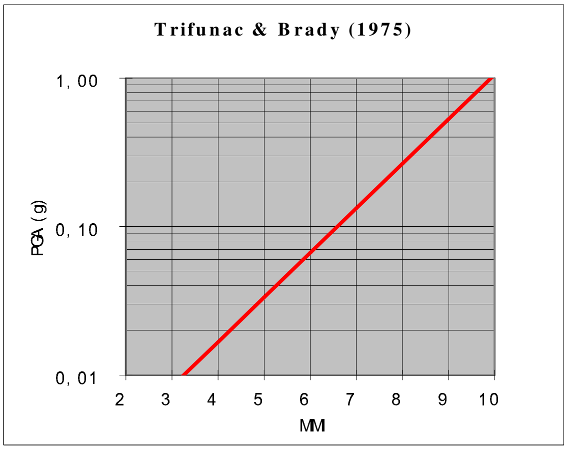


Table 4.3. MMI & PGA



4.1.2.2. Vulnerability Assessment

As it is mentioned in 4.1.1.2, vulnerability assessment is done incrementally. In the scope of this thesis urban pattern analysis and building stock analysis will be taken into consideration explaining the method used in Istanbul Master Plan.

4.1.2.2.1. Building Block Vulnerability Assessment

Process

Assessing the existing buildings' earthquake risk and strengthening the ones if required is the core of the Istanbul Earthquake Master Plan (IEMP). There are some methods for assessing and strengthening the buildings. In the content of IEMP these methods are explained.

For the accuracy of the results, all the methods mentioned in the content of IEMP proposed three-stage vulnerability assessment procedure. Within first stage called "Street Observation", buildings are classified as "high, moderate and low risk" according to their earthquake performance score that is estimated according to the vulnerability parameters that will be mentioned below. It is aimed within the first stage to presume the buildings that are high risk from the point of loss in human lives. (WEB_1, 2005)

According to the survey evaluation, if a building falls in the lower (high-risk) part of the scale, then a more detailed vulnerability assessment is required. Their risk rank, determines their priority for being assessed in detail in the second stage**.** The performance scale sorts building stock according to seismic vulnerability. When building data are obtained from street surveys and evaluated, it is possible to identify buildings as low, moderate and high-risk according to their performance scores. (WEB_1, 2005)

High and moderate risk buildings require a further evaluation. They should be subjected to further evaluation before final decisions on strengthening or demolition are made. At the end of the first stage, the areas that have the priority for further assessments are determined.

Within the second stage, experts get into buildings and take measured drawings from the building's ground plan, takes concrete, and iron examples from beams and columns to be used for the laboratory tests.

Third stage consists of analyzing the important public buildings, multi-floored housing and offices in detail using the advanced engineering methods.

The first Stage called "Street observation" is the method revealed from the inventory of 477 buildings that are severely damaged or collapsed following the Marmara earthquakes in 1999, in Turkey. These buildings are analyzed so that to learn which structural vulnerability parameters causes collapse or damage. The data is evaluated with statistical methods. Statistical analysis is conducted with the program package SPSS Version 11, using the "Multivariable Stepwise Linear Regression Analysis" procedure. The weight of each building vulnerability parameter is evaluated statistically based on Düzce database. This method is similar to the seismic evaluation procedure developed in FEMA–154 (1988). (Sucuoğlu and Yazgan 2005)

The street survey is based on simple structural parameters that can be observed easily from the sidewalk. Masonry and concrete buildings earthquake performance score are evaluated using the building vulnerability parameters represented by:

1–7 Floor Reinforced Concrete Buildings (WEB_1, 2005)

1. The number of levels above ground (1 to 7)
2. Presence of a soft floor (yes or no)
3. Presence of heavy overhangs, such as balconies with concrete parapets (yes or no)
4. Apparent building quality (good, moderate or poor)
5. Presence of short columns (yes or no)
6. Pounding between adjacent buildings (yes or no)
7. Plan Irregularity

8. Local soil conditions (stiff or soft)

9. Topographic effects (yes or no).

10. Building Age

1–5 Floor Masonry and Mixed Buildings (WEB_1, 2005)

1. The number of levels above ground (1 to 7)
2. Apparent building quality (good, moderate or poor)
3. Pounding between adjacent buildings (yes or no)
4. Plan Irregularity
5. Solid-Void Ratio (Less, Moderate or More)
6. Solid-Void Order (Regular, Moderate, Irregular)
7. Local soil conditions (stiff or soft)
8. Topographic effects (yes or no)

Each parameter reflects a negative feature of the building system on a variable scale under earthquake excitations. The correlation between observed building damage and parameter variation, based on building data from Düzce, allows assessment of the weight of each parameter to be rated for seismic performance. A linear combination rule for the selected parameters was determined in order to predict the damage distribution displayed by the data. (Sucuoğlu and Yazgan 2005)

Each vulnerability parameter that affects the damage distribution of the building is discussed in detail in the following paragraphs:

The number of Floors

The number of floors of buildings is important to calculate the period of the building with engineering methods

If the majority of buildings in an earthquake zone do not ensure compliance with building codes, then increasing the number of stories increases seismic forces linearly. According to the statistical evaluation of 9.685 damaged buildings of Marmara earthquakes, the correlation between damage distribution and number of floors shows this. (Sucuoğlu and Yazgan 2005)

As the number of stories increases, the percentage of undamaged and lightly damaged buildings decreases. This is an indication that the number of stories is significant, perhaps the most dominant parameter in determining the seismic vulnerability of typical multilevel concrete buildings in Turkey. (Sucuoğlu and Yazgan 2005)

Presence of a Soft Floor [No (0), Yes (1)]

A soft floor usually exists in a building when the ground floor has less stiffness and strength than the upper floors. This mostly arises in buildings located along a main street. The ground floors, level to the street, are used as commercial spaces whereas residents occupy the upper floors. Ground floors also tend to have higher clearances and a different axis system resulting in irregularity. From an earthquake engineering perspective, these negative characteristics result in a 'soft floor.' Worldwide, buildings with soft floors often collapse in a pancake manner during earthquakes. Different height of floors named as 'weak floored' may cause damage also. (Coza an Ozgen 2005)

Figure 4.1. Soft Floor Effect

Presence of Heavy Overhangs [No (0), Yes (1)]

Heavy balconies and overhanging cantilever floors in multilevel reinforced concrete buildings shift the mass center upwards, increasing seismic lateral forces and moments for overturn during earthquakes. (Sucuoğlu and Yazgan 2005)

Balconies with large overhanging cantilever spans and heavy concrete parapets sustained heavier damage than regular buildings during recent earthquakes in Turkey.

Apparent Building Quality [Good (0), Moderate (1), Poor (2)]

Material, workmanship, moisture, maintenance and quality of junction points of structural elements create building's apparent quality. During recent earthquakes in Turkey, a close relationship is observed between apparent quality and building damage. A building with poor apparent quality is expected to have weak material strength and inadequate detailing. (Coza an Ozgen 2005)

Presence of Short Columns [No (0), Yes (1)]

Semi-filled frames, band windows in semi-buried basements and mid-floor beams around stairway shafts lead to the formation of short columns in concrete buildings. These captive columns usually sustain heavy damage during strong earthquakes since they are not originally designed to receive high shear force relevant to their shortened lengths. Short columns can be identified from outside because they usually form along the exterior axes. (Sucuoğlu and Yazgan 2005)

Figure 4.2. Short Column Effect

Figure 4.3. Pounding Effect

Pounding between Adjacent Buildings [No (0), Yes (1)]

Because of different vibration periods and non-synchronized vibration amplitudes, close buildings knock together during an earthquake. Uneven floor levels aggravate the effect of such pounding. Buildings subjected to pounding receive heavier damage on higher stories.

Plan Irregularity

Irregularity in building plans is a deviation from a rectangular plan and has orthogonal axis systems in two directions. Such deviation from plan regularity leads to irregularities in stiffness and strength distribution, which in turn increases the risk of damage localization under strong ground excitations. In an earthquake resistant design, regularity in plan is encouraged. It is advised that the plan should be symmetric. (Bayındırlık ve Iskan Bakanlığı1998)

Local Soil Conditions

The intensity of ground motion under a building during an earthquake depends upon the distance of the building from the causative fault and local soil conditions.

Earthquake hazard, or ground motion intensity, is mapped in terms of PGA (peak ground accelerations) or PGV (peak ground velocities). The effect of ground motion intensity expected in different zones was considered by applying velocity-based conversion factors as explained below. PGV is selected to represent the ground motion intensity in Istanbul Earthquake Master Plan. 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. (WEB_1, 2005)

Topographic Effects [No (0), Yes (1)]

Topographic amplification is another factor that may increase ground motion intensity on hilltops. Buildings located on steep slopes (more than 30 degrees) usually have stopped foundations that are incapable of distributing ground distortions evenly to the structural components above. Therefore, these two factors must be taken into account in earthquake vulnerability assessment. Both factors can be observed easily during a street survey. (Sucuoğlu and Yazgan 2005)

Solid- Void Ratio: [Less (0), Moderate (1), More (2)]

Total door and window opening proportion to total observed elevation length is classified as less, moderate or more. If the proportion is bigger than 1/3, it is defined as "less"; if it is between 1/3–2/3, "moderate"; if it is more than 2/3 it is defined as "more". These values depend on straight eye assessment.

Solid- Void Order: [Regular (0), Moderate (1), Irregular (2)]

Two and more floored masonry buildings' solid-void order along the elevation is an important criterion. They should be one above the other. If the openings are not aligned on the facade, this causes danger because earthquake forces are not distributed equally along the wall. It is the irregular situation if the openings projection is all different along the facade; if it is same, it means regular situation; and in-between situations are called moderate.

Building Performance Score

Once the vulnerability parameters of a building are obtained from the survey, the earthquake performance scores to be used for prioritizing the buildings, is calculated using tables below for reinforced concrete and masonry buildings.

In these tables, an initial score is given with respect to the number of floors and the intensity zone. Then, the initial score is reduced for every vulnerability parameter that is observed. A general equation for calculating the earthquake performance score (PS) can be formulated as follows: (WEB_1, 2005)

PS = (Initial Score) – ∑ (Vulnerability parameter) x (Vulnerability Score)

The vulnerability scores are given in tables 4.4 and 4.5 and the vulnerability parameters are defined under the tables.

Table 4.4. Earthquake Scoring of Reinforced Concrete Buildings

Earthquake scoring of Reinforced Concrete Buildings							
Story #	Zone 1 60<PGV<80	Pounding	Apparent Quality	Soft Story	Short Column	Plan Irregularity	Heavy Overhang
1,2	100	0	-10	0	-5	0	0
3	90	-2	-10	-10	-5	-2	-5
4	75	-3	-10	-15	-5	-5	-10
5	65	-3	-10	-20	-5	-5	-10
6,7	60	-3	-10	-15	-5	-5	-10

Vulnerability Parameters

Pounding Effect	No (0); Yes (1)
Apparent Quality	Good (0); Moderate (1); Poor (2)
Soft Story	No (0); Yes (1)
Short Column	No (0); Yes (1)
Plan Irregularity	No (0);Yes (1)
Heavy Overhang	No (0); Yes (1)

Building Seismic Performans Score = Zone Score - Total (Vulnerability Parameters x Vulnerability Score)

BSPS < 20 = Highest Risk

20<BSPS < 30 = High Risk

30<BSPS<40 = Moderate

40<BSPS< 60 = Low Risk

60<BSPS = Lowest Risk

Table 4.5. Earthquake Scoring of Masonry Buildings

Earthquake scoring of Masonry Buildings						
Storey #	Zone 1 60<PGV<80	Pounding	Apparent Quality	Plan Irregularity	Solid-Void Proportion	Solid-Void Order
1,2	100	0	-10	0	-5	-2
3	85	-3	-10	-2	-5	-5
4	70	-5	-10	-5	-5	-5
5 and more	50	-5	-10	-5	-5	-5

Vulnerability Parameters

Pounding Effect	No (0); Yes (1)
Apparent Quality	Good (0); Moderate (1); Poor (2)
Plan Irregularity	No (0);Yes (1)
Solid-Void Proportion	Less (0); Moderate (1); More (1)
Solid-Void Order	Regular (0); Moderate(1); Irregular (2)

Building Seismic Performans Score = Zone Score - Total (Vulnerability Parameters x Vulnerability Score)

BSPS < 20 = Highest Risk
20<BSPS < 30 = High Risk
30<BSPS<40 = Moderate
40<BSPS< 60 = Low Risk

4.1.2.3. Damage Estimation

4.1.2.3.1. HAZUS

HAZUS is a GIS-based (Geographical Information System) regional damage or loss estimation tool developed by FEMA. (The Federal Emergency Management Agency). HAZUS provides an approach to quantify future earthquake losses that is national in scope, uniform in application, and comprehensive in its coverage of the built environment. (WEB_12, 2005)

FEMA first release HAZUS in 1997 followed by an updated version in 1999. HAZUS is a tool that local, state and federal government officials and others can use for earthquake-related mitigation, emergency preparedness, response and recovery planning and disaster response operations. The methodology in HAZUS is comprehensive. It incorporates approach for: (WEB-12, 2005)

1) Characterizing earth science hazards including ground shaking, liquefaction, and landslides;

2) Estimating damage and losses to buildings and lifelines;

3) Estimating fires following earthquake;

4) Estimating casualties, displaced households, and shelter requirements; and

5) Estimating direct and indirect economic losses.

Since HAZUS is a uniform national methodology, it serves as a tool for assessing and comparing seismic risk across the United States. The HAZUS technology is built upon an integrated geographic information system (GIS) platform that produces regional profiles and estimates of earthquake losses. The methodology addresses the built environment, and categories of losses, in a comprehensive manner.

The methods used for the estimation of damage within Istanbul and Izmir Earthquake Master Plans are derived from HAZUS tool.

4.1.2.3.2. RADIUS Computer Software

There is another damage estimation method of the buildings using the computer program called "A simplified program for earthquake Damage Estimation for RADIUS" in the content of RADIUS project.

The computer program is developed by the OYO Group (OYO Corporation and OYO International), based on the experiences of the nine case studies within the RADIUS project. The results of the application of the program should be regarded as a preliminary estimation. It is intended that this program will be used as a practical tool (United Nations 2005)

The program requires input of a simple data set and provides visual results. Input data are population, building types (the classification is given below), ground types, and lifeline facilities. Outputs are seismic intensity (MMI), building damage, lifeline damage and casualties, which are shown with tables and maps. It is also needed to apply a hypothetical scenario earthquake. (United Nations 2005)

There are many ways to classify building types, but 10 building classes are adopted in RADIUS Program. These have been classified based on the strength of buildings against shaking in an earthquake. It is expected to enter the building inventory percentages for building classes in the target region, by AreaID, which most closely matches to the building classes in the RADIUS Program. An explanation of the building classes is given below: (United Nations 2005)

- RES1---Informal construction: mainly slums, row housing etc. made from unfired bricks, mud mortar, loosely tied walls and roofs
- RES2---URM-RC composite construction: substandard construction, not complying with the local building code provisions. Height up to 3 stories.

  URM = Unreinforced Masonry, RC = Reinforced Concrete
- RES3---URM-RC composite construction: old, deteriorated construction, not complying with the latest building code provisions. Height 4 - 6 stories
- RES4---Engineered RC construction: newly constructed multi-story buildings, for residential and commercial purposes
- EDU1---School buildings, up to 2 stories: generally, the percentage of this type of building should be very low
- EDU2---School buildings, greater than 2 stories: office buildings should also be included in this class; generally, the percentage of this type of buildings should be very low
- MED1---Low to medium rise hospitals: generally, the percentage of this type of building should be very low
- MED2---High rise hospitals: generally, the percentage of this type of building should be very low.
- COM----Shopping Centers
- IND -----Industrial facilities: both low and high risk

The computer program proposed in the content of RADIUS project is not used in Izmir RADIUS Project. After the RADIUS project is resulted a study is done by Prof.Dr.Mustafa Düzgün from 9 Eylül University using the RADIUS computer software. Damage estimation of Izmir within the bordered area is done using the data derived from earthquake master plan and Izmir scenario earthquake is adopted.

This computer program will be used for the damage estimation of the case study of this thesis. The results of the program will be compared with the observed vulnerability results percentages done in the field. The application of the software will be explained in section 5.3.2 using for the case study.

4.2. Risk Mitigation & Earthquake Conscious Urban Transformation

In the content of previous section the process and the methods used for risk assessment is discussed. Earthquake performance of the buildings used as the base of vulnerability maps is revealed using these methods. Vulnerability maps are obtained to be used for urban safety strategy of the city or the area.

4.2.1. Strategies for Earthquake Safety

There are different strategies to make the living environment safer against earthquake risk. One of the strategies is "*transformation*" in the project area and the other is "*relocation*" that is to move and relocate the population into a new settlement area. Latter should not be preferred because of the social and economical problems that will occur in the vacated area and in the new settlement area.

After 1999 Marmara earthquakes, the population is moved out of the city for the new post-earthquake permanent houses. And the spaces become empty after the buildings are demolished. The studies have shown that the new settlement areas are not supply the needs of population and the evacuated areas could not be revaluated.

The strategies keeping the population in site that are types of transformation projects should be searched for a sustainable urban environment. The suitable selection of transformation type depends on ground structure, building quality, vulnerability map of the project area and other engineering studies. After the risk assessment process the buildings are ranked to be able to take decision about transformation type such as;

- Conserving the existing structure
- Partial Conservation and Partial Redevelopment
- Comprehensive Urban Transformation

Conserving the Urban Pattern

This alternative which is a kind of improvement plan is possible for the planned urban pattern and for the historical cores. Structure of ground and the building stock should be safe enough to be conserved. This alternative is not possible in the illegal areas because the building stock mostly does not have project.

It is aimed to improve the urban quality by urban design and strengthening the buildings compliant to building code. Other profit of this planning process is to satisfy open space need, and to do functional decomposition within the land use. (Şengezer 2003)

Partial Conservation and Partial Redevelopment

It is aimed to take profit from qualified, safe building stock and especially from infrastructure. The buildings, which have no risk or low risk, are conserved. High-risk buildings are demolished and replace with the new ones. Because of redevelopment, building stock has dual structure because of the different island dimensions, setback distance and building heights. (Şengezer 2003)

Comprehensive Urban Transformation of the Urban Fabric

This planning action is the most difficult but the most healthy and safe one. This alternative handles the area as a whole. Transportation axles, infrastructure data and all the facilities should be obtained to be able to develop a new plan. This type of areas usually is high risk and need to be demolished totally. It is not possible to have solution with the existing building code. It should be rearranged considering the earthquake risk. As it is mentioned above; for the realization of the urban transformation, financial source should be provided. Realization of urban transformation, depend on the profitability of the investor and real estate owners. An applicable urban transformation model should also include financial, administrative and corporate governance models, strategic communication model, and a model for public participatory

Urban transformation is needed to mitigate the risk. Within the following section, urban transformation processes will be discussed.

4.2.2. Concept of Urban Transformation

Transformation means to turn into a form, which is not how it is used to. It can be understood that the whole city or part of it also turn into another form when it is transformed. Transformation is a multi-dimensional process including the physical or social change and the causes of the change. Transformation is affected by physical, geographical, social, political, economical factors. When an area or a building is transformed, its physical and social structure, or the function of it, may change partly or totally. For actualizing the transformation, demolishment of the building or redevelopment of the area is not enough. The change should be observed functionally, physically and socially.

Urban Transformation is one of the most important concepts that everyone perceives differently and attributes different meanings on. As a concept Urban Transformation is first mentioned in “1.International Urban Transformation and Sustainability” conference held in Rio de Janeiro on 2000 (Yapıcı 2004)

The city has always been a landscape of change, driven in different directions by fluctuating capital flows, social restructuring, and new cultural tastes. Urban transformation is a process of development of built environment. It has a complex content running in parallel with the development of social structure. Built environment is in a perpetual transformation, which can be seen since the human beginning. (İncedayı 2004)

Urban Transformation has been one of the most commonly used planning concepts recently. There is numerous other concepts exist meaning more or less the same phenomenon which are not overlap exactly. Urban renewal, urban regeneration, urban restructuring, urban revitalization, urban rehabilitation, urban renaissance, urban redevelopment, urban conservation, urban gentrification, etc are used instead of urban transformation in some cases. (Keleş 2004)

Urban transformation is the plan, process and model, which the environmental quality of large derelict areas is upgraded through rehabilitation, conservation or redevelopment, etc. according to new layouts in comprehensive plans prepared for the purpose.

Urban Transformation Area means a blighted area or urban decay (slum) or a combination of thereof which the local governing body designates as appropriate for an urban transformation project. It can be a city, a town, a district or a project area that is bounded for the transformation where a structural and social change is being made. This structural change consists of products to serve a large part of the society and some private individual. (Incedayı 2004)

Urban Transformation can be realized in the blighted areas, slum areas old industrial areas, in the historical core of the city, in the areas that have especially high earthquake risk and other urban risks.

Urban transformation project may include undertakings and activities of a municipality in an urban transformation area for the defined aim and may involve redevelopment, rehabilitation conservation or any combination thereof in an urban transformation area or in accordance with an urban transformation plan. The urban design projects may be for;

- Changing the function of old Industrial areas in the city center
- Removing the earthquake risk
- Improving the prestige of the area in the context of urban identity
- Environs of the historical core
- Satisfying the open space need

4.2.1.1. Realization - Applicability

Terms & Problems

Population and building density, social and economic structure of the population, existing housing area, building value after transformation, structure of the landownership, may affect the realization- applicability of transformation. These factors should be evaluated in the project area. To minimize the problems economical, social, financial, and administrative and transformation planning models should be undertaken. (Şengezer 2003).

Physical Problems

Population and building density causes problems. Multi-ownership structure, shared property is seen as an obstacle for urban transformation. To assemble individual properties into lots capable of comprehensive redevelopment, numerous separate legal interests have to be acquired first. The problem may be further complicated by the existence of defective titles and untraceable owners.

Social Problems

Social problems are observed within the urban transformation projects. The quality of the urban area increases after the transformation is actualized. Conclusionally, increased value and rant represent a profound change for the inner city. The new wave of gentrifies is transformed into the new revitalized living environment. The change in social structure causes great economic and social problems to the people who are from lower class. The cost of life standard conditions makes them to leave the area. As a conclusion of change in urban pattern, people living in the area may have problems about being belonging to.

Most critics of urban transformation have emphasized its failure to recognize the *public participation* that urban transformation process should be oriented or based on.

Urban Transformation should be handled as a social problem including the people living in the area. (Gursel 2004)

Participation would reduce owners' resistance to redevelopment and enable them to join in the outcome of the redevelopment project. However, where lots are in fragmented ownership, it is difficult to persuade a large number of owners to agree to redevelop and on the terms on which redevelopment should be carried out.

Economical problems

Urban Transformation project consists of the social and economic forces. It has an organic organization consisting of private agencies, central government departments and agencies, local governments, construction firms, public private partnerships and users. Many groups and organizations consist of different goals. Some group want qualities in the physical environment another group want maximum benefit.

To realize the transformation project the user and the investor should like and prefer it. Transformation should be profitable. The investor expects from a project to have a return of his/her investment. Therefore, the investor has to fulfill some basic principles reflecting the demands of the society. *Participation of private sector* is essential to realize the project. (İncedayı 2004)

In the transformation project area, if the *real-estate value* is low then it is not easy to attract the private sector. The potential of the area is very important.

For a comprehensive urban transformation, the area should be evacuated temporarily. Residents and business is relocated into another area until the redevelopment process finishes. *Compensation of business and tenants* result in high financial and social costs within this process. The compensation should be afforded by the financial source of the project whether by municipality or by investors.

Financial Source should be created for realization the urban transformation project. This problem should be overcome. Financial source should be provided in the content of the project. Local consortiums may be a solution. For a profitable project approximately %50 of the construction site should be belonging to the investor and also it should be proposed to landowners more then they have so that to make the project attractive. The more the project is profitable the more it s realized. (Gümüş 2000)

In the content of IEMP a model is developed for this problem. Local consortium is founded. The landowner is the member of the project. Transformation project is considered as a whole with landowners, investors and municipality or with all the actors of the project. The product of the project belongs to both investor and landowners and operating income and operating cost is shared by the actors of the project. (WEB_1, 2005)

Legislative Rearrangements

In Turkey one of the most important problems of the applicability of urban transformation project are the lack of legislative rearrangements, inadequate tools for implementation, lack of organization and wrong planning process. (Chamber of Architects Izmir, 2005)

The legislative rearrangements should define the legal processes, procedure for the financial aid**,** and process for the participation. The possibilities, to be organized on cooperatives that consist of financial foundations, real estate owners and municipality should be arranged. (Şengezer 2003)

Urban transformation process which based on the relationship between illegal building owners (squatter) and the investors should be brought legal agreement. (Keleş 2004)

4.2.2.2. Planning Legislation in Turkey

The new draft law for urban transformation defines the areas to be transformed. According to the legislation, illegal city parts that have disaster risk should be transformed. (Keleş 2004)

The kind of urban transformation going on in practice in Turkey, is taking place to a great extent in a haphazard manner, while a new Planning & Building act draft proposal prepared by the parliament aims to make this process planned one. A second feature of the new law project on urban transformation is its intention to separate the ownership of the urban land on which an illegal shelter is built and the structure itself. (Keleş 2004)

For a planned activity, the city should be renewed by dividing into parts. Every ten year a district should be transformed. Ownership of the land and ownership of the building on the land should be discriminated. The land should belong to public. It is hoped that would discourage profit-seeking initiatives in building unauthorized dwellings. Turkish legal system has to be revised in order to allow a separation of ownership of the land and building in illegal settlements. (Keleş 2004)

The new law project does not represent a novelty because transformation is expected to take place in accordance with the rules of the existing article of 18 of the City Planning Law of 3194. A final criticism of the law project lies in the fact but not a legal one. The most important point, which matters ideologically most, is the way in which the increased urban rent is shared by between public authorities and the private individuals. (Keleş 2004)

4.2.3. Earthquake Conscious Urban Transformation

Earthquake consciousness is possible through transformation. It should be based on earthquake risk and earthquake safety should be aimed.

Earthquake conscious urban transformation is an interdisciplinary issue that a comprehensive planning is definitely needed for realizing the transformation model. A city-scale transformation model for the planning is proposed in the content of Istanbul Master Plan. The planning process for the transformation model is defined as below: (WEB_1, 2005)

1. COMPREHENSIVE DEVELOPMENT PLANNING
2. RISK ASSESSMENT & FIELD SURVEY
3. PRE-STUDIES FOR URBAN TRANSFORMATION PLANNING
    - Defining the priority areas for Urban Transformation
    - Open Space analysis for temporarily post earthquake settlement
    - Determining, conserving and assessing the historical and cultural treasures and architectural heritage
    - Evaluation and usage of the existing and proposed green areas to be used before and after an earthquake Transformation of Green corridor
    - Transportation Analysis studies
    - Analytic Study for the transformation area
4. ECONOMIC AND SOCIAL TRANSFORMATION MODEL FOR PLANNING
5. PLANNING OF URBAN TRANSFORMATION

Alternative Planning approaches

- Evacuating the high risk area and removal of the population
- Action Plan for Sustainable District Renewal
- Action Plan and Participatory Approach
- Transformation of the Urban Pattern

Synthesis scenario of planning model and implementation stages

- Sub-zoning
- Zoning
- Alternative plan scenarios
- Synthesis plan scenario and implementation stages
    i. Demolishing the high risk buildings
    ii. Developing the evacuation corridors
    iii. Forming the concentration areas
    iv. Moving the industrial areas and dangerous usages

6. ACTION PLAN

7. FORMING AND CHOOSING THE PROJECTS AND PROGRAMS

8. ENSURING THE NECESSARY CONDITIONS FOR THE APPLICABILITY

- Legal Arrangement
- Administrative and corporate governance model
- Public participatory Model
- Financial models
- Strategic communication model
- Project Management Model
- Data-Information Management

As it is mentioned above transformation planning is multi-dimensional process aiming to implement the transformation project to reduce the determined earthquake risk in the area designated by the local government.

Earthquake risk is the accelerative factor for the transformation process. High-risk areas and buildings defined by risk assessment process should be transformed according to their risk level. The areas that should be redeveloped and the areas that can be rehabilitated by strengthening the building stock and improving the urban pattern should be determined according to the risk assessment results.

Urban transformation in the high-risk urban areas is a process of planning for risk management following the order of "risk avoidance", "risk minimization" and "risk sharing" (Balamir 2001). Most of the obligatory steps to be undertaken under the first priority fall into the concerns of land-use planning and the location decisions for urban activities. Land–use planning in existing settlements of high risk include steps as indicated below:

Land Use Planning in Settlements of High-Risk Urban Areas

- Integrated Disaster Maps
- Micro-zonation
- Urban Vulnerability Assessment

- Urban Risk Map (Vulnerability Map)
- Strategies for Earthquake Safety
- Transformation Projects in High-Risk Urban Areas

For the identification of new settlement area the same procedure is followed. Location criteria are defined according to designation of the integrated disaster maps and micro-zonation maps. After identifying the new settlement area earthquake conscious design is implicated, compliant to regulations.

4.2.3.1. Micro-zonation

Integrated Disaster Maps are the city-scale geological maps, which are to show all hazardous factors of the city. The sources of the "hazardous factors" places and sources are indicated in the maps. Geological, hydraulic and atmospheric systems and hazardous accumulations like chemical, biological, radioactive fulminate and flammable is defined in 1/25 000, 1/5 000 and 1/ 1 000.

Depending on the integrated disaster maps, micro-zonation maps are prepared as the initial requirement of urban vulnerability assessment. For the determination of the local natural constraints micro-zonation maps appropriately produced (at 1/5 000 and partly at 1/1000 scales) as base maps for urban land-use decisions. This is not a described obligation in "Development Law "in Turkey, but only briefly mentioned in one of the mandates of the Ministry of Public Works and Settlement, General Directorate of Disaster Affairs, dating 1980. The requirements of this mandate need to be updated. The ideal procedure would be the central ratification of these maps produced *under new standards,* and their notification to the local authorities with the obligation of revising existing urban plans. (Balamir 2001)

Micro-zonation and urban vulnerabilities assessment are to provide the bases for the determination of areas where no development should be allowed , no residential buildings should be allowed, and those where controlled building activity could be permitted. (Balamir 2001)

Physical constraints have to be specified with reference to micro-zonation maps in law and by means of a special regulation to fulfill the purposes of avoiding risk. This is likely to introduce at least four types of restrictions:

- *Based on information indicated in earthquake micro-zonation maps, land –use restrictions may be imposed as necessary, to cover cases of total avoidance of development, limited development of specific types of construction and use categories, and imposition of special controls.*
- *Based on the existence of fault structures, standards could be imposed for distancing buildings and uses from such faults.*
- *The regulations concerning the configurations of roads, infrastructural networks, the shaping of land subdivisions and even of "building form" could be highly relevant for urban areas.*
- *Constraints in building and population densities in relation to specific uses could again provide a powerful control variable with due reference to micro–zonation.*
- *The form of city may reveal over-compactness, over-fragmented or over-spread spatial configurations which may increase vulnerabilities of different types. Detrimental effects of this overall formation could be better perceived when reviewed in conjunction with the micro-zonation maps.* (Balamir 2001)

4.2.3.2. Legislative Rearrangement of Building & Planning Act

Major areas of regulation are omitted up in the provision of safe buildings and urban environment. The regulation of the existing disaster law remains to be specified by performance standards, measures and allowable limits. It is needed to control the exterior surfaces of buildings, the use of immediate surroundings of buildings, the alignment and fixture of infrastructural systems within buildings as well as the rules for the building itself.

In preliminary geological reports, there is no sanction for earthquakes except not letting reconstructions over forbidden fields, landslide areas, and building the constructions according to the rules. But on the other hand, there are still unclear subjects about taking precautions for the usages which have risk such as: (Balamir 2000)

- The roads and artworks belong to them and infrastructures,
- Energy and communication systems to be earthquake resistant system features,
- The place of the trees being planted and the width of the roads,
- The system of open areas and landscape principles,

- The location of helicopter tracks,
- Connection between the buildings and parking lots,

The gap in these areas should be cleared by the changes that will be made over building code law and regulations.

4.2.3.3. Transformation Projects in High-Risk Urban Areas

The designation of action areas by local authorities , the condemnation of such areas for public action, undertaking building research and environmental evaluation work, preparation of special plans, provision of special funding for operations in action areas, cooperation contexts between parties involved , are some of the *procedural requirements* that must be formally described and responsibilities for which need be clarified. (Balamir 1999)

Powers for direct intervention in property rights and ownership, realignment of properties, forms of cooperation between public agencies and property owners, transfer of development rights and other physical rearrangements for the public benefit are forms of power that must be held by local authorities within high-risk "action areas". *T*he execution of such powers should not cause the depletion of limited public resources. (Balamir 2003)

Process of Project:

- Action Plan area boundaries
- Partial removals/ vacating
- Land-use changes
- Rearrangement of the densities
- Extension and continuity of open areas
- Building demolition / strengthening
- Increasing road capacities
- Infrastructure retrofitting (realignment/network/capacity/material changes)
- Urban design
- Future Emergency Scenarios (for buildings/ responsible individuals /roles)

4.2.3.3. Proposals for Urban Safety

City Level

- Partitioned macro-form
- Multi-centered urban structure
- Compatible land-use and development pattern
- Coordinated land-use
- Network of open and green areas
- Continuity in access with alternatives
- Network of infrastructure networks
- Typology of building design
- Tested materials and detailing (Balamir 2003)

Continuity in access: The districts should have at least two alternative means of access. The network has to avoid all forms of culs-de sac. Several connections should to be ensured to the main motorway system. Width of roads should be wide enough to take into account the wreckage of collapsed buildings. Bridges, tunnels, fly-over etc. should not be allowed. Their alternative connections ought to be provided. Special arrangements are necessary on roads to evacuate specific districts. (Balamir 2001)

Network of open and green areas: Continuity of green areas, which may include sports areas, urban parks, natural sites protected, shoreline strips, open area car parks, etc. may prove a major asset at the instance of a disaster. Multi-floor car parks recommended where green areas meet major roads**.** (Balamir 2001)

Network of infrastructural systems: All infrastructural networks are to target reserve storage and alternative routes. Networks are not to be allowed croos - fault lines. If inevitable, these crossings are to be minimized in number with special precautions. Power network must have alternative connections to the national interconnected energy network. Natural gas lines and pressure change stations must not give rise to environmental problems. (Balamir 2001)

Some of the appropriately sized and located private buildings could also be allowed to provide relief services in the event of an earthquake, should the owners, and operators of these buildings apply to the local authorities to enjoy the reciprocal privileges (like reduced property taxes, insurance premiums, etc.) and incentives (like credits etc.) (Balamir 1999b)

4.2.4. Concluding Remarks

Urban transformation is needed to reduce the risk. In Chapter 4, Risk assessment process and urban transformation process as a solution of urban safety is discussed. It is clarified how to organize an earthquake conscious urban transformation project. The process of risk assessment and methods to be used in the vulnerability assessment are discussed. For the applicability of an urban transformation project the problems and terms are defined.

Earthquake conscious urban transformation is an interdisciplinary issue. An applicable urban transformation model should also include financial, administrative and corporate governance models, strategic communication model, and a model for public participation. These issues should be held within further studies.

As a case study Fikri Altay District in Karşıyaka is chosen. General information about Karşıyaka and Fikri Altay is given. The analyses of topography, geology, the strategies and techniques that are discussed in the previous chapters are executed, implicated on Fikri Altay District to mitigate the earthquake risk**.**

In the content of Chapter 5, vulnerability of Fikri Altay District is assessed using the methods defined in Chapter 4. Earthquake performance of the buildings is determined using these methods. The vulnerability map of the area is obtained to be used for determining the transformation strategy of the area. A transformation project is proposed for reducing the risk of Fikri Altay District. And the design principles are proposed for safer and livable more qualified urban environment. Basic Urban design principles also used as a tool for the design proposal.

CHAPTER 5

CASE STUDY ON FİKRİ ALTAY DISTRICT AND REPERCUSSIONS OF RADIUS PROJECT

5.1. Problem Definition

After an earthquake due to the immediate solutions, people are forced to leave their living area to move their new "permanent dwellings". The surveys revealed out that people do not want to move to new residential areas. So, a settlement should not be moved. People should stay and go on live where they live.

Within this case study, urban transformation is aimed considering urban design principles to keep people in their living area. In the content of the case study a risk assessment survey is organized to define the urban transformation strategy. Based on the survey, the transformation type is determined and planning and designing standards are proposed.

5.1.1. Aim of the Case Study

It is necessary to presume the earthquake performance of the buildings for developing alternatives providing the earthquake safety. The buildings are ranked via the survey so that to have a general opinion about the risk level of the area. It is not aimed to decide that which of buildings should be demolished using the results of this survey. Because, to be able to take this decision, more detailed analysis should be used.

The aim of the procedure is to develop a building database, presume, and rank the high-risk buildings with respect to their expected earthquake performance.

At the end of this pre-assessment study, in case of presuming buildings' earthquake performance as low, that means high risk, the priorities are defined for the Urban Transformation Project**.** In the content of the survey, it is intended:

- To acquire the statistical data about housing, population and work places and open areas
- To acquire the statistical building structure data

- To identify the earthquake risk level of the buildings
- To estimate the damages and losses
- To reveal the need for urban transformation

5.1.2. Methods of the Study

1. Risk Assessment

Hazard Assessment

Izmir Earthquake Scenario is adopted for the damage assessment. RADIUS computer Program is used for the damage estimation of the area. (See 4.1.2.3.2)

Vulnerability Assessment

The process and methods to assess the building's vulnerability has explained in detail in the previous chapter. (See 4.1.2.2.) The method used in Istanbul Earthquake Master Plan is assumed as the base for Fikri Altay Project Area. For the project area, the method is modified and readjusted because of the additional points, which are realized after observing the project area. (See 5.3.2.1)

Damage Assessment

RADIUS Computer program is used a tool to estimate the damage. The buildings are also classified compliant to RADIUS Computer program coding and Izmir Earthquake Master Plan coding to be able to compare the results.

2. Transformation project

Essential dwelling number that is needed to realize the transformation project is estimated based on the re-distribution models explained in section 5.4.3.

5.1.2. Limits of the Study

Because of the risks and potentials it has, Fikri Altay District is choosen as a case study area. The area is observed and divided into three sub-regions. Out of three sub-regions, one of them is chosen as the "Project Area". A site survey is organized within the area for Earthquake Conscious Urban Transformation Project.

130 buildings on 122 plots are analyzed in the Project Area to presume the earthquake risk.

5.2. Fikri Altay District

5.2.1. General Location

Fikri Altay District is located on the north-west of Karsıyaka. The district spreads on about 17, 4 ha. land. Population is about 6000 persons.

Figure 5.1. Fikri Altay District's location in Izmir
(Source: Izmir Earthquake Master Plan)

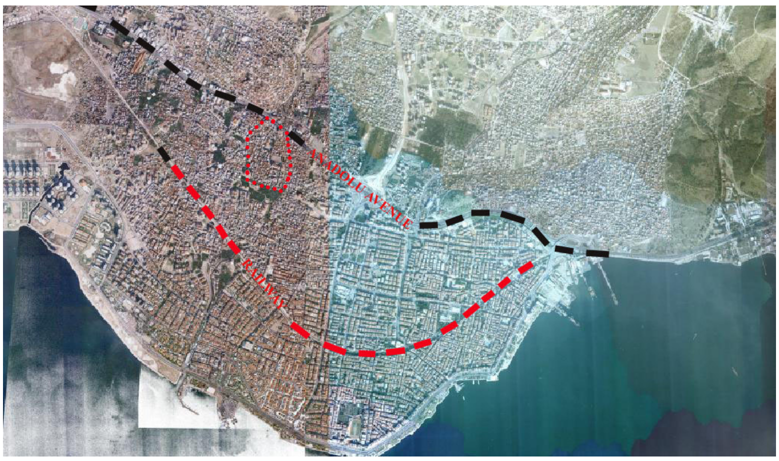


Figure 5.2. Fikri Altay District's location in Karşıyaka
Source: Izmir Metropolitan Municipality air Photo 2002

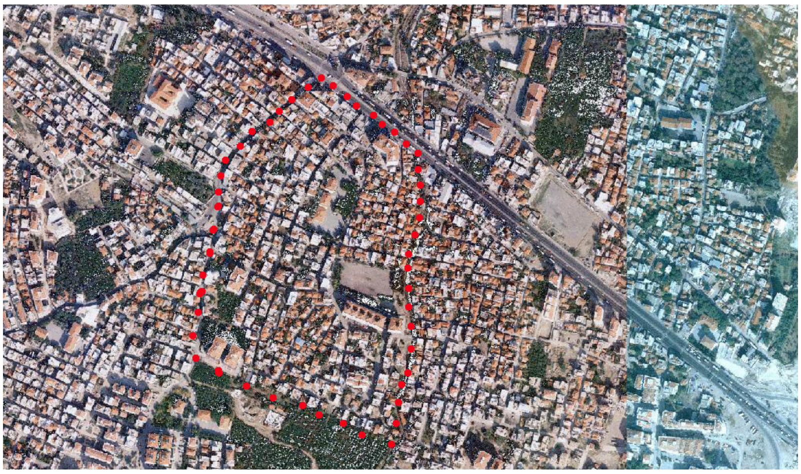


Figure 5.3. Fikri Altay District
(Source: Izmir Metropolitan Municipality air Photo 2002)

It matches to the L18A03A-4D and L18A03D-1A that are the 1/1000 maps of Izmir's digital maps order, according to country coordinate system. Within Izmir RADIUS Project, this coding system is also used. Total district area is the 1/8 of the total grid area of L18A03A and L18A03D for 1/5000 scale. Izmir RADIUS results are given for the 1/5000 grids. So it is important to know that the results are used to have a general opinion of the district's vulnerability.

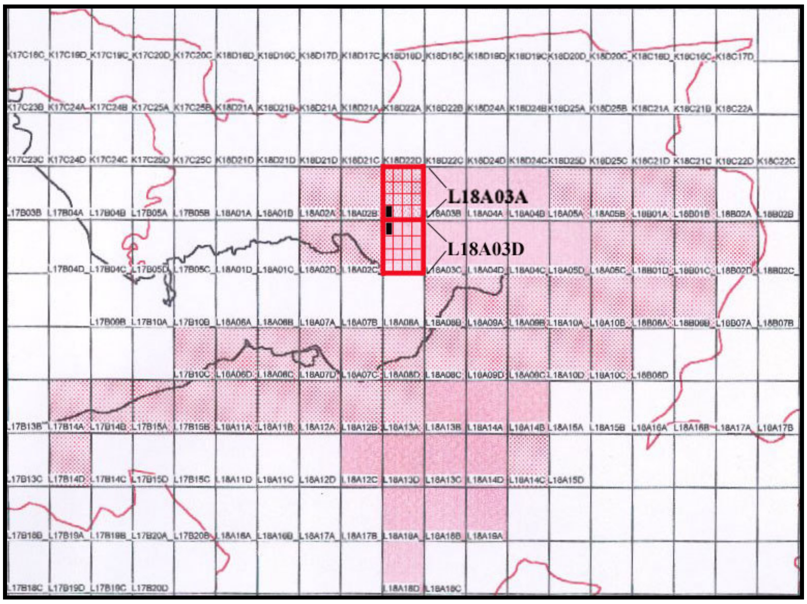


Figure 5.4. Fikri Altay District's location in gridal coding system
(Source: Izmir Earthquake Master Plan)

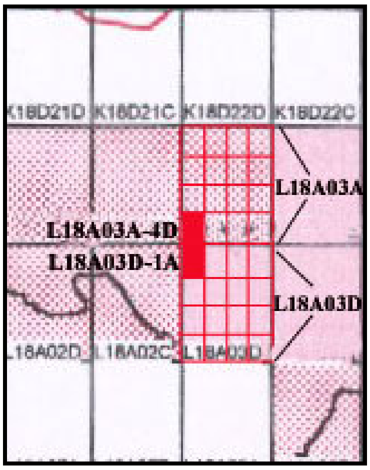


Figure 5.5. Fikri Altay District (L18A03A-4D and L18A03D-1A)
(Source: Izmir Earthquake Master Plan)

5.2.2. Earthquake Risk in the District

Presumed Earthquake Risk According to RADIUS percentages

In the content of RADIUS project, earthquake risk level of the buildings is defined. According to it, especially in Karşıyaka, the percentage is very great for masonry and reinforced concrete buildings. Fikri Altay District is one of the high-risk areas, which match to L18A03A and L18A03D grids. %28 of the total reinforced concrete (R/C) buildings and %64 of the total masonry buildings in the grid of L18A03A is high-risk. %39 of total R/C and %79 of total masonry buildings in the of L18A03D grid, are also defined as high-risk buildings as in the table below. The risk levels are shown in the map below and the percentages are defined in the table 10. (WEB_2, 2005)

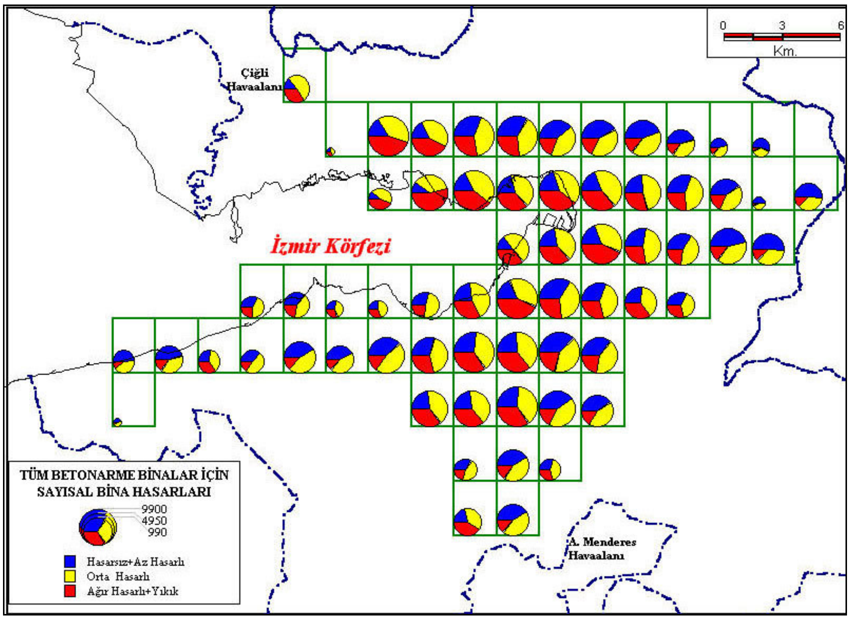


Figure 5.6. Risk Levels of Reinforced Concrete Buildings (All Types)
(Source: Izmir Earthquake Master Plan)

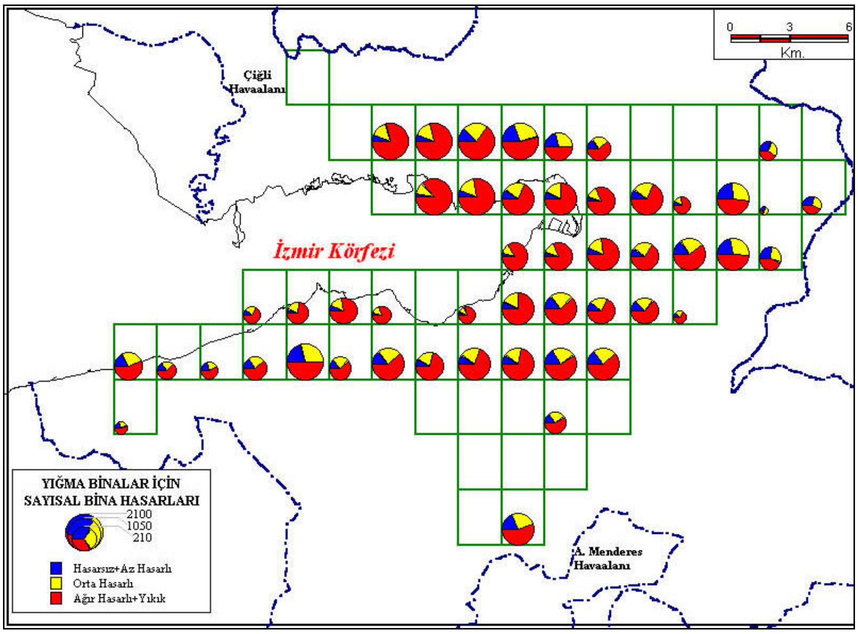


Figure 5.7. Risk Levels of Masonry Buildings
(Source: Izmir Earthquake Master Plan)

Table 5.1. Risk Levels of Map Grid: L18A03A and L18A03D Zones

RISK LEVEL ACCORDING TO IZMIR MASTER PLAN								
Construction System		**L18A03A**			**L18A03D**		
		High Risk	Moderate Risk	Low Risk	High Risk	Moderate Risk	Low Risk
Reinforced Concrete	1-2 Floor	39%	36%	25%	56%	30%	14%
	3-5 Floor	20%	47%	33%	35%	45%	19%
	6 and More	35%	50%	15%	33%	50%	17%
	TOTAL	**28%**	**42%**	**30%**	**39%**	**44%**	**17%**
	RC Before 1975	49%	33%	18%	60%	29%	11%
	RC After 1975	36%	47%	17%	31%	47%	22%
Masonry	All Masonry Buildings	**64%**	**25%**	**11%**	**79%**	**15%**	**6%**

Densely Built Existing Urban Fabric

Attached and high-density housing development pattern causes open area inadequacy and imbalance of proportion of open and closed area.

The configurations of the multi-floor and 1-floor buildings standing adjacent, causes an important risk during the earthquake as it distinguishes earthquake oscillation frequency of the buildings. The formation of the area as an adjacent order, buildings that reveal various characteristics due to their mass during the earthquake and different floor levels also increase the risk. (Şengezer 2003)

Inadequate Quality of Urban Facilities

The service roads inside the buildings are not qualified wide enough. Urban Services such as parks, car parks, children playground areas, and recreational facilities are not adequate. Because of insufficient area for car parking the streets are used for car parking which make the streets narrower.

Irregular and Unplanned Structuring

In the area, buildings usually do not have projects. Initially, they are built without permission. They are legalized after being constructed. That's why the buildings are not ensuring compliance with building codes and earthquake codes, which also cause unqualified urban environment.

The buildings are constructed in different periods. Consequently, the material and occupation differences increase earthquake risk.

5.2.3. Potentialities of the Area for Urban Redevelopment

Legal piecemeal development has started near to the planned part of Karşıyaka. Old buildings are being demolished and replaced by 5-floor apartment buildings which are compliant with the planning act and building codes. In Fikri Altay District, this redevelopment type is not widespread which enables the realization of collective urban transformation models rather than other districts that the piecemeal development is expanded.

The district's real estate value are increasing because of the market demand. The district is on the development axis of Karşıyaka. It gains importance due to the development potentials. To renew the old buildings and to supply the run of the market, the area should be redeveloped.

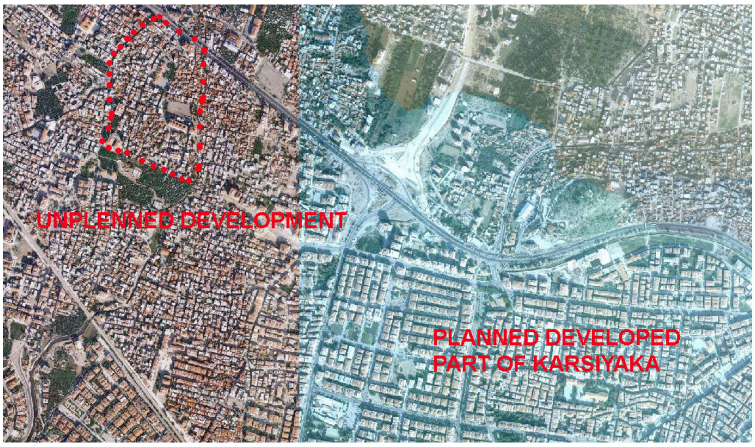


Figure 5.8. Karsıyaka's Residential Development
(Source: Izmir Metropolitan Municipality Air Photo 2002)

Local Soil Conditions

The area is by the riverbed. The flooding happened on 4.11.1995 in Izmir affected the buildings in the area and this surely caused damages to buildings. Because of the water, which reaches to building ground floor, the materials' resistance reduced and buildings' corrosion risk increased.

The liquefaction of the area is low comparing the neighborhood districts. Because of better ground conditions, the district is chosen out of the other districts in the high-risk zone.

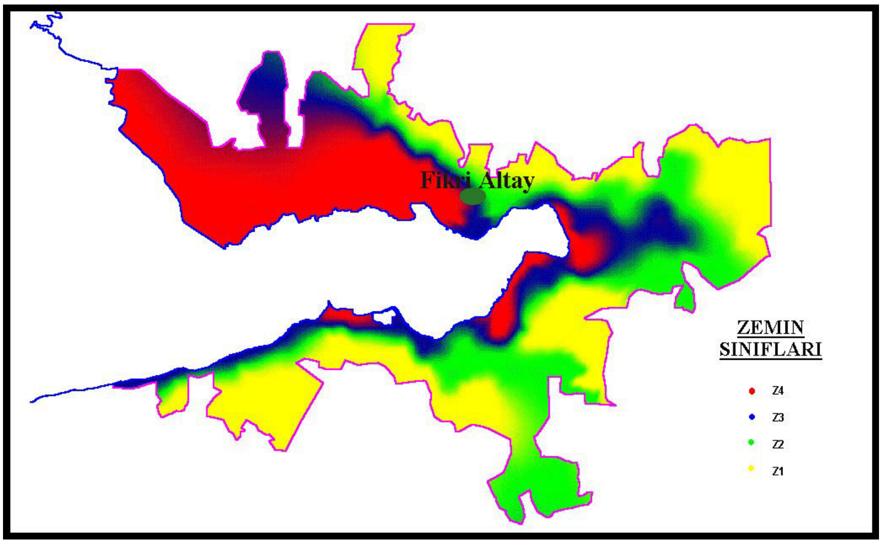


Figure 5.9. Geological Soil Classification of Izmir (Fikri Altay Matches Z3*)
(Source: Izmir Earthquake Master Plan)

*The risk increases from Z1 to Z4

Locational Advantages

The area's accessibility is high being close to Anadolu Avenue, which is a main road supplying access between Karşıyaka, Çiğli, Bornova and Konak. This is an important feature for the land value of the area.

5.2.4. Physical Features of the District

5.2.4.1 Geographical

Fikri Altay District is located on the alluvional part of Karşıyaka. Its soil condition is better comparing with the other districts in the neighborhood.

The district is not a sloping topography. It is in the lower slopes of the mountains enclosing Izmir north-south direction. The area is on the see level. Bostanlı Stream has 33, 4 km^2 river basin on the district. (Erdem and Nurlu 2001)

The private gardens of the houses form the green areas of the district. There are only two public green areas. Total green area is 2000 m^2 with the %1.14 of total. Green area percentage per person is % 0.63 m^2 (Erdem and Nurlu 2001)

5.2.4.2. Past Residential Development

The residential development process in the area starts with the immigrant population of Greece, Bulgaria, and Macedonia in 1925. In those periods, constructions which started as vineyard houses in gardens has the first speeding up process in 1940s and in 1960s second speeding up process started with selling of the shared plots. This factor is the starting period of the transformation of meadow and agriculture areas to an unhealthy urban structure.

Residential development is in a perpetual transformation, which is started around 1925. The process is observed as demolishing the existing buildings or adding up floor above the existing ones. Firstly, 1-floor buildings are constructed either with roof or without roof. The roofed ones are demolished around 1975 and new reinforced concrete 1-2 floor buildings are built instead. These buildings and the 1-floor buildings without roof are transformed into 3-4 maximum to 5-floor buildings with added floors. This transformation process is legalized with the approval of the improvement plan in 1985. As a result of this development process, the district has various floor heights which increase the earthquake risk. This plan conserves the district's existing urban pattern. Only the parcels are rearranged. Today, in line with this plan, piece meal development has been realized.

Around 1990, these old buildings get into legal transformation process by the effect of building contractor firms. The piece meal development is realized with an agreement with the parcel owners. Existing buildings are demolished and instead 5-floor buildings are constructed compliant to building codes. This redevelopment process has started mostly in the neighborhood of Fikri Altay District but it is not yet widespread enclosure of the district.

5.2.4.3. Physical Structure of the Area

As it is summarized above, Fikri Altay District is an illegally developed area and has a perpetual transformation. The buildings are constructed by individuals, without projects, permission, and technical support. This content revealed a spontaneously developed urban identity both in land use and in building features. The most important components of this identity are the minimized sections with its access axis and the inadequate urban facilities such as green areas.

The area has limited urban facilities. There are a few urban open spaces in the area that people can feel safe when any earthquake happens. Sections of the access roads to 5-6 meters are unsafe and inadequate. Because of the car parking problems, streets are being used as parking lots. At the time of any earthquake, this unhealthy urban pattern may cause to obstructions during rescue works. These structural problems have to be solved not to hinder accessibility.

Within the district, buildings are neglected and they need to be repaired or renewed. Present buildings are approximately having 30-40 year usage. Above the reasons mentioned that form the high-risk, caused low rent and real estate prices.

The mentioned transformation process in the area increases earthquake risk. If this process continues due to the existing improvement plan, it can not be possible to have lively spaces and to decrease the urban risk. Methods for creating healthy and safe spaces should be investigated.

The area could be divided into three sub-zones:

Plan-led Development:

This area consists of high-rise apartment blocks compliant with building codes. Comparing with the other districts around, high-rise apartment buildings percentage is low. Some of the buildings on the main streets have commercial activities on the ground floors.

Unlawfull Development:

Most of the district is illegally developed as mentioned above. Commercial activities fewely observed on the ground floors of the buildings.

Undeveloped, Old settlement Area:

Within this sub-region, the buildings are the oldest one and mostly not transformed to 3-4 floored buildings. This region is chosen for the project area

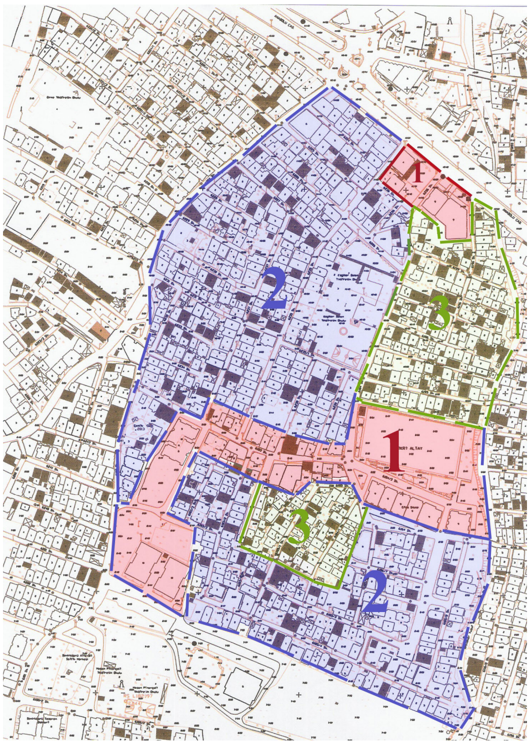


Figure 5.10. Sub-Zones

5.2.5. Project Area

Sub-zone 3, the undeveloped, old settlement area, is choosen as the "earthquake conscious urban transformation project area" because of the following reosans:

- Earthquake risks mentioned above (see 5.2.2) are highly observed within the area.
- Buildings are old and deformed by the flood.
- Piece meal development has not started yet.
- Closest to Anadolu Avenue

▪ Legal development process has not started.

▪ Potential of the transformation is high

The project area includes seven building blocks. It is aimed to design healthy urban environment. If a settlement ensures the condition for a healthy and livable environment no hesitate that it will provide the earthquake safe city standards. It should be studied what to do more than optimum design standards for earthquake safety.

Figure 5.11. Project area in Fikri Altay District

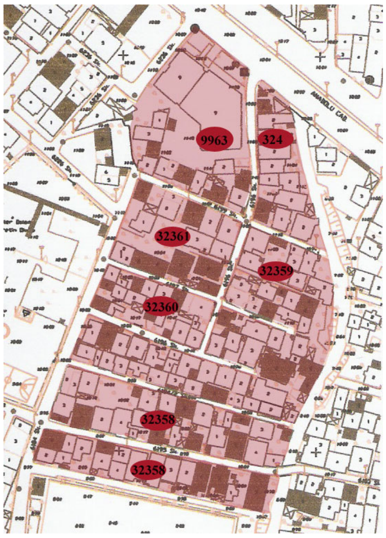


Figure 5.12. Building Blocks

5.3. Risk Assessment

As it is mentioned in Chapter 4.2, the earthquake risk should be assessed to be able to choose proper strategy for urban safety. Consciously a vulnerability assessment survey is organized within the project area. Damage is assessment of RADIUS Computer Program for the grid L18A03A and L18A03D is used for the project area.

5.3.1 Vulnerability Assessment Survey

It is aimed to presume the earthquake performance of the buildings. They are ranked due to their presumed risk level obtained via observed vulnerability assessment.

Preparation of the Survey

The maps needed for the site survey are gotten from Municipality of Karşıyaka (Development plan, the map showing the existing situation and land subdivision plan).

The building stocks' no, and plots' no, are pointed off on present situation map. Buildings' door numbers are marked on the map and digital photos of each building are taken on site.

Data Collection

There are two forms used in the content of site survey to get the buildings' and building stocks' data. (Appendix B). One is prepared to be used in the site to get all the needed data. These data about vulnerability parameters are synthesized on the second building earthquake performance scoring risk form that helps to estimate the scores. The accuracy of the data obtained from the street survey is checked with the help of digital photos. Scoring of the buildings are estimated same as within IEMP.

Random interviews are made to have general information about the project area.

The Method

The method used within Istanbul Master Plan (thereafter it is stated as "Istanbul Method") is modified and readjusted for the project area. It is readjusted because this area has different vulnerability parameters and Istanbul Method omits important vulnerability factors that should be in the content of such a vulnerability assessment process. The parameters used for Istanbul Model and for the project area are defined in the Table 5.3.

The factors, that impact the damage distribution of the buildings' are discussed in detail within the following paragraphs:

Building Age

In the content of the Istanbul Method, building's age, which is very important for buildings material resistance, is a missing vulnerability parameter. The parameter is added and its effect on scoring is estimated. Its vulnerability score is given "5" point. Moreover, the following evaluation is made for the parameters as it is showed Table 5.2

Table 5.2. Building Age Parameters

Building Age (d)	Vulnerability Parameter	Vulnerability Score
d<1960	3	5 (-15)
1961<d<1974	2	5 (-10)
1975<d<1990	1	5 (-5)
1991<d	0	5 (0)

Table 5.3.Vulnerability Parameters used in IEMP and Fikri Altay Project

Structure System	**Vulnerability Parameters**	**Istanbul Earthquake Master Plan**	**Fikri Altay Vulnerability Survey**
Common	Number of Floors	x	x
Common	Local Soil conditions	x	x
Common	Topographic Effects	x	
Common	River Bed		x
Common	Building Age		x
Common	Project existence		x
Common	Plan Irregularity	x	x
Common	Pounding between adjacent buildings	x	x
Common	Apparent Quality	x	x
Reinforced Concrete	Presence of a Soft Floor	x	x
Reinforced Concrete	Presence of Heavy Overhangs	x	x
Reinforced Concrete	Presence of Short Columns	x	x
Masonry	Solid-Void Ratio	x	x
Masonry	Solid-Void Order	x	x
Masonry	Opening position along the wall		x

Project Existence

As a result of the survey it is clear that all buildings have been constructed without any architectural & structural project. They are mostly substandard structures. Therefore, it is not expected that they would attain to earthquake safety requirements.

River Bed

Some of the buildings are on the riverbed in the project area. This is taken into consideration while scoring the earthquake performance of the buildings. In the content of Istanbul method this vulnerability parameter is not scored.

Window and Door position along the wall [Proper (0), Not Proper (1)]

There should be one more parameter to assess the risk of the masonry buildings' which is about window and door position along the wall. Related design codes are defined in the earthquake codes.

If the window and door positions are, complaint to building codes it is stated as 'proper'. In accordance with building code, the parameters are defined as:

- Opening distance from the corner of the building should not be less than 1,5 meters
- Distance between openings should not be less than 1 meters.
- Height of the openings should not be more than 3 meters.
- Bearing Bar's height should not be less than 20 cm. (IMO,1998)

For each additional vulnerability factor, vulnerability parameters and vulnerability scores are defined comparing the Istanbul Model. Istanbul Model's calculation method is used to estimate the buildings' earthquake performance score. The distribution of the vulnerability parameters and scores are given in the Tables 5.4 and 5.5.

A general equation for calculating the seismic performance score (P S) can be formulated as follows: (WEB_1, 2005)

$$PS = (\text{Initial Score}) - \Sigma\ (\text{Vulnerability parameter}) \times (\text{Vulnerability Score})$$

Table 5.4. Scoring For Reinforced Concrete Buildings

Earthquake scoring of Reinforced Concrete Buildings										
Number of Floor	Zone 1 60<PGV <80	Building Age	Project Existence	River Bed	Pounding	Apparent Quality	Soft Story	Short Column	Plan Irregularity	Heavy Overhang
1,2	100	-5	-5	-5	0	-10	0	-5	0	0
3	90	-5	-5	-5	-2	-10	-10	-5	-2	-5
4	75	-5	-5	-5	-3	-10	-15	-5	-5	-10
5	65	-5	-5	-5	-3	-10	-20	-5	-5	-10
6,7	60	-5	-5	-5	-3	-10	-15	-5	-5	-10

Vulnerability Parameters

Building Date d< 1960=3 1961<d<1974=2 1975<d1990=1 1991<d=0

River Bed No (0) ; Yes (1)

Pounding Effect No (0); Yes (1)

Apparent Quality Good (0); Moderate (1); Poor (2)

Soft Floor No (0); Yes (1)

Short Column No (0); Yes (1)

Plan Irregularity No (0);Yes (1)

Heavy Overhang No (0); Yes (1)

Project Existence No (1); Yes (0)

Building Seismic Performans Score = Zone Score - Total (Vulnerability Parameters x Vulnerability Score)

BSPS < 60 = Highest Risk

60<BSPS < 80 = Modarate Risk

80<BSPS = Lowest Risk

Table 5.5. Scoring for Masonry Buildings

Earthquake scoring of Masonry Buildings										
Number of Floor	Zone 1 60<PGV <80	Project Existence	Building Age	River Bed	Pounding	Apparent Quality	Plan Irregularity	Solid-Void Proportion	Solid-Void Order	Window and Door Position along the Wall
1,2	100	-5	-5	-5	0	-10	0	-5	-2	-10
3	85	-5	-5	-5	-3	-10	-2	-5	-5	-10
4	70	-5	-5	-5	-3	-10	-5	-5	-5	-10

Vulnerability Parameters

Building Date d< 1960=3 1961<d<1974=2 1975<d1990=1 1991<d=0

River Bed No (0) ; Yes (1)

Pounding Effect No (0); Yes (1)

Apparent Quality Good (0); Moderate (1); Poor (2)

Plan Irregularity No (0);Yes (1)

Solid-Void Proportion 1/3= Less (0); 2/3=Moderate (1); >2/3 =More (1)

Solid-Void Order Regular (0); Moderate(1); Irregular (2)

Window and Door position dimension in the Wall Proper to Earthquake Regulation (0) Not proper (1)

Project Existence No(1); Yes (1)

Building Seismic Performans Score = Zone Score - Total (Vulnerability Parameters x Vulnerability Score)

BSPS < 50 = Highest Risk

50<BSPS < 80 = Moderate Risk

80 <BSPS = Lowest Risk

5.3.1.1. Characteristics of Buildings in the Area

131 buildings are analyzed on 122 plots. Collected data are evaluated according to their earthquake performance score, their constructing systems, construction dates, number of floors, and vulnerability parameters.

Land Use

The area mostly consists of residential units. One of the buildings is commercial; four are residential commercial buildings. Five of the total buildings are not used. Residential units have gardens.

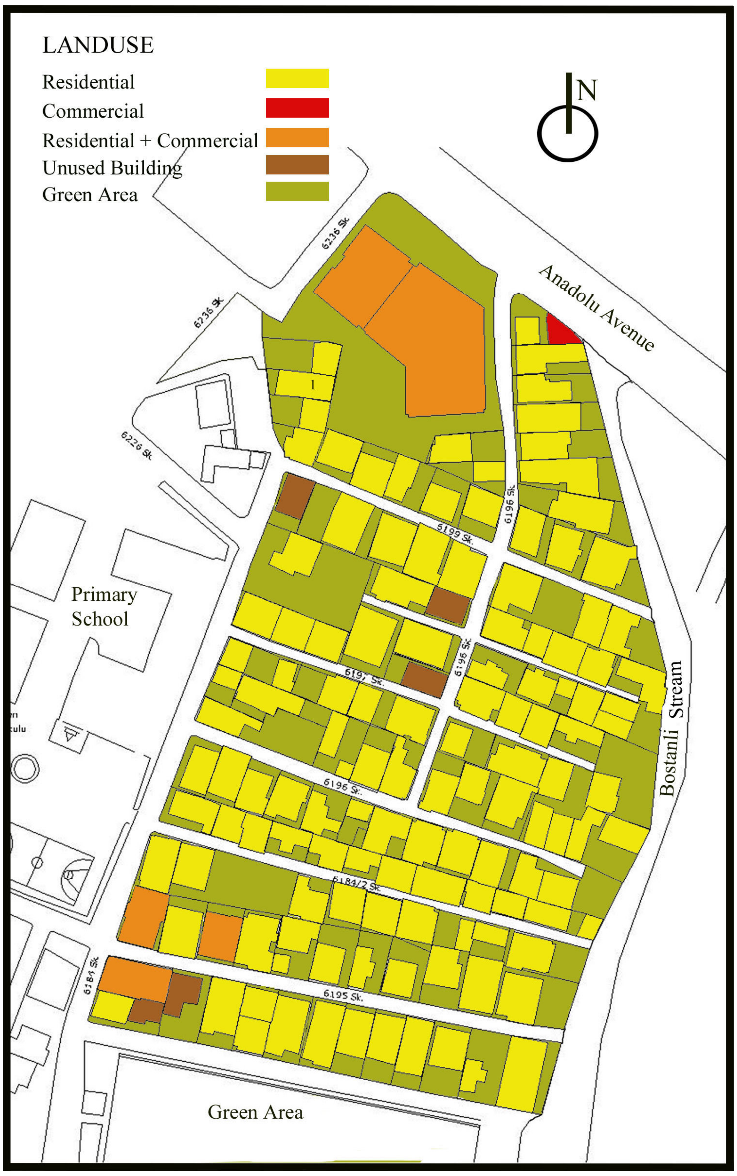


Figure 5.13. Land Use Map

Building Construction Year

It can be said that residential development is old in the area. 46% of the buildings' are constructed before 1960. 24% are between 1961 and 1974; 25% of them are between 1975 and 1989 years; 5% of the buildings are constructed after 1990.

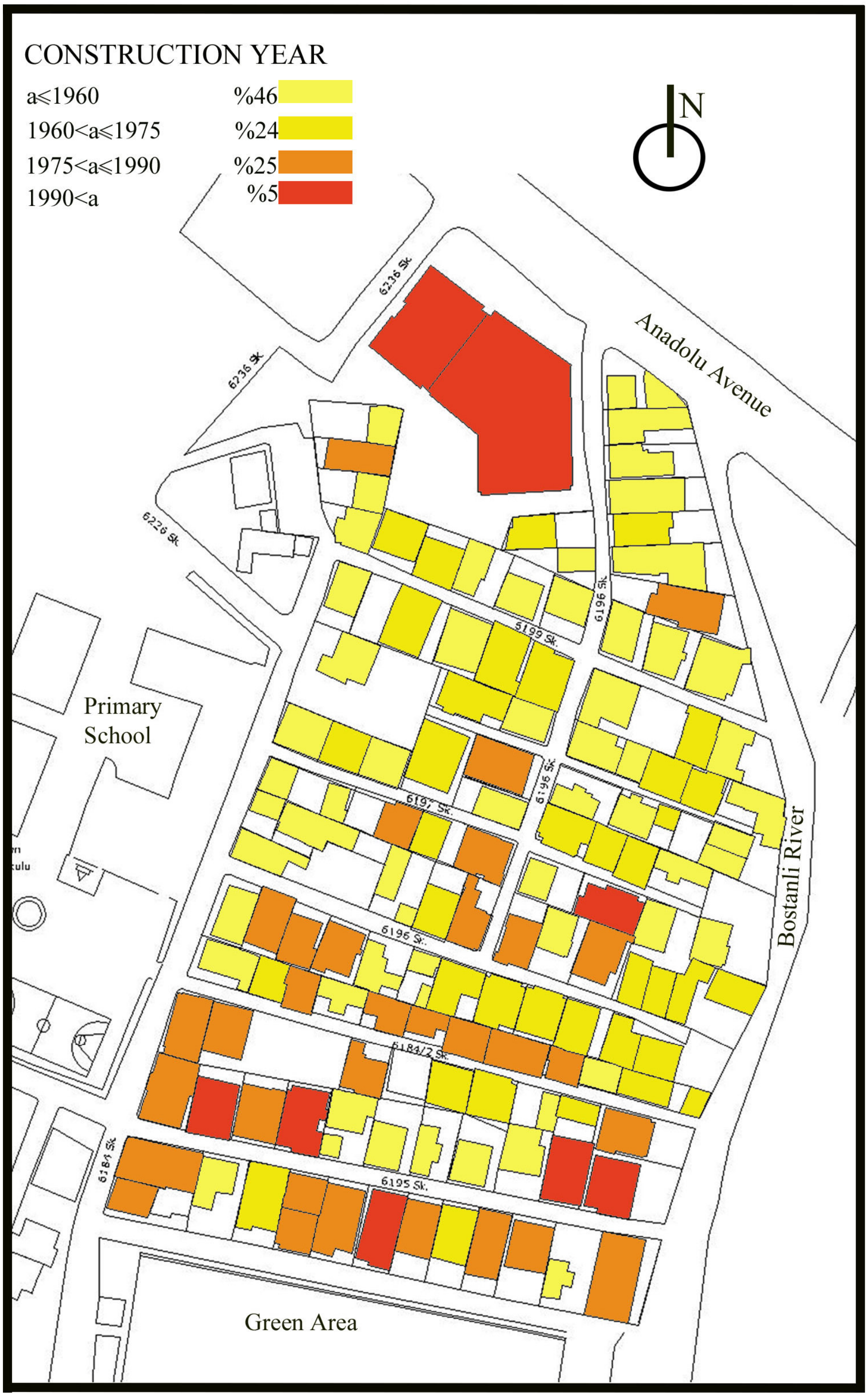


Figure 5.14. Building Construction Year

Number of Floors

The area mostly consists of 1–2 floor buildings. 27% are 1 floor buildings , 49% of are 2 floor, 18% of are 3 floor, 5% are 4 floor, 0,5 % of the buildings are 5 floor and also 0,5 % of is 9 floor.

Table 5.6. Distribution of the Buildings according to Number of Floors

BUILDING BLOCK NO	**NUMBER OF BUILDINGS**						
	1 Floor	2 Floor	3 Floor	4 Floor	5 Floor	9 Floor	TOTAL Number of Building
9963	4	6	1			1	11
324	3	7	1				11
32361	4	10					14
32360	3	3	2	2			10
32359	14	25	10	1			50
32358	6	7	5	2			20
32357	1	6	4	2	1		14
TOTAL Number of Building	35	64	23	7	1	1	131

Figure 5.15. Number of Floors

Building Construction System

42% of the buildings are masonry; 41% are reinforced concrete; 17% are both reinforced concrete and masonry buildings. Usually, they are initially built as masonry and the floors that are add up, are built as reinforced concrete.

Figure 5.16. Building Construction Types

Project Existence

In the area, all of the buildings are initially built without a project. 1–2 floor buildings are mostly old buildings and they are constructed without a project. 3- 5 floor buildings also do not have any project. They are constructed in time by adding floor up. They do not have building permit.

River Bed

The district is highly affected by the river basin. As a matter of this, 18% of the buildings just by the river are mostly affected. Therefore, their risk parameter is high.

Figure 5.17. Buildings on River Bed

Vulnerability Map

In the area, %56 of the buildings is high-risk. 31% of them are moderate-risk and 13% of them are low-risk.

Masonry buildings are more risky than reinforced concrete buildings. 69% of the masonry buildings are high-risk where as 30% of RC buildings.

3–5 floor buildings are more risky than 1–2 floor buildings. Detailed data are shown in the table given next.

Old buildings are more risky (%60 is 1960>a; %20 is 1961>a>1974; %10 is a>1975>1990; and %10 is a>1991)

These criterias are superimposed on this vulnerability map, which is also a synthesis of vulnerability parameters. This map shows the earthquake risk level of the buildings. The evaluation of the vulnerability parameters are given in the following section.

Figure 5.18. Synthesis

Table 5.7. Risk Levels according to Construction System and Number of Floors

RISK LEVELS OF THE PROJECT AREA																						
RADIUS AREA CODE		3 - L18A3A4D							13 - L18A3D1A							TOTAL						
Construction Sytem	Number of Floors	High Risk		Moderate Risk		Low Risk		Total Building Number	High Risk		Moderate Risk		Low Risk		Total Building Number	High Risk		Moderate Risk		Low Risk		Total Building Number
Reinforced Concrete	1-2 Floors	1	**33%**	1	**33%**	1	**33%**	3	4	**17%**	6	**26%**	13	**57%**	23	5	**19%**	7	**27%**	14	**54%**	26
	3-5 Floors	1	**50%**	1	**50%**	No	**No**	2	10	**40%**	15	**60%**	No	**No**	25	11	**41%**	16	**59%**	No	**No**	27
	TOTAL R/C	2	**40%**	2	**40%**	1	**20%**	5	14	**29%**	21	**44%**	13	**27%**	48	16	**30%**	23	**43%**	14	**26%**	53
Masonry	TOTAL Masonry Buildings	12	**60%**	7	**35%**	1	**5%**	20	26	**74%**	7	**20%**	2	**6%**	35	38	**69%**	14	**25%**	3	**6%**	55
R/C + Masonry	1-2 Floors	5	**83%**	1	**17%**	No	**No**	6	10	**83%**	2	**17%**	No	**No**	12	15	**83%**	3	**17%**	No	**No**	18
	3-5 Floors	1	**100%**	No	**No**	No	**No**	1	3	**100%**	No	**No**	No	**No**	3	4	**100%**	No	**No**	No	**No**	4
	TOTAL	6	**86%**	1	**14%**	No	**No**	7	13	**86%**	2	**14%**	No	**No**	15	19	**86%**	3	14%	No	**No**	22
TOTAL		*20*	***63%***	*10*	***31%***	*2*	***6%***	*32*	*53*	***54%***	*30*	***31%***	*15*	***15%***	*98*	*73*	***56%***	*40*	***31%***	*17*	***13%***	*130*

5.3.1.2. Evaluation of Vulnerability Parameters

Soft Floor Effect:

The buildings that have trade on ground floors the ones that are not built once, mostly has this vulnerability factor. The irregularity in vertical structural elements is also scored with soft floor effect.

Figure 5.19. Soft Floor Effect

Heavy Overhangs

As it is shown in the graphic %67 of the buildings has heavy overhangs.

Figure 5.20. Heavy Overhangs

Plan Irregularity

The urban pattern is developed without planning. Therefore, %89 of the buildings' plan is not rectangular or symmetric. They are as T, L shapes.

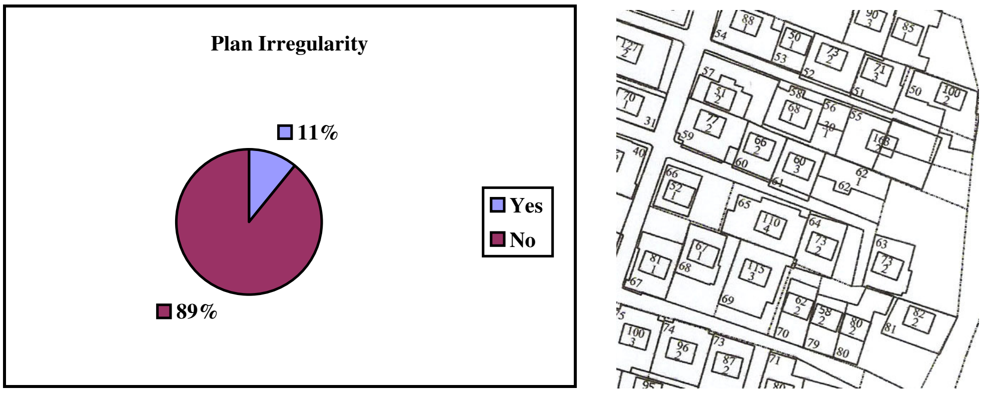


Figure 5.21. Plan Irregularity

Short Column Effect

Figure 5.22. Short Column Effect

Pounding Effect

Because of the irregular urban pattern, pounding effect is highly observed in the area. Different height of the floors and the different slab levels increase the risk.

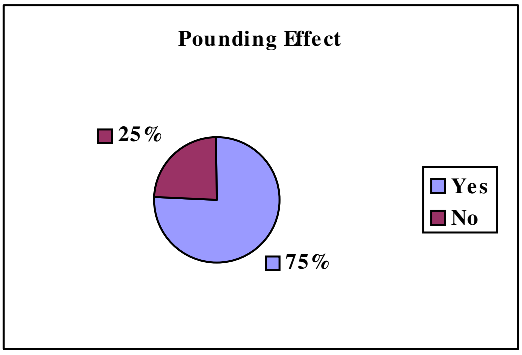


Figure 5.23. Pounding Effect

Solid-Void Ratio

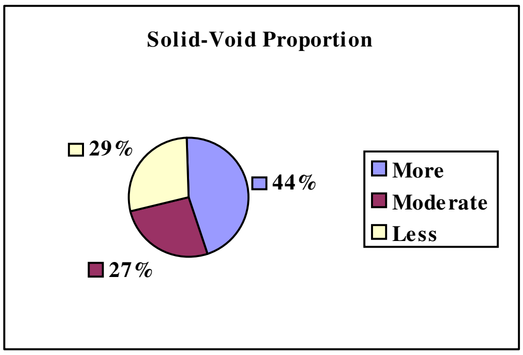
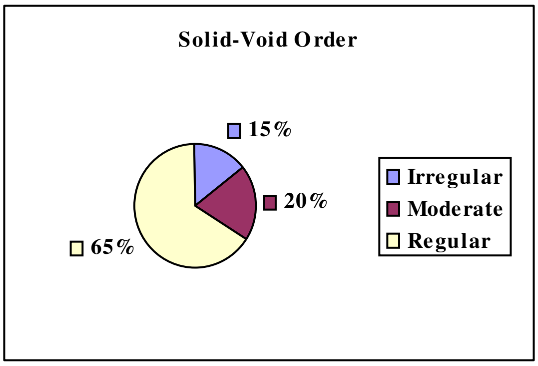


Figure 5.24. Solid-Void Ratio

Solid-Void Order



Apparent Quality

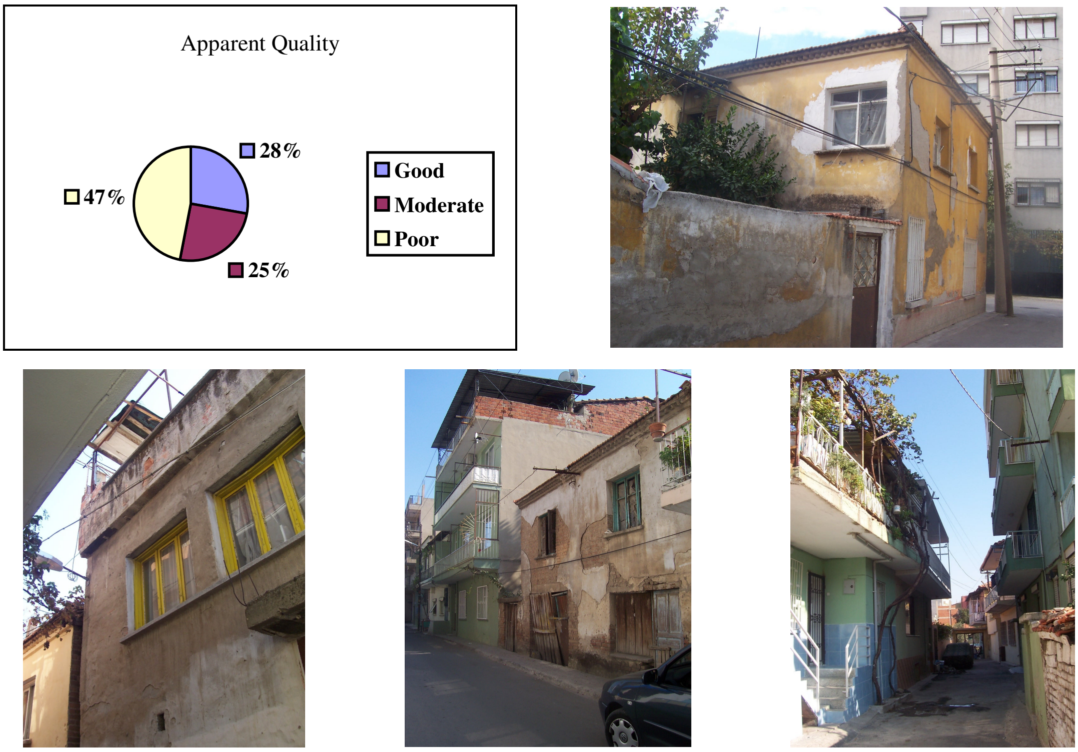


Figure 5.25. Apparent Quality

5.3.2. Damage Estimation with RADIUS Computer Software

It is aimed to estimate the damage of the project area using the simplified computer program mentioned in section 4.1.2.3.2. The result of the damage estimation should not be taken as accurate. They are not precise. It may be used just to understand the possible damage to be base for further, more technical engineering studies. The results also should not be taken as the main aim of the project. They are the just the starting point to emphasize and explain the possible damage emanating the specific scenario earthquake.

Below, in the Figure 5.26 the flow diagram of the software is given explaining the outline of the running the program.

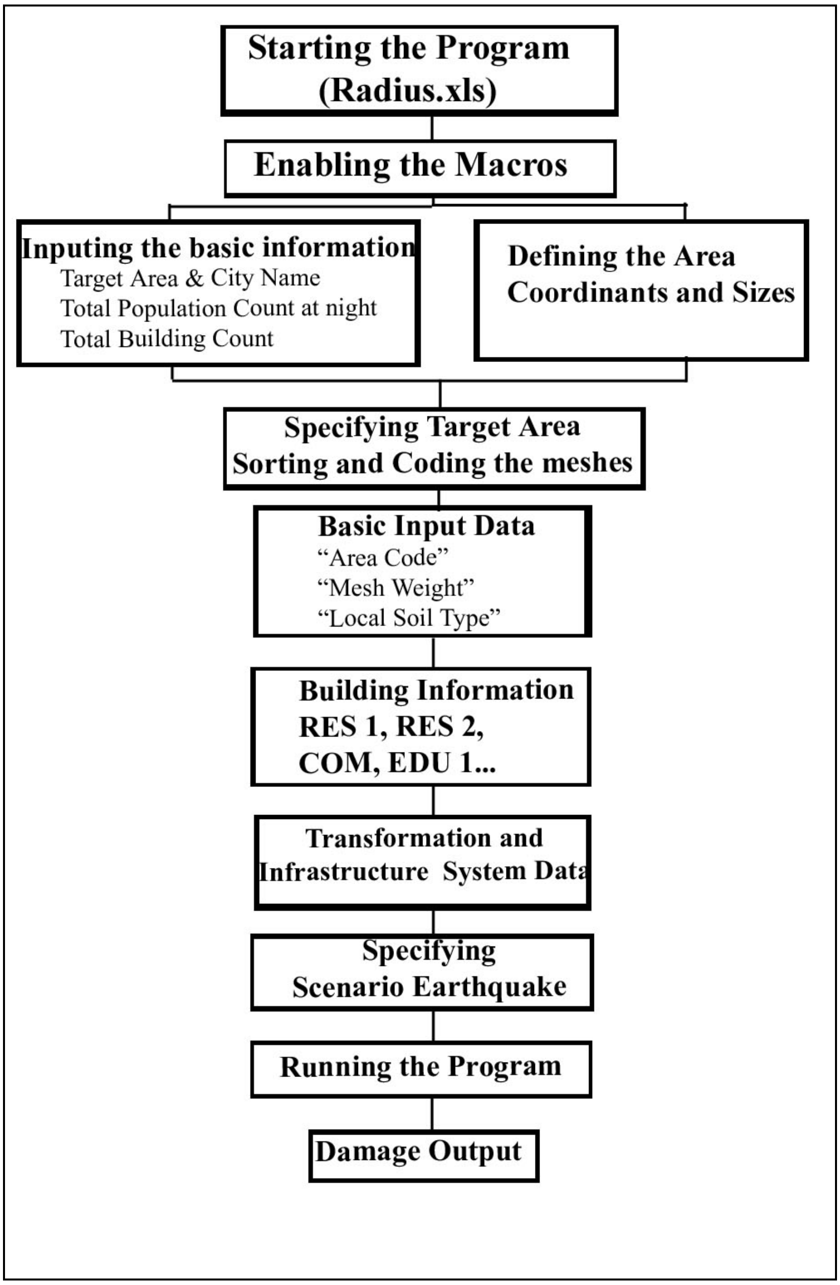


Figure 5.26. RADIUS Software Flow Diagram

Attempts have been made to perform damage estimation as one mesh with minimum recommended mesh size which is 0, 5 km and which is bigger than the size of the project area. But the software gives error if the area is handled as one mesh. So the project area is divided into meshes as it is shown in the Figure 5.27. One of the meshes size is taken as 0,13 ^{km} x 0,13 ^{km} averagely. The meshes is stated as "1" and "2" as in the Figure 5.28. The software maps this also as in the Figure 5.28.

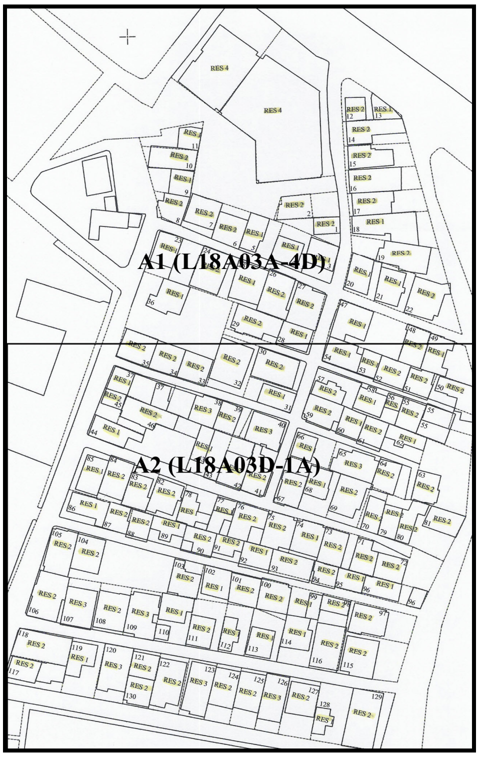


Figure 5.27. The meshes of the Project Area

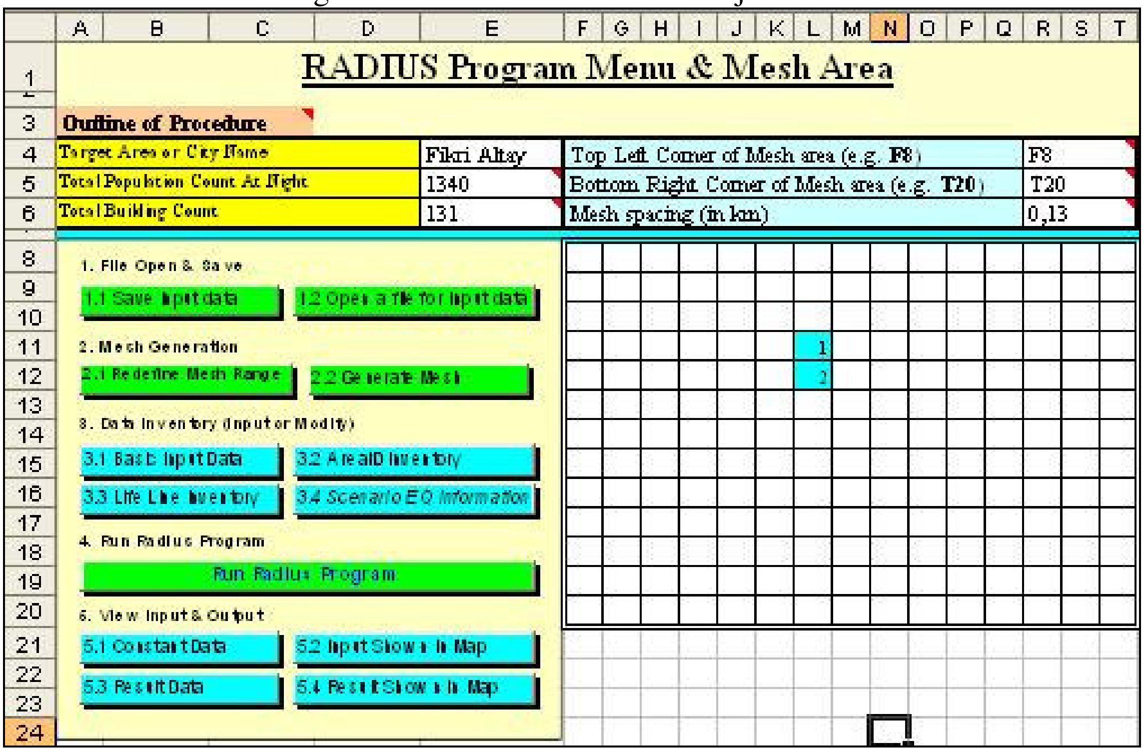


Figure 5.28. Mesh Area as mapped by software

Area1's density is lower than Area 2's and so the mesh weights are taken as in Figure 5.29.

Figure 5.29. Mesh Weight Distribution map

Building information is defined for each mesh using the building classification RES1, RES 2, RES3… which are given in detail in the Figure 5.30 and in section 4.1.2.3.2. Total building number belongs to each mesh is given in the Figure 5.30 and Table 5. 8.

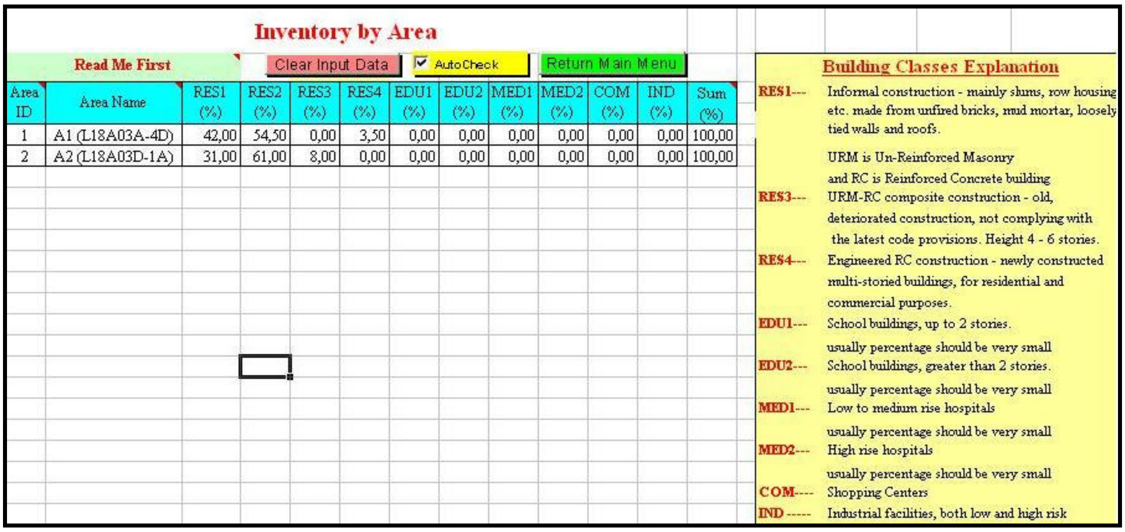


Figure 5.30. Building Inventory Data

Table 5.8. Building Inventory Partitioned to meshes

Table 3 --- BUILDING INVENTORY PARTITIONED TO MESHES														
City is Fikri Altay						Total MeshID is 2					Total Building Count is 131			
Mesh ID	Mesh Weight	Area ID	Area Name	RES1	RES2	RES3	RES4	EDU1	EDU2	MED1	MED2	COM	IND	Total Bldg Count
1	1	1	A1 (L18A03A-4D)	14	18	0	1	0	0	0	0	0	0	33
2	3	2	A2 (L18A03D-1A)	30	60	8	0	0	0	0	0	0	0	98
	Summarry Information			RES1	RES2	RES3	RES4	EDU1	EDU2	MED1	MED2	COM	IND	Total
				44	78	8	1	0	0	0	0	0	0	131

And finally selected scenario earthquake is defined. As it is mentioned before Izmir Scenario Earthquake is adopted for the project area.

- Earthquake Magnitude is: 6,5
- Earthquake Occurrence Time (hours): 17
- Earthquake Depth: 10 km
- Earthquake Epicentral distance: 10 km

This program checks the accuracy of the data for each step and alert if there is any error.

After these operations are completed, the program is run and percentages for damaged buildings, damaged building number, distribution of death and casualties are obtained. The tables related to damage, injuries and death are shown in theTable 5.9.

Table 5.9. Estimated Damage and Casualties

Table 1 --- MAIN RESULTS														
Max MeshID is	2			Total Building Count is			131		Total Population Count (night) is				1340	
Mesh ID	Area ID	Area Name	Mesh Weight	Soil Type	Distance(km)	PGA (g)	MMI	Bldg Count	Dmg Bldg Count	MDR (%)	Pop Day	Pop Night	Injury (Severe & Moderate)	Death
1	1	A1 (L18A03A-4D)	1	3	14,1	0,2	7,8	33	8	24,9	171	342	9	1
2	2	A2 (L18A03D-1A)	3	3	14,1	0,2	7,8	98	24	24,9	499	998	32	4
					Average	Average	Average	Total	Total	Average	Total	Total	Total	Total
					Distance	PGA	MMI	Building	Dmg Bldg	MDR	Pop Day	Pop Night	Injury	Death
					14,1	0,2	7,8	131	33	24,9	670	1340	41	5

According to results % 25 of the buildings will be damaged and the death proportion will be %0, 7. However the high-risk buildings proportion was %56 due to observed vulnerability assessment results which is higher than the damage estimation result's. as the software recommend, It can be said that it is not so suitable to use the program for the areas that the dimensions is smaller than 0,5 km.

After RADIUS Project has resulted, damage estimation of the city of Izmir is done also with RADIUS computer program. This study is realized by Dokuz Eylul University and Izmir Metropolitan Municipality. (Düzgün 2001) Within this study, 44 grids (2, 5 km×2, 5 km) divide Izmir as mentioned in section 5.2. Out of these 44 grids, Fikri Altay District takes places in the grids which are coded as region 3, (L18A03A) and region 13, (L18A03D). According to results, death and casualties for each grid, which is 8 times bigger than Fikri Altay District, is estimated as in the Table 5.10:

Table 5.10 Results of the Damage Estimation done in the content of RADIUS

DAMAGE ESTIMATION of RADIUS Computer Program								
RADIUS Zone No	Number of Building	Number of Damaged Building	Day Population	Night Population	Death Proportion	Total Casualties	Injured Proportion	Total Injured
Zone 3 (L18A03A)	5106	1449	38394	61690	0,50%	193	6,50%	2493
Zone 13 (L18A03D)	5106	2114	48046	85291	1%	496	11%	5309

Table 5.11. Comparison of RADIUS Results and Fikri Altay Risk Level

	RADIUS GRID						Fikri Altay Project Area								
Zone No	3 (L18A03A)			13(L18A03D)			3 (L18A03A 1A)			13 (L18A03D 1A)			TOTAL		
Building Classification	Number of Building	# High Risk		Number of Building	# High Risk		Number of Building	# High Risk		Number of Building	# High Risk		Number of Building	# High Risk	
	5106	**28,40%**	1449	5106	**41%**	2114	33	**63%**	20	98	**54%**	53	131	**56%**	73
RES 1	1072	33%	354	715	46,50%	332	14	64%	9	30	70%	21	44	68%	30
RES 2	1379	23%	317	460	31,90%	147	18	61%	11	60	47%	28	78	50%	39
RES 3	2247	32,50%	731	3319	46,50%	1543				8	50%	4	8	50%	4
RES 4	306	9,30%	28	562	13,40%	76	1						1		

5.4. Fikri Altay Transformation Project

The vulnerability assessment is only done for the chosen "project area". It is proposed to organize transformation project strategies throughout the all district in stages. It should be started from the most risky one and also the chosen one should have the potential for transformation project. It is mentioned about the possible risks and potentials within the previous chapter. (See 5.2.2 and 5.2.3)

Both observed vulnerability results and damage estimation according to RADIUS tool indicates the high risk within the area. Only %13 of the buildings are low-risk whereas %31 are moderate and %56 are high-risk. Consequently, a comprehensive transformation project is needed to ensure the urban safety in the area. All the buildings should be demolished at one jerk and new settlement area should be designed and redeveloped via urban design and planning principles.

5.4.1. A Framework for the Proposed Transformation Project

As it is mentioned before, change in social structure causes problems; so it should be ensured that inhabitants should stay in the area after the redevelopment process finished. The participants of the project are determined as local people living within the project area, the investor(s) and the municipality. (See 4.2.1.1)

The project should be self-supporting system. Due to this, the investor(s) should provide the implementation project by taking housing right with %50 percent of the total constructed buildings. Investor(s) is liable for removal expenditures of eligible's during the redevelopment process considering the market price.

Municipality should choose the investor and should inspect the project.

It should be ensured that all the eligible has at least one dwelling to provide the participation of them needed for the realization of the project.

The population density should not be increased more than ensuring the minimum total dwelling unit determined by redevelopment model mentioned below. Building density also should be keep minimum for urban safety.

The redevelopment model should be improved by urban design principles. To ensure the building and urban environment safety seismic urban design principles should be developed.

Benefits of the Participants

People who are entitled to get new dwellings also have benefits due to project. They acquire new dwelling units, which are legal and safe. Unless they participate the project, the municipality has the right to demolish their buildings in the case of taking the decision of dangerous buildings, due to article 39 (3194 Planning Act) and may impose sanctions if they don't demolish and pay the demolition costs.

Investor(s) also has benefits. On a rough cost and benefit account, the firm totally constructs 700 dwelling units, 350 of them is for eligibles and 350 is for his benefit. If it estimated that one dwelling's cost is estimated as 20.000 $, total cost will be 14.000.000. $. If the removal expenditures are added total cost is estimated as 16.000.000 $. The firm will earn 35.000.000 $ estimating a dwelling unit cost as 100.000 $. Hence, the profit is estimated as %54.

Moreover, the investor will have credit facilities and tax concession. Because of the land subdivision confusion and legal process, there are big difficulties for the ongoing piecemeal development. This is a very big obstacle for the development of the area. Due to the comprehensive transformation project, the agreement difficulties with the landowners will be abrogated via joining the plots as a whole.

5.4.2. Size Analysis of the Project Area

Building Blocks

The sizes and PAR [Plot Area Ratio; (TAKS)] and FAR [Floor Area Ratio; (IAKS)] values are shown in Figure 5.31 and in Table 5.12 in detail:

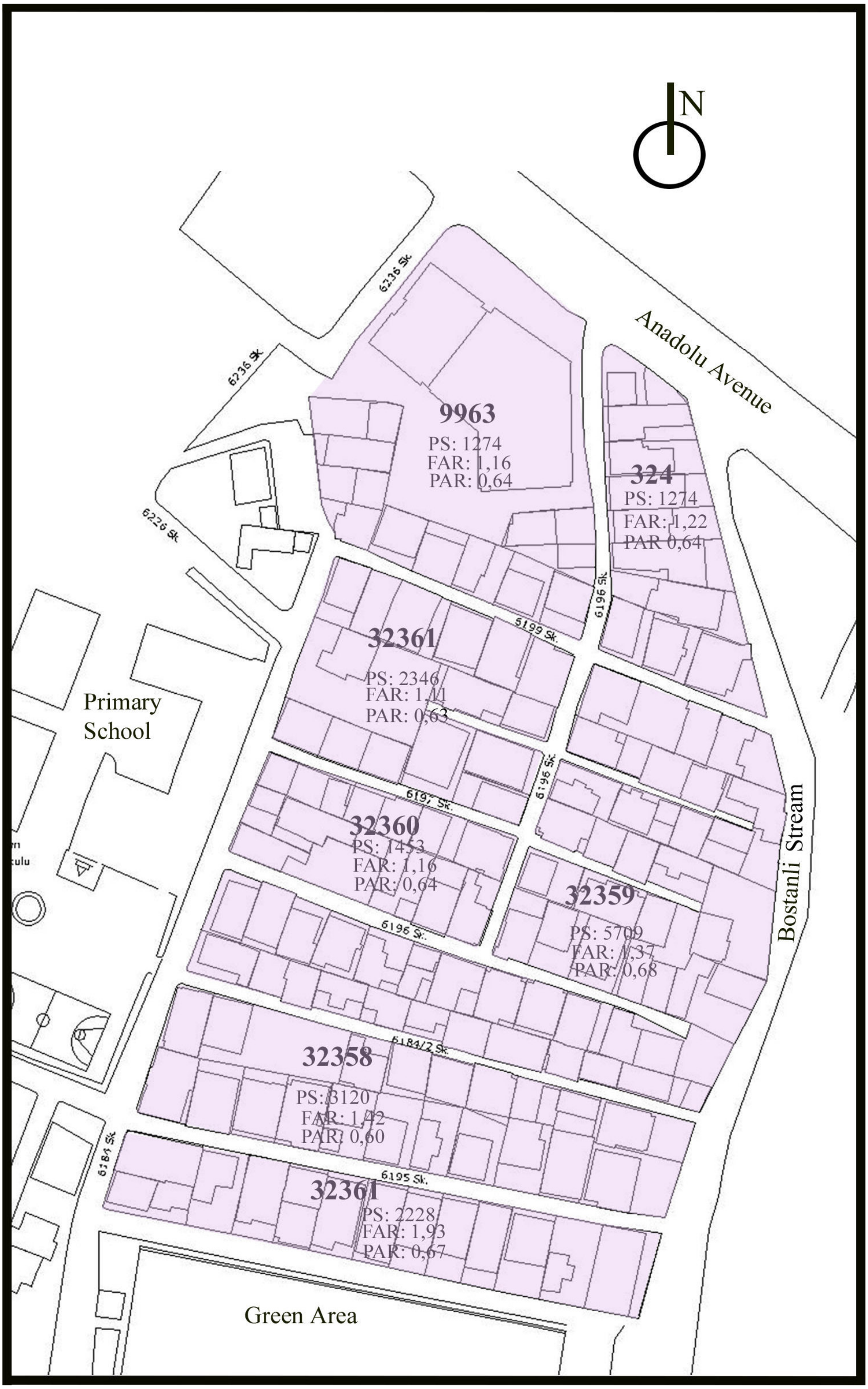


Figure 5.31. Building Block Area

Tablo 5.12. Size Analysis of the Building Blocks

SIZE ANALYSIS OF THE BUILDING BLOCKS												
Building Block No	Number of Building	Number of Plot	Number of Dwelling	Population	Number of Floors	Building Floor Area	Open Space	Total Plot Area	Total Construction Area	Total Plot Area	Plot Area Ratio (TAKS)	Floor Area Ratio (IAKS)
9963	11	11	17	68	19	794	456	1250	1443	1250	0,64	1,16
324	11	10	15	60	20	1124	631	1755	2136	1755	0,64	1,22
32361	10	14	19	76	24	1482	864	2346	2594	2346	0,63	1,11
32360	14	10	21	84	23	830	623	1453	1925	1453	0,57	1,33
32359	50	45	91	364	99	3899	1810	5709	7842	5709	0,68	1,37
32358	20	19	42	168	43	1877	1243	3120	4437	3120	0,6	1,42
32357	14	13	32	128	38	1495	733	2228	4290	2228	0,67	1,93
TOTAL	130	122	237	948	266	11501	6360	17861	24667	17861	0,64	1,38

Plots

There are 122 plots on the project area on seven building blocks. The plot sizes are changing between 56 m^2 and 582 m^2. Total plot area size of the buildings is 17861 m^2.

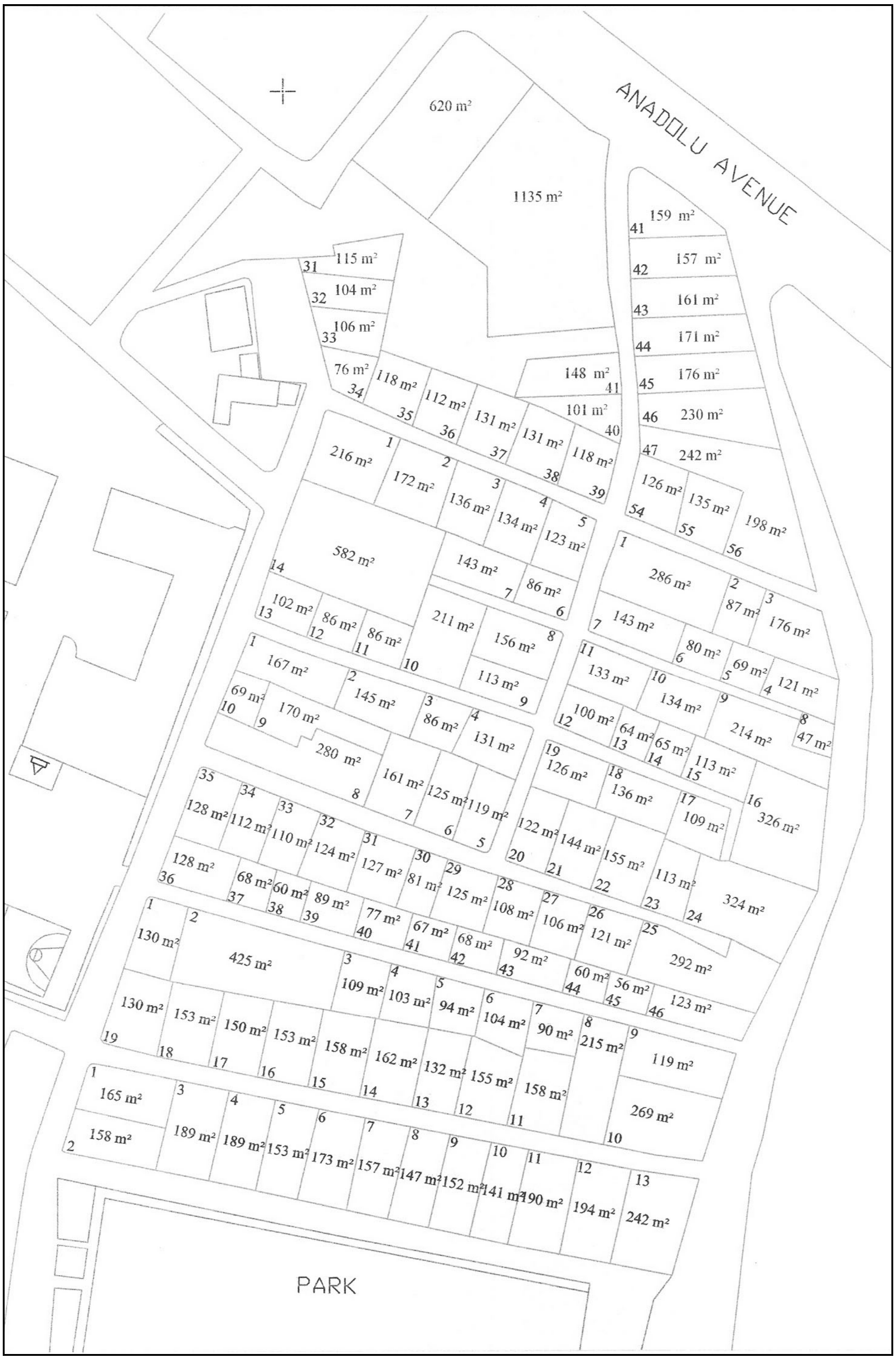


Figure 5.32. Plot Area Size

Buildings

The area covers 24600 m^2 of land. 131 buildings take place with various sizes. Total Construction area of the buildings is 24667 m^2.

Figure 5.33**.** Building Quantity, Floor area size and number of floors

Project Area Boundary

The project area with 24 600 m^2 (2.46ha) of land comprises also two apartment buildings which have already transformed into 8-floors buildings. They are left out of the “transformation project area”. Therefore, to be able to get the accurate data for transformation project area, the size values belonged to the apartment buildings are reduced from the total values of the Development Plan values.

Existing Development Plan dated 1987, proposes 8678 m^2 total floor area for 5-floor buildings and 2413 m^2 total floor area for 8-floor buildings, which makes 62.649-m^2 total construction area. These values are estimated using the Development Plan. (See Appendix) Based on this construction area number of dwelling unit is estimated as (62.649 ÷ 100 = 626; 100 m^2 per dwelling), and population is estimated as 2504 people (626 × 4 = 2504; 4 people per dwelling unit)

Two apartment buildings cover 1755 m^2 of land. The floor area of the 8-floor buildings is 1230 m^2, which makes 9840 m^2 (1230×8) total construction area. Number of the dwelling unit is estimated as 98 units (9840÷100) (100 m^2 per dwelling unit) and the estimated population is 392 people. (392×4).

Consequently (24600-1755 = 22845) 22.845 m2 of land is available to use within the transformation project. Potentially, it is possible to construct 528 dwelling unit which makes 52.809 m2 construction area within the transformation project.

Table 5.13. Estimation of Available Area for Transformation Project

EXISTING SITUATION						
	Total Area	Total Floor Area	Total Construction Area	Number of Dwelling	Population	Population Density
Implementation Plan	24600 m^2	11091 m^2 (8678+2413)	62649 m^2 (8678×5)+(2413×8)	626 (100 m^2 per dwelling)	2504	1017 (Person/Hectare)
Constructed Area (Two 8 Floors Apartment)	1755 m^2	1230 m^2	9840 m^2 (1230×8)	98	392	
Not Constructed (Available Area for Transformation Project)	22845 m^2	9861 m^2	52809 m^2	528	2112	

5.4.3 Proposed Redistribution Models

It is important to know the total dwelling unit as datum print to determine the planning principles. Three alternative redistribution models have been designed and attempts were made to find out optimum number of dwelling units that both provides the realization of the transformation project and optimum population and building density. The models are summarized in the Table 5.14 and are explained in the following paragraphs:

Table 5.14. Estimation of the Required Number of Dwelling Units

PROPOSED REDISTRIBUTION MODELS										
Models	Project Area	Plot Area	Number of Dwelling	Population	Increased Population	Increased "Urban Services"	Minimum Total Floor Area	Total Construction Area	Population Density	Increase in Population Density *
Model 1	22845 m2	17861 m2	638	2552	440	7760 m2	15084 m2	63800 m2	1117	10,00%
Model 2	22845 m2	17861 m2	1190	4760	2648	46706	NOT Possible	119000 m2	2083	104%
Model 3	22845 m2	17861 m2	698 (638+60)	2792	680	11994 m2	10850 m2	69800 m2	1222	20%

*It is compared with the population density of Development Plan 1987

Model-1

The model is developed based on the dwelling unit that is essentially needed to realize the transformation project. Total dwelling unit that is proposed within the project should supply both the eligible's and investor's share for self supporting system. The proportion for investor is defined as %50 based on the market value.

It is aimed that all the eligible should get at least one dwelling based on the proportional share according to *plot sizes*. The distribution of the dwellings is estimated based on the minimum plot size, which is ***56 m2***. Plot sizes of the each building's are divided by 56, to obtain the building coefficient, which is equal to total dwelling number. Table 5.15 and 5.16

Building Coefficient (n) = Plot Size (n) ÷ Minimum Plot Size

Consequently 319 dwelling units are estimated which seems enough for the 237 eligible but not resulting to each eligible's share.

Table 5.15. Total Number of Dwelling Units estimated with Model-1

Total Number of Dwelling Units (Model-1)			
Building Blocks No	Number of Dwelling	Plot Size	Building Coefficient = Plot (n) / minPlotsize (ex: 101/56)
9963	17	1250	22,32142857
324	15	1755	31,33928571
32360	19	2346	41,89285714
32361	21	1453	25,94642857
32359	91	5709	101,9464286
32358	42	3120	55,71428571
32357	32	2228	39,78571429
TOTAL	237	17861	318,9464286

Table 5.16 Example of Redistribution Model-1

Example of Redistribution Model-1 (Min Plot Size=56)						
Building Block No	Building No	Plot Number Plot (n)	Plot Size	Number of Dwelling	Building Coefficient 1 = Plot (n)/minPlot size (ex: 104/56)	Difference
324	10	32	104	3	1,857142857	-1,142857143
	11	31	115	1	2,053571429	1,053571429
9963	16	44	171	1	3,053571429	2,053571429
	19	47	242	3	4,321428571	1,321428571
32361	34	12	86	2	1,535714286	-0,464285714
	36	14	582	1	10,39285714	9,392857143
32360	37	1	167	2	2,982142857	0,982142857
	40	4	131	4	2,339285714	-1,660714286
32359	75	28	108	3	1,928571429	-1,071428571
	95	45	56	1	1	0
32358	103	3	109	3	1,946428571	-1,053571429
	104	2	425	2	7,589285714	5,589285714
32357	126	10	141	4	2,517857143	-1,482142857
	128	12	194	1	3,464285714	2,464285714

. * Difference shows the inadequate coefficient that is essential for the distribution of the needed minimum dwelling unit

Model-2

Model-1 indicates that it is not possible to provide at least one dwelling unit per eligible based on only the plot sizes. Within this model, *both the plot size and the building on it* are taken into consideration to be able to supply dwelling for each eligible. The calculation of this value, stated as "A" is formulated as:

A = Plot size (n) ÷ Number of Dwelling on Plot (n)

After calculating all the "A" values for each dwelling unit, minimum value is obtained as "30" to be used for finding the building coefficient. Plot sizes of the each building's are divided by min.A to obtain the building coefficient, which is equal to total dwelling number of the project. (Appendix D)

Min A=30

Building Coefficient = Plot size (n) ÷ Min A

The estimation indicates that 595 dwelling units are needed for the eligibles and 595 for the investor. Totally 1190 dwelling units are constructed which needs 46.706 m^2 area for social and physical infrastructure. This exceeds the total transformation projects area, 22845 m^2

Table 5.17. Total Number of Dwelling Units estimated with Model-2

Total Number of Dwelling Unit (Model 2)				
Building Block No	Number of Dwelling	Plot Size	A = Plot (n) / Dwelling (n)	Building Coefficient 2 = Plot (n) / minA (ex: 101/30)
9963	17	1250	73,52941176	41,66666667
324	15	1755	117	58,5
32361	19	2346	123,4736842	78,2
32360	21	1453	69,19047619	48,43333333
32359	91	5709	3455,666667	190,2
32358	42	3120	74,28571429	104
32357	32	2228	69,625	74,26666667
TOTAL	237	17861	3982,770953	595,2666667

Table 5.18. Example of Redistribution Model-2

Example of Redistribution Model-2						
Building Block No	Building No	Number of Dwelling	Plot Number	Plot Size	A = Plot (n) ÷ Number of Dwelling (n)	Building Coeeficient 2 = Plot Size (n) ÷ minA (ex: 101÷30)
9963	1	1	40	101	101	3,366666667
	8	2	34	76	38	2,533333333
324	19	3	47	242	80,66666667	8,066666667
	20	1	54	126	126	4,2
32361	34	2	12	86	43	2,866666667
	36	1	14	582	582	19,4
32360	44	1	8	280	280	9,333333333
	46	1	10	69	69	2,3
32359	63	1	16	326	326	10,86666667
	94	2	38	60	30	1
32358	104	2	2	425	212,5	14,16666667
	112	1	13	132	132	4,4
32357	126	4	10	141	35,25	4,7
	129	3	13	242	80,66666667	8,066666667

Model-3

Another redistribution model is developed which based on Model-1. Within Model-1, 319 dwelling unit does not supply dwelling for each eligible. Therefore, it is estimated how much more is needed to supply the need of eligibles who can not take share. It is found that 30 dwelling unit is needed more. As a conclusion, 698 [(319+30) ×2] dwelling units are proposed both ensuring the eligible and investor need and providing the optimum population and buildings density. Total dwelling number estimated with Model-3 is the basic data for redevelopment plan. Physical and Social requirements essential for of the area to define the planning principles are estimated based on the total dwelling number.

Table 5.19 Additional Required Number of Dwelling Units

Additional Number of Dwelling Unit for Model -1						
Building Block No	Building No	Plot No	Plot Size	Number of Dwelling	Building Coeeficient = Plot (n) / minPlotsize (ex: 101/56)	Number of additional dwelling Unit
9963	6	36	108	2	1,92857143	-0,0714286
	8	34	76	2	1,35714286	-0,6428571
	10	32	104	3	1,85714286	-1,1428571
324	33	11	86	2	1,53571429	-0,4642857
	34	12	86	2	1,53571429	-0,4642857
	35	13	102	2	1,82142857	-0,1785714
32361	38	2	145	3	2,58928571	-0,4107143
	39	3	86	2	1,53571429	-0,4642857
	40	4	131	4	2,33928571	-1,6607143
	41	5	119	3	2,125	-0,875
32359	48	2	90	3	1,60714286	-1,3928571
	51	5	69	2	1,23214286	-0,7678571
	52	6	80	2	1,42857143	-0,5714286
32359	59	12	100	2	1,78571429	-0,2142857
	60	13	64	2	1,14285714	-0,8571429
	61	14	65	2	1,16071429	-0,8392857
32359	64	17	109	2	1,94642857	-0,0535714
	65	18	136	4	2,42857143	-1,5714286
	67	20	122	3	2,17857143	-0,8214286
	79	24	324	2	5,78571429	-0,2142857
	80			2		
	81			2		
32359	75	28	108	3	1,92857143	-1,0714286
	76	29	125	3	2,23214286	-0,7678571
	83	33	110	2	1,96428571	-0,0357143
	84	34	112	3	2	-1
	87	37	68	2	1,21428571	-0,7857143
	88	38	60	2	1,07142857	-0,9285714
	90	40	77	2	1,375	-0,625
	91	41	67	2	1,19642857	-0,8035714
	93	43	92	2	1,64285714	-0,3571429
	94	44	60	2	1,07142857	-0,9285714
32358	100	6	104	2	1,85714286	-0,1428571
	101	5	94	2	1,67857143	-0,3214286
	103	3	109	3	1,94642857	-1,0535714
	106	19	161	3	2,875	-0,125
	107	18	153	4	2,73214286	-1,2678571
	109	16	153	4	2,73214286	-1,2678571
	116	8	215	3	3,83928571	-0,1607143
	98			1		
32357	120	4	167	3	2,98214286	-0,0178571
	121	5	153	2	2,73214286	-2,2678571
	130			3		
	123	7	157	4	2,80357143	-1,1964286
	126	10	141	4	2,51785714	-1,4821429
TOTAL						**-30,285714**

5.4.4. Redevelopment Plan

5.4.4.1. Spatial Requirements

Physical-Social Infrastructure

Total dwelling unit construction area and consequently total number of dwelling unit that is essential for the realization of transformation process is estimated as it is explained within the previous section. 69800 m^2 total construction area which makes approximately 698 dwelling units (min.100 m^2 for each dwelling) is proposed based on the proposed Model-3. The population is estimated as 2792 people. (698×4=2792). This population is 680 people more than the potential of the area proposed with Development Plan (1987) (2792-2504 = 680). Therefore, it is aimed to estimate the physical-social infrastructure requirements providing the need of 680 people.

Within the following paragraph it is defined the basic criteria for car parking, green area and road system. Later, compliant to these criteria infrastructure requirements will be estimated for 680 people.

Green Area: Minimum green area per person is defined as 10 m^2 / person in the building act 3194. This value is proposed to estimate the total green area. (680×10=6800 m^2) The green area should include sports areas, urban parks, emergency concentration areas, evacuation exes, equipment storage and emergency center.

Car Parking: Izmir's Metropolitan Municipality car parking regulation proposes at least one car parking for each four dwelling with 20 m^2 for each car parking. It can be said that 1.25 m^2 car parking area is needed per person. (4 dwelling unit x 4 people= 16 people; 20 m2 car parking). Car Parking area is estimated as 850-m2 (680x1.25= 850 m2)

Roads:

% 20 of the total project area is proposed to be allocated for roads within the transformation project.(22.845 × %20 = 4569). The distance between the building stocks, and road widths should be as in the formula: (WEB_1)

Roads Width= [(h1+h2)/2 - ∑ [front garden width] + 7m

*" h1" and "h2" are the height of the buildings on the two side of the road

5.4.4.2. Plan Proposal

Based on the criteria put forward above project program is estimated as in the following paragraphs;

Total Construction Area = 69800 m²

Minimum dwelling unit gross size is proposed as 100 m^2 to constrain the population. If it become smaller, number of dwelling unit increases and so does population. The size of the dwelling units variety may be increased on the condition that not to exceed total construction area. By this way, eligibles may choose whether smaller but more unit, or bigger but less unit.

Consequently, the eligibles have had the construction right with a coefficient estimated as dividing total construction area by their total plot size. If the coefficient is stated as "E", it is formulated as below:

E= Total Construction Area ÷ Total Plot Size of the Eligible

E = 69800 ÷ 17861

E = 3, 91

Min. Total Urban Infrastructure Area = 12.219 m²

Green Area = 6800 m^2

Car Parking = 850 m^2

Roads = 4569 m^2

Max. Total Floor Area = 10626 m²

Total floor area is limited with (22845- 12219) 10.626 m^2 to provide the minimum urban infrastructure area. Number of floor may depend on the used floor area. The height of the buildings is not limited. However, the designer should provide buildings' height same especially if the buildings are designed as adjacent order.

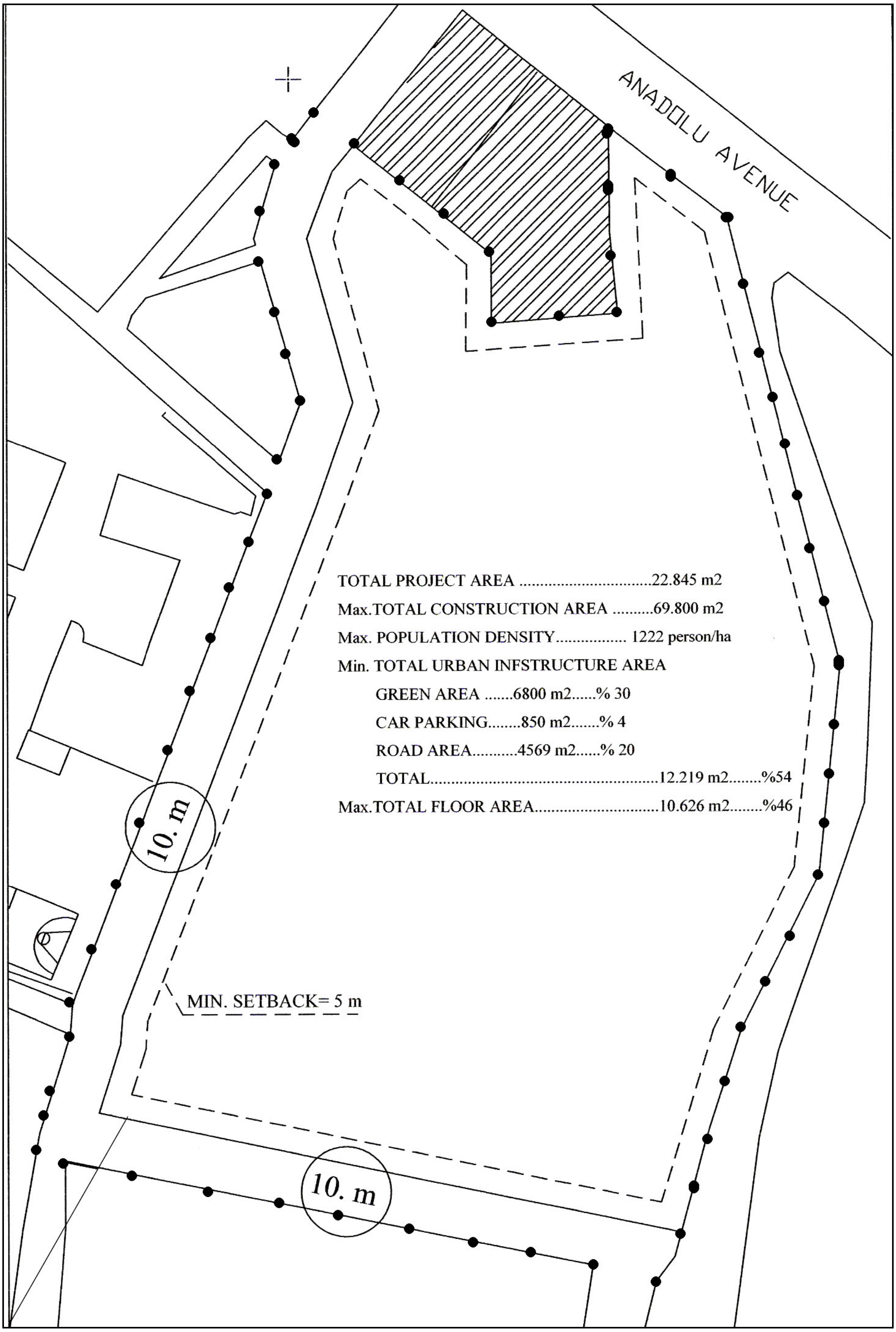


Figure 5.34. Redevelopment Plan Proposal

5.4.4.3. General Urban Design Criteria

Engineering and architectural design of the buildings should be compliant to building codes and earthquake code 1998. In the content of Fikri Altay Project, it is aimed that the buildings should be resistant to earthquake Mg. 6, 5 which is defined as the magnitude of the Izmir's scenario earthquake.

Hence, it can be said that the cities should have earthquake scenarios. It should be known the possible magnitude of the earthquake that is possible to occur within future.

Moreover, Earthquake Conscious Urban Design should aim:

- To built a system of highways for evacuation, in association with squares and open areas for the concentration of population after the earthquake. (Evacuating Axes, an emergency concentration places)
- To plan reserve areas to be used for post earthquake recovery using the existing open and green areas.
- To optimize the population density in persons/hectares and the reduction of plot & floor area ratios (reduction of building density)
- To provide low floor area ratio, unification and expansion of open areas
- To provide underground car parking areas available to be used in the case of an emergency
- To design for a variety of housing sizes or block solutions
- To remove the unnecessary commercial area from the residential area
- To isolate the districts with green axes (fire buffers)
- To design spaces for rehabilitation center after the earthquake especially elderly people and children
- To stiffen neighborhood relationship
- To ensure direct and strong relationship of the user with the ground
- To design compliant to local and climatic conditions
- To design reserve areas for post earthquake recovery

CHAPTER 6

CONCLUSION

6.1. Conclusion about Research Question or Hypothesis

Earthquakes are considered as more destructive since they strike without early warning and since they may result in some secondary hazards such as tsunamis, fires, landslides and rock falls. Moreover, the technology to predict their specific time, location and magnitude has not developed yet. The lack of attention to natural limits in the building and management of settlements renders them vulnerable to losses and increases the toll of natural and human-induced disasters.

Turkey is exposed to earthquakes because of its geological and tectonic structure, topographic and climatic characteristics. This is mostly due to the fact that a great majority of buildings still do not conform to building codes. The course in Turkey for urbanization, which is developed up to now, is not a result of a healthy process of planning. Therefore, the deficiency of the urban environment against earthquakes should be removed or supplied through the process of Earthquake-Mitigation. *Disaster management system in Turkey* is still on disaster response and recovery rather than on disaster mitigation and preparedness. This should definitely be overcome in the near future.

1999 Marmara earthquakes have proven to be true that mitigation and preparedness activities carried out up to now in Turkey have not been successful to prevent and reduce the damages of earthquakes. Due to these earthquakes, it is become possible to arouse the civil consciousness, which is very important for the applicability of the mitigation activities and projects. People started to judge the safety of their houses and workplaces and strengthened them if required.

The only way to prevent or reduce the damages of earthquakes is through a risk mitigation system and an environment built in conformity with building codes. Pre and post disaster activities both gain importance in this context. Post disaster activities give the start to the risk reduction process, which continues until to a new earthquake strikes.

Because of those projects or activities that should be executed *before, during and after an earthquake* better be considered as a whole and the equal importance should be shown to all of the phases for a comprehensive risk mitigation activity. In this extend, the reconstruction after an earthquake must be the part of the progress directed to future. Earthquake resistant urban environments should be planned and designed. All these works should aim creating urban environments that are development oriented, content with itself, and safer.

*Relocation***,** among the post disaster activities is an effective tool to prevent or reduce the damages of future hazards with its improved quality of housing. Removal of people from their existing habitats creates some major unwanted consequences for the victims involved. Aftermaths of an earthquake due to immediate solutions people are forced to leave their living area to move for their new "permanent housings". The surveys revealed out that people do not want to live in new residential areas. Involuntary displacement should be avoided or minimized, whenever feasible. People should stay and go on live where they live. Relocation process must be regarded as an opportunity to change the existing building stock and create safe and healthy and satisfactory physical and social environments. That's why also in mitigating activities, urban design principles should be searched to keep people in their habitat. It is not correct to move the population of high-risk areas to the city edges. It is surely needed to find ways to revalue the exiting urban pattern. This is one of the major ways to prevent or reduce the damages of future hazards. In this context, urban transformation is proposed as a solution of high-risk areas.

Residential developments are mostly developed illegally in a haphazard way in Izmir and in Karşıyaka. They are unhealthy and unsafe for earthquakes. The already developed ones are the result of the piece-meal development process, which does not qualify these urban areas. It is not possible to make existing situation safer, healthier via piecemeal development. Developing urban transformation models which are necessary for strengthening or redeveloping the existing urban structure; planning and designing criterions for safe, livable new urban environments, as it is discussed on the case of Fikri Altay District, in the scope of this thesis.

Within the scope of this thesis, it is concentrated on the activities and projects for mitigating the cities' earthquake risk. Izmir RADIUS Project and Earthquake Master Plan is studied in the 3rdchapter. Connecting with RADIUS Project the proposals can be articled as below:

- The results of these projects are mostly concentrated on the social, administrative issues. There has been studied almost any project on spatial studies as architectural, urban design and planning. All the projects are on governmental, educational issues aiming to raise public awareness via dissemination the result of the projects. This thesis is the first example as mitigation activities on urban scale.

- Moreover, Izmir Earthquake Master Plan takes the grids as borders of the project area. The grids are not developed according to natural threshold or governmental borders. So they are rather arbitrary boundaries to simplify data collection and processing. It is proposed that the mitigation activities should be executed on more realistic borders such as on "mahalle" basis that is the smallest unit local government.

6.2. Implications for Theory

Earthquake risk might be conceived as an *advantage* of building safer and healthier cities. Earthquake mitigation activities should be taken into consideration at urban and building scale. For a healthy and safe cities there is no need waiting for a destructive earthquake. Solutions are possible through earthquake conscious urban transformation.

Seismic safety of a settlement is important in terms of avoiding losses to life and material. However, seismicity is far from being the only concern or condition to be considered in the planning, design and management of a settlement. *Urban design* in an earthquake-prone area needs to include seismic safety as means of creating healthy and livable urban environment but should never exclude basic urban design concerns when addressing seismic safety.

6.3. Implications for Practice

Pre-earthquake Proposals

- Microzonation is needed before taking decisions about land use.
- The high-risk buildings, highways, bridges which Izmir Earthquake Master Plan indicates, should be analyzed and if necessary should be retrofitted. High-risk areas that are also determined by Master Plan should be transformed or evacuated if the risk can not be removed such as within the landslide areas. Essential legislative rearrangements should be undertaken for urban transformation.

- Communication, transportation, security system and health organization should take the priority to be retrofitted for sustaining social and economic life after the earthquake.
- Geographical Information System (GIS) should be established within the Municipality, covering and filing all the data collected throughout the RADIUS Project and enlarge its scope and content. For an effective action plan, the results should be shown in visual forms by computerization, using a GIS to enable and increase public consciousness and participation.
- Within the disaster law of Turkey, there is an authority disagreement between local and central administrative. Lack of coordination and cooperation causes delays at emergency period. Throughout the country, the coordination between local and central administration units should be ensured.
- Financial aid models should be developed for transformation and strengthening projects of high-risk areas and buildings.
- A Disaster Management Unit should be established within Metropolitan Municipality and in every "mahalle".
- Disaster management plan should be periodically updated

Post-earthquake proposals are ;

- Alternatives should be determined for the public service buildings such as hospitals, fire departments, crisis centers, equipment storage center, communication system, bridges, and roads for post-earthquake situation.
- Evacuation axes should be planned. Space for the emergency activities should be organized.
- Open and green areas should be analyzed through the city and their functions should be defined at the time of an earthquake. The result of the analysis should be evaluated and the required work such as infrastructure services should be supplied.

6.4. Further Research

Building act should be reviewed and rearranged considering earthquake risk. Design standards of roads, building blocks, building heights, emergency concentration places etc., should be redefined. Earthquake resistant design and planning criteria should be developed. All the building, underground and service network should be designed considering the earthquake risk.

A system should be developed to superimpose “mahalle” borders and the gridal system that is used Izmir Earthquake Master Plan.

RADIUS Project scope and content should be enlarged. To ensure it, in addition to statistical building and population data also building’s observed structural data, such as defined in the content of the thesis (See 5.3.1), should be obtained and collected on GIS database.

Alternative observed vulnerability systems and methods for performance scoring of the buildings should be developed. In the content of this thesis Istanbul model is modified but the result is not tested on damaged areas.

Optimization and statistical models can be developed for the redistribution of dwelling units. (See 5.4.3)

Earthquake conscious urban transformation is an interdisciplinary issue. An applicable urban transformation model should also include financial, administrative, legal corporate governance models, and strategic communication model. These issues should be held within further studies.

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APPENDIX A

GLOSSARY

This glossary includes words commonly used to describe the nature of earthquakes, how they occur, and their effects, as well as a discussion of the instruments used to record earthquake motion. Each word or phrase that is in bold print in the text is explained in this glossary.

Acceleration: When you step on the accelerator in the car or put on the brakes, the car goes faster or slower. When it is changing from one speed to another, it is accelerating (faster) or decelerating (slower). This change from one speed, or velocity, to another is called acceleration. During an earthquake when the ground is shaking, it also experiences acceleration. The **peak acceleration** is the largest acceleration recorded by a particular station during an earthquake.

Aerial Photography: Form of remote sensing that captures images of objects using photographic cameras and film from platforms in the atmosphere.

Affected people: People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance (definition considered in EM-DAT; included in the field « total affected »); Appearance of a significant number of cases of an infectious disease introduced in a region or a population that is usually free from that disease.

Aftershock: Smaller earth tremors that occur seconds to weeks after a major earthquake event.

Alluvium: Loose gravel, sand, silt, or clay deposited by streams.

Amplification: Most earthquakes are relatively small, in fact, so small that no one feels them. In order for seismologists to see the recording of the movement of the ground from the smaller earthquakes, the recording has to be made larger. It's like looking at the recording through a magnifying glass, and the amount that it is magnified is the amplification. Shaking levels at a site may also be increased by focusing of seismic energy caused by the geometry of the sediment velocity structure, such as basin subsurface topography, or by surface topography.

Building Codes: Ordinances and regulations controlling the design, construction, materials, alteration and occupancy of any structure to insure human safety and welfare. Building codes include both technical and functional standards

Countermeasures: All measures taken to counter and reduce disaster risk. They most commonly refer to engineering (structural) measures but can also include non-structural measures and tools designed and employed to avoid or limit the adverse impact of natural hazards and related environmental and technological disasters.

Coefficient: Statistic that measures the proportion of the variation in the dependent variable that is associated with the statistical regression of an independent variable. Can be calculated by taking the square if the correlation coefficient.

Correlation Coefficient: Statistic that measures the degree of linear association between two variables. Its values vary from between -1 and 1. Perfect positive (the dependent variable increases with an increase in the independent variable) linear association has a correlation coefficient of 1. Perfect negative (the dependent variable decreases with an increase in the independent variable) linear association has a correlation coefficient of -1. Absolutely no association between variables has a value of zero.

Density The floorspace of a building or buildings or some other unit measure in relation to a given area of land. Built density can be expressed in terms of plot ratio (for commercial development); number of units or habitable rooms per hectare (for residential development); site coverage plus the number of floors or a maximum building height; or a combination of these.

Design guide A document providing guidance on how development can be carried out in accordance with the design policies of a local authority or other organisation often with a view to retaining local distinctiveness.

Design principle An expression of one of the basic design ideas at the heart of an urban design framework, design guide, development brief or a development.

Design standards: Specific, usually quantifiable measures of amenity and safety in residential areas.

Design statement: (a) A pre-application design statement is made by a developer to indicate the design principles on which a development proposal in progress is based. It enables the local authority to give an initial response to the main issues raised by the proposal. (b) A planning application design statement sets out the design principles that the planning applicant has adopted in relation to the site and its wider context, as required by PPG1.

Disaster: Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance (definition considered in EM-DAT); an unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins. Wars and civil disturbances that destroy homelands and displace people are included among the causes of disasters. Other causes can be: building collapse, blizzard, drought, epidemic, earthquake, explosion, fire, flood, hazardous material or transportation incident (such as a chemical spill), hurricane, nuclear incident, tornado, or volcano

Disaster Risk Management: 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. This comprises all forms of activities, including structural and non-

Disaster Risk Reduction: 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.

• The disaster risk reduction framework is composed of the following fields of action, as described in ISDR's publication 2002 "Living with Risk: a global review of disaster reduction initiatives", page 23:

• 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 organizational, 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;

Earthquake: Sudden break within the upper layers of the earth, sometimes breaking the surface, resulting in the vibration of the ground, which where strong enough will cause the collapse of buildings and destruction of life and property.

Earthquake risk: The probable building damage, and number of people that are expected to be hurt or killed if a likely earthquake on a particular fault occurs. Earthquake risk and earthquake hazard are occasionally used interchangeably.

Early Warning: The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response. Early warning systems include a chain of concerns, namely: understanding and mapping the hazard; monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings.

Emergency Management: The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. Emergency management involves plans, structures and arrangements established to engage the normal endeavors of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.

Emergency: Sudden and usually unforeseen event that calls for immediate measures to minimise its adverse consequences.

Endogenic: Refers to a system that is internal to the Earth.

Epicenter: Surface location of an earthquake's focus

Exogenic: Refers to a system that is external to the Earth.

Epidemic: Either an unusual increase in the number of cases of an infectious disease, which already exists in the region or population concerned; or the appearance of an infection previously absent from a region (in EM-DAT the epidemic disease in included as a disaster subset).

Estimated Damage: The economic impact of a disaster usually consists of direct (e.g. damage to infrastructure, crops, housing) and indirect (e.g. loss of revenues, unemployment, market destabilisation) consequences on the local economy. In EM-DAT estimated damage are (if available) given in 2 different currencies (in thousand): Dam US$ and Dam Euros. If cost damage is given in the local currency, it will be directly converted in US$ and in EURO for European countries. For each disaster, the registered figure corresponds to the damage value at the moment of the event, i.e. the figures are shown true to the year of the event.

Evacuation: Organized, phased, and supervised dispersal of people from dangerous or potentially dangerous areas.

Fault: A fracture along which the blocks of crust on either side have moved relative to one another parallel to the fracture. **Strike-slip faults** are vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally. If the block opposite an observer looking across the fault moves to the right, the slip style is termed right lateral; if the block moves to the left, the motion is termed left lateral. **Dip-slip faults** are inclined fractures where the blocks have mostly shifted vertically. If the rock mass above an inclined fault moves down, the fault is termed **normal**, whereas if the rock above the fault moves up, the fault is termed **reverse (or thrust)**. Oblique-slip faults have significant components of both slip styles.

Geological Hazard: Natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Geological hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows. Geological hazards can be single, sequential or combined in their origin and effects.

Geographic Information Systems (GIS):: Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer program for capturing, storing, checking, integrating, analyzing and displaying data about the earth that is spatially referenced. Geographical information systems are increasingly being utilized for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.

Ground motion (shaking): The movement of the earth's surface from earthquakes or explosions. Ground motion is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.

Hazard: Threatening event, or probability of occurrence of a potentially damaging phenomenon within a given time period and area.

Hazard Analysis: Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behavior.

Hydrometeorological Hazards: Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Hydrometeorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydrometeorological hazards can be single, sequential or combined in their origin and effects.

Hypothesis: A tentative assumption that is made for the purpose of empirical scientific testing. A hypothesis becomes a theory when repeated testing and evidence suggests the hypothesis has a strong chance of being correct

Intensity: A measure of the severity of shaking at a particular site. It is usually estimated from descriptions of damage to buildings and terrain. The intensity is often greatest near the earthquake epicenter. Today, the Modified Mercalli Scale is commonly used to rank the intensity from I to XII according to the kind and amount of damage produced.Before1931 earthquake intensifies were often reported using the Rossi-Forel scale (Richter, 1958).

Injured: People suffering from physical injuries, trauma or an illness requiring medical treatment as a direct result of a disaster

Landslide: In general, all varieties of slope movement, under the influence of gravity. More strictly refers to down-slope movement of rock and/or earth masses along one or several slide surfaces.

Less Developed Country (LDC): Country characterized by minimal industrialization, low technological development, low per capita income, and high population growth rates. Many of these countries are found in Asia, Africa, and Central and South America. Also see more developed country.

Lifelines: Structures those are important or critical for a community to function, such as roadways, pipelines, power lines, sewers, communications, and port facilities.

Liquefaction: Temporary transformation of a soil mass of soil or sediment into a fluid mass. Occurs when the cohesion of particles in the soil or sediment is lost. Often triggered by seismic waves from an earthquake. For this condition to take place the pore spaces between soil particles must be at or near saturation.

Magnitude (1) The quantifiable size of a natural event. (2) A quantitative measure of the size of an earthquake using the Richter scale.

Microzonation: The identification of separate individual areas having different potentials for hazardous earthquake effects.

can be seen beneath the ocean as a line of ridges that form as molten rock reaches the ocean bottom and solidifies.

Mitigation: Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

More Developed Country (MDC): A highly industrialized country characterized by significant technological development, high per capita income, and low population growth rates. Examples of such countries include the United States, Canada, Japan, and many countries in Europe.

Natural Hazards (1) Natural phenomena that produce negative effects on life. (2) The study of the hazards of natural phenomena.

Population Density Number of individuals of a particular species found in a specified area

Preparedness: Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

Prevention: Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters.

Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behavior contribute to promoting a "culture of prevention".

Public Awareness: The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster. This involves public information, dissemination, education, radio or television broadcasts, use of printed media, as well as, the establishment of information centers and networks and community and participation actions.

Recovery: Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.

Relief / Response: The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.

Resilience / Resilient: The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Retrofitting: Reinforcement of structures to become more resistant and resilient to the forces of natural hazards. Retrofitting involves consideration of changes in the mass, stiffness, damping, load path and ductility of materials, as well as radical changes such as the introduction of energy absorbing dampers and base isolation systems. Examples of retrofitting include the consideration of wind loading to strengthen and minimize the wind force, or in earthquake prone areas, the strengthening of structures.

Risk: 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.

Risk Assessment / Analysis: A methodology to determine the nature and extent of risk by analyzing 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. 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.

Seismic: Shaking displacement usually caused by an earthquake

Soil Fertility: The ability of a soil to provide nutrients for plant growth

Spatial Analysis: The examination of the spatial pattern of natural and human-made phenomena using numerical analysis and statistics.

Technological Hazards: Danger originating from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Threshold: The level of magnitude of a system process at which sudden or rapid change occurs.

Urbanization: Expansion of cities into rural regions because of population growth. In most cases, population growth is primarily due to the movement of rural based people to urban areas.

Velocity: The fastness of a point on the ground is shaking as a result of an earthquake.

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

APPENDIX B

LAND SUBVDISION AND DEVELOPMENT PLAN OF THE PROJECT AREA

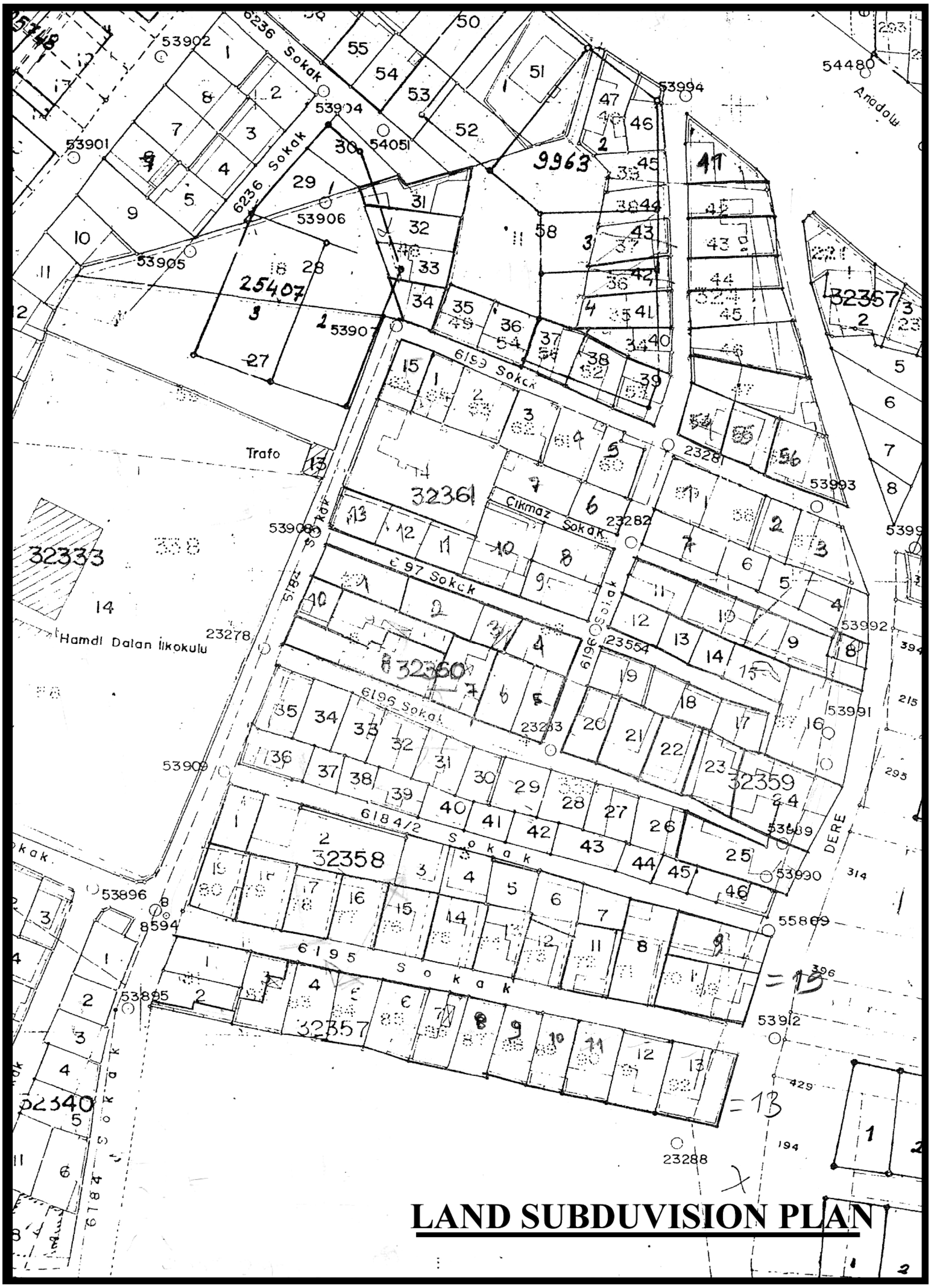

Figure B.1. Land Subdivision Plan of Project Area
(Source: Karsıyaka Municipality archive, 2005)

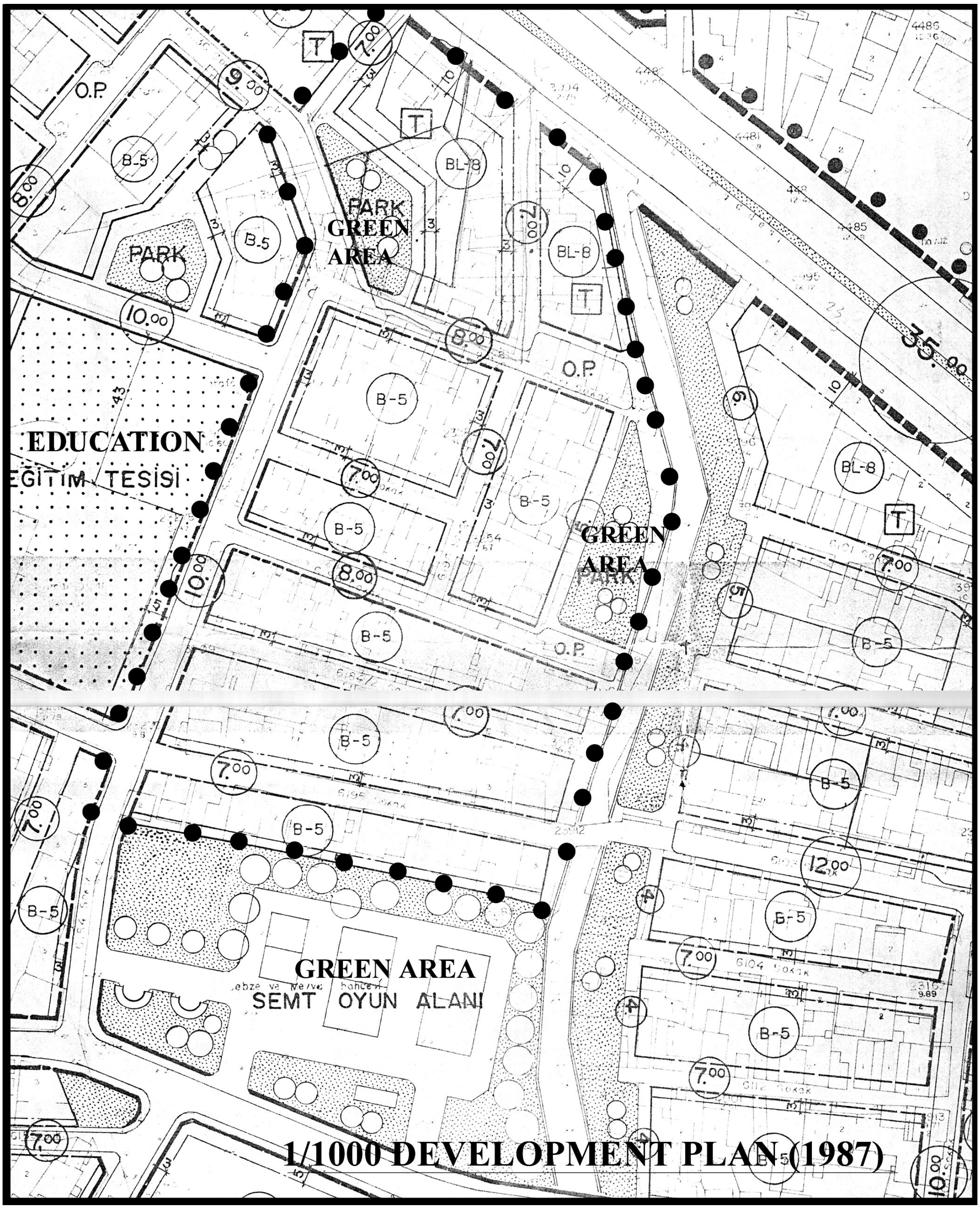

Figure B. 2. Development Plan (1987) of Project Area
(Source: Karsıyaka Municipality archive, 2005)

APPENDIX C

FIELD SURVEY FORMS

Table C. 1. Data Collection Form

RADIUS ZONE NO	
SUB-REGION NO	
BUILDING BLOCK NO	

DATA COLLECTION FORM

1			2				3			4									5					6						7														
STREET			PLOT				GROUND CONDITION			GENERAL BUILDING INFORMATION									BUILDING'S VISIBLE QUALITY					BUILDING LOCATION						BUILDING STRUCTURE SYSTEM														
																								Attached				Detached		System	Structural Irregularity											Intervention Yes/No		
																	Function							Slab Level (Same or Different)		Floor Level					Masonry		Reinforced Concrete				Balcony Position							
Photo NO	Name	Width	NO	Vacant	Construction	Area	River Bed	Normal	PGA / PGV	Photo NO	Building NO	Project yes/no	Const. Date	# of Floor	# of Dwelling	Area	Building Type	Ground Floor	Cracked	Moisture	Slanting Balcony	Wall Material	Finishing	S	D	S	D	Detached	Semi Detached	Masonry RC RC+M	Solid Void Proportion	Solid Void order	Soft Story	Short Column	Vertical Element	Irregular Plan	No balcony	Open	Closed	All around Open	All around Closed	No	If Yes? What kind?	Additional Opinion

Table C.2. Earthquake Performance Scoring Form

EARTHQUAKE PERFORMANCE SCORING FORM																						
Building No	RADIUS Zone NO:		RADIUS Classification	Building Block No	Photo No	Building Story Number	Building Zone Score	Building Date a<1960=1 1961<a<1974=2 1975<a<1990=3 91<a=4	River Bed	Project Existence	Building Structure System	Solid-Void Proportion	Solid-Void Order	Window and Door Position along the wall	Pounding	Apparent Quality	Plan Irregularity	Soft Floor	Short Column	Heavy Overhang	E.Performance Score	E.Performance Level

APPENDIX D

RAW DATA FOR EARTHQUAKE PERFORMANCE SCORING OF THE BUILDINGS

Table D.1. Earthquake Performance Scoring of the Buildings

EARTHQUAKE PERFORMANCE SCORING OF THE BUILDINGS																							
Building No	RADIUS Zone NO:		RADIUS Classification	Building Stock No	Photo No	Number of Floors	Building Zone Score	Building Date a<1960=1	River Bed Yes (1) -5	Project Existence	Building Structure System	Solid-Void Proportion	Solid-Void Order	Window and Door Position along the wall	Pounding	Apparent Quality	Plan Irregularity	Soft Floor	Short Column	Heavy Overhang	Biilding Score	Earthquake Performance Level
1	L18A3A4D	3	RES 2	9963	21	2	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Poor (2)-10					50	High
2		3	RES 2	9963	10,22	2	100	2 (2) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Moderate (1)-10					55	Moderate
3		3	RES 1	9963	20	2	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					41	High
4		3	RES 1	9963	18	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					50	High
5		3	RES 1	9963	17	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Good (0)-10					46	High
6		3	RES 2	9963	14	2	100	2 (2) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Good (0)-10					60	Moderate
7		3	RES 2	9963	12	2	100	2(2) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10				Yes (1) -0	41	High
8		3	RES 2	9963	11	2	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					46	High
9		3	RES 1	9963	209	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					36	High
10		3	RES 2	9963	207	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Poor (2)-10		Yes (1) -10		Yes (1) -5	43	High
11		3	RES 1	9963	211	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					36	High
12		3	RES 2	324	1,2	2	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	Less (0) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Moderate (1)-10					55	Moderate
13		3	RES 1	324	3	1	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	More (2) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					35	High
14		3	RES 2	324	2,6	2	100	2 (2) -5	Yes (1) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Moderate (1)-10	Yes (1) -2				41	High
15		3	RES 2	324	5,7	2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	Less (0) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Moderate (1)-10					66	Moderate
16		3	RES 2	324	25,8	2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Moderate (1)-10					41	High
17		3	RES 2	324	25,23	2	100	2 (2) -5	Yes (1) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Good (0)-10					80	Low
18		3	RES 1	324	24	2	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					31	High
19		3	RES 2	324	27,26	3	90	3 (1) -5	Yes (1) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Good (0)-10	Yes(1) -5	Yes (1) -10			66	Moderate
20		3	RES 1	324	28	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Moderate (1)-2	Proper (0) -10	Yes (1) -0	Good (0)-10					78	Moderate
21		3	RES 1	324	35	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Good (0)-10					68	Moderate
22		3	RES 2	324	29,3	2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10	Yes (1) 0		Yes(1) -5	Yes (1) -0	21	High
23		3	RES 1	32361	101,13	2	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Poor (2)-10					56	Moderate
24		3	RES 2	32361	15,16	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				No (0)	Poor (2)-10		Yes (1) 0		Yes (1) -0	60	High
25		3	RES 1	32361	102,19	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Moderate (1)-2	Proper (0) -10	Yes (1) -0	Moderate (1)-10					83	Low
26		3	RES 2	32361	102,103	2	100	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Poor (2)-10			Yes(1) -5	Yes (1) -0	36	High

Count. On next page

Table D.1. Count.

Building No			RADIUS Classification	Building Stock No	Photo No	Number of Floors	Building Zone Score	Building Date a<1960=1	River Bed Yes (1) -5	Project Existence	Building Structure System	Solid-Void Proportion	Solid-Void Order	Window and Door Position along the wall	Pounding	Apparent Quality	Plan Irregularity	Soft Floor	Short Column	Heavy Overhang	Building Score	Earthquake Performance Level
		EARTHQUAKE PERFORMANCE SCORING OF THE BUILDINGS																				
27		3	RES 2	32361	104-106	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10		Yes (1) 0		Yes (1) -0	65	Moderate
28	L18A3A4D	3	RES 1	32361	39	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					40	High
29		3	RES 2	32361	40,44	2	100	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10				Yes (1) -0	51	High
30		13	RES 2	32361	45	2	100	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				No (0)	Good (0)-10					90	Low
31		13	RES 1	32361	87	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Poor (2)-10					boş50	High
32		13	RES 2	32361	41-43,90,91,94	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Good (0)-10				Yes (1) -0	85	Low
33		13	RES 2	32361	93,99	2	100	1 (3) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Good (0)-10			Yes(1) -5	Yes (1) -0	41	High
34		13	RES 2	32361	95,99	2	100	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Moderate (1)-10			Yes(1) -5	Yes (1) -0	50	High
35		13	RES 2	32361	99,76	2	100	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	Moderate (1) -5	Moderate (1)-2	Not Proper (1) -10	No (0)	Good (0)-10				Yes (1) -0	68	Moderate
36		13	RES 1	32361	97,98,100	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Poor (2)-10	Yes (1) 0				40	High
37		13	RES 1	32360	77,78	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					45	High
38	L18A3D1A	13	RES 3	32360	22	4	75	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -3	Moderate (1)-10					52	High
39		13	RES 2	32360	88,89	3	90	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Poor (2)-10		Yes (1) -10	Yes(1) -5	Yes (1) -5	33	High
40		13	RES 3	32360	86,112	4	75	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -3	Good (0)-10					62	Moderate
41		13	RES 2	32360	b151	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Moderate (1)-10					78	Moderate
42		13	RES 2	32360	b138,b139	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Good (0)-10			Yes(1) -5		70	Moderate
43		13	RES 1	32360	b140,141	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Moderate (1)-2	Not Proper (1) -10	No (0)	Poor (2)-10					40	High
44		13	RES 1	32360	123,129,127	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Moderate (1)-2	Not Proper (1) -10	No (0)	Good (0)-10					58	Moderate
45		13	RES 2	32360	116,17,119,120	2	100	1 (3) -5	No (0) -5	No (1) -5	RC + Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Good (0)-10		Yes (1) 0		Yes (1) -0	61	Moderate
46		13	RES 2	32360	75	2	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10					55	Moderate
47		3	RES 1	32359	37,36	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Poor (2)-10					40	High
48	L18A3A4D	3	RES 2	32359	32,33,34	3	85	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2)-5	Proper (0) -10	Yes (1) -3	Poor (2)-10		Yes (1) -10		Yes (1) -5	32	High
49		3	RES 1	32359	31	1	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	Less (0) -5	Regular (0)-2	Proper (0) -10	Yes (1) -0	Poor (2)-10	Yes (1) 0				55	Moderate

Count. On next page

Table D.1. Count.

		EARTHQUAKE PERFORMANCE SCORING OF THE BUILDINGS																				
Building No			RADIUS Classification	Building Stock No	Photo No	Number of Floors	Building Zone Score	Building Date a<1960=1	River Bed Yes (1) -5	Project Existence	Building Structure System	Solid-Void Proportion	Solid-Void Order	Window and Door Position along the wall	Pounding	Apparent Quality	Plan Irregularity	Soft Floor	Short Column	Heavy Overhang	Building Score	Earthquake Performance Level
50		13	RES 2	32359	50-54	2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	Less (0) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10	Yes (1) 0	Yes (1) 0	Yes(1) -5	Yes (1) -0	36	High
51		13	RES 2	32359	55	3	85	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	Moderate (1) -5	Irregular (2)-5	Proper (0) -10	Yes (1) -3	Poor (2)-10		Yes (1) -10		Yes (1) -5	17	High
52		13	RES 2	32359	58-60	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10			Yes(1) -5		60	High
53		13	RES 1	32359	61	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					38	High
54		13	RES 1	32359	66	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					48	High
55		13	RES 2	32359	47-50	2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10		Yes (1) 0	Yes(1) -5	Yes (1) -0	41	High
56		13	RES 1	32359	56,63	2	100	2 (2) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					46	High
57		13	RES 2	32359	46,62	2	100	1 (3) -5	No (0) -5	No (1) -5	RC + Masonry	Less (0) -5	Irregular (2) -2	Proper (0) -10	Yes (1) -0	Poor (2)-10	Yes (1) 0	Yes (1) 0	Yes(1) -5	Yes (1) -0	51	High
58		13	RES 1	32359	65,56	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					45	High
59		13	RES 2	32359	68-70	2	100	2 (2) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					51	Moderate
60		13	RES 1	32359	71	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10		Yes (1) 0	Yes(1) -5		60	High
61		13	RES 2	32359	81	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10		Yes (1) 0	Yes(1) -5		60	High
62		13	RES 1	32359	82	1	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	Moderate (1) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10	Yes (1) 0				38	High
63		13	RES 2	32359	79	2	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					31	High
64	L18A3D1A	13	RES 2	32359	83,84	2	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Regular (0)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					41	High
65		13	RES 3	32359	72	4	75	4 (0) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -3	Moderate (1)-10					57	High
66		13	RES 1	32359	73,85	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Regular (0)-2	Not Proper (1) -10	No (0)	Poor (2)-10					60	Moderate
67		13	RES 2	32359	74	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Poor (2)-10	Yes (1) 0	Yes (1) -10	Yes(1) -5	Yes (1) -5	43	High
68		13	RES 1	32359	b150,142	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					38	High
69		13	RES 2	32359	b143	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Moderate (1)-10				Yes (1) -5	63	Moderate
70		13	RES 2	32359	b147,148	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10				Yes (1) -0	65	Moderate
71		13	RES 2	32359		2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Proper (0) -10	Yes (1) -0	Moderate (1)-10		Yes (1) 0	Yes(1) -5	Yes (1) -0	56	High
72		13	RES 2	32359	b147	2	100	1 (3) -5	Yes (1) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2	Proper (0) -10	Yes (1) -0	Moderate (1)-10		Yes (1) 0	Yes(1) -5	Yes (1) -0	56	High
73		13	RES 2	32359	b146,145	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Good (0)-10					85	Low
74		13	RES 1	32359	b144	2	100	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Moderate (1)-10			Yes(1) -5		75	Moderate
75		13	RES 2	32359	b136	2	100	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10		Yes (1) 0			70	Moderate
76		13	RES 2	32359	b134	2	100	2 (2) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					41	High
77		13	RES 1	32359	b133	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					36	High
78		13	RES 1	32359	b141	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	No (0)	Moderate (1)-10	Yes (1) 0				51	Moderate

Count. On next page

Table D.1. Count.

		EARTHQUAKE PERFORMANCE SCORING OF THE BUILDINGS																				
Building No			RADIUS Classification	Building Stock No	Photo No	Number of Floors	Building Zone Score	Building Date a<1960=1	River Bed Yes (1) -5	Project Existence	Building Structure System	Solid-Void Proportion	Solid-Void Order	Window and Door Position along the wall	Pounding	Apparent Quality	Plan Irregularity	Soft Floor	Short Column	Heavy Overhang	Bilding Score	Earthquake Performance Level
79	L18A3D1A	13	RES 2	32359	b132	2	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10				Yes (1) -0	36	High
80		13	RES 2	32359		2	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10				Yes (1) -0	41	High
81		13	RES 2	32359		2	100	1 (3) -5	Yes (1) -5	No (1) -5	Masonry	Moderate (1) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10				Yes (1) -0	46	High
82		13	RES 2	32359	a118,b129,b135	2	100	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				No (0)	Good (0)-10			Yes(1) -5	Yes (1) -0	85	Low
83		13	RES 2	32359	b131,130	2	100	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				No (0)	Good (0)-10				Yes (1) -0	90	Low
84		13	RES 2	32359	126,130,155	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				No (0)	Good (0)-10		Yes (1) -10			70	Moderate
85		13	RES 1	32359	125,86	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10					46	High
86		13	RES 1	32359	85	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Moderate (1)-10					46	High
87		13	RES 2	32359	b90,91	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Good (0)-10		Yes (1) 0	Yes(1) -5		80	Low
88		13	RES 2	32359	b93,122	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Good (0)-10					78	Moderate
89		13	RES 1	32359	b123	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Moderate (1)-2	Proper (0) -10	No (0)	Good (0)-10	Yes (1) 0				78	Moderate
90		13	RES 2	32359	b98,121	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Good (0)-10					78	Moderate
91		13	RES 2	32359	b120	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Moderate (1)-10			Yes(1) -5	Yes (1) -5	58	High
92		13	RES 1	32359	b118,115	2	100	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -0	Poor (2)-10		Yes (1) 0		Yes (1) -0	70	Moderate
93		13	RES 2	32359	b114,116,117	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Moderate (1)-10					68	Moderate
94		13	RES 2	32359	b111,113	3	90	3 (1) -5	No (0) -5	No (1) -5	Reinforced Concrete				Yes (1) -2	Poor (2)-10		Yes (1) -10		Yes (1) -5	43	High
95		13	RES 1	32359	b131,11	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	More (2) -5	Irregular (2) -2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					43	High
96		13	RES 1	32359	b108,109	2	100	2 (2) -5	Yes (1) -5	No (1) -5	Reinforced Concrete				No (0)	Poor (2)-10		Yes (1) 0	Yes(1) -5	Yes (1) -0	55	High
97		13	RES 2	32358	a133,135,132	3	90	3 (1) -5	Yes (1) -5	No (1) -5	Reinforced Concrete				No (0)	Moderate (1)-10					75	Moderate
98		13	RES 2	32358	b104,107	2	100	2 (2) -5	No (0) -5	No (1) -5	Reinforced Concrete				No (0)	Moderate (1)-10					80	Low
99		13	RES 1	32358	b105	1	100	1 (3) -5	No (0) -5	No (1) -5	Masonry	Less (0) -5	Moderate (1)-2	Not Proper (1) -10	Yes (1) -0	Poor (2)-10					48	High
100		13	RES 2	32358	b102, 66	2	100	2 (2) -5	No (0) -5	No (1) -5	RC + Masonry	More (2) -5	Irregular (2) -2		Yes (1) -0	Poor (2)-10		Yes (1) 0			41	High

Count. On next page

APPENDIX E

SIZE ANALYSIS OF THE BUILDINGS AND PLOTS

Table E.1. Size Analyses Buildings and Plots

SIZE ANALYSIS OF THE BUILDINGS and PLOTS													
Building Stock No	Building No	Number of Dwelling	Populatio n	Number of Floors	Building Floor Area	Total Construction Area	Plot No	Plot Size	Building Coeeficient1 = Plot (n) / minPlotsize (ex: 101/56)	A = Plot Size (n) ÷ Dwelling (n)	Building Coeeficient 2= Plot (n)/minA (ex: 101/30)	Plot Area Ratio (TAKS)	Floor Area Rati (KAKS)
9963	1	1	4	2	44	88	40	101	1,803571429	101	3,366666667	0,435643564	0,871287129
	2	2	8	2	76	152	41	148	2,642857143	74	4,933333333	0,513513514	1,027027027
	3	1	4	2	78	156	39	118	2,107142857	118	3,933333333	0,661016949	1,322033898
	4	1	4	1	72	72	38	131	2,339285714	131	4,366666667	0,549618321	0,549618321
	5	1	4	1	70	70	37	131	2,339285714	131	4,366666667	0,534351145	0,534351145
	6	2	8	2	85	170	36	108	1,928571429	54	3,6	0,787037037	1,574074074
	7	2	8	2	91	182	35	112	2	56	3,733333333	0,8125	1,625
	8	2	8	2	75	150	34	76	1,357142857	38	2,533333333	0,986842105	1,973684211
	9	1	4	1	50	50	33	106	1,892857143	106	3,533333333	0,471698113	0,471698113
	10	3	12	3	100	300	32	104	1,857142857	34,66666667	3,466666667	0,961538462	2,884615385
	11	1	4	1	53	53	31	115	2,053571429	115	3,833333333	0,460869565	0,460869565
TOTAL		17	68	19	794	1443		1250	22,32142857	73,52941176	41,66666667	0,6352	1,1544
324	12	1	4	2	50	100	41	159	2,839285714	159	5,3	0,314465409	0,628930818
	13	Not	Not	1	73	73					0	0,459119497	0,459119497
	14	1	4	2	110	220	42	157	2,803571429	157	5,233333333	0,700636943	1,401273885
	15	2	8	2	90	180	43	161	2,875	80,5	5,366666667	0,559006211	1,118012422
	16	1	4	2	124	248	44	171	3,053571429	171	5,7	0,725146199	1,450292398
	17	1	4	2	91	182	45	176	3,142857143	176	5,866666667	0,517045455	1,034090909
	18	2	8	2	156	312	46	230	4,107142857	115	7,666666667	0,67826087	1,356521739
	19	3	12	3	131	393	47	242	4,321428571	80,66666667	8,066666667	0,541322314	1,623966942
	20	1	4	1	83	83	54	126	2,25	126	4,2	0,658730159	0,658730159
	21	1	4	1	87	87	55	135	2,410714286	135	4,5	0,644444444	0,644444444
	22	2	8	2	129	258	56	198	3,535714286	99	6,6	0,651515152	1,303030303
TOTAL		15	60	20	1124	2136		1755	31,33928571	117	58,5	0,526217228	1,217094017

Count. On next page

Table E.1. Count.

Building Stock No	Building No	Number of Dwelling	Populatio n	Number of Floors	Building Floor Area	Total Construction Area	Plot Number	Plot Size	Building Coeeficient1 = Plot (n) / minPlotsize (ex: 216/56)	A = Plot (n) / Dwelling (n)	Building Coeeficient 2 = Plot (n) / minA (ex: 216/30)	Plot Area Ratio (TAKS)	Floor Area Ratio (KAKS)
32361	23	Not	Not	2	80	160	15	216	3,857142857	113	7,2	0,37037037	0,740740741
	24	2	8	2	131	262	2	172	3,071428571	86	5,733333333	0,761627907	1,523255814
	25	1	4	1	117	117	3	136	2,428571429	136	4,533333333	0,860294118	0,860294118
	26	2	8	2	125	250	4	134	2,392857143	67	4,466666667	0,932835821	1,865671642
	27	2	8	2	120	240	5	123	2,196428571	61,5	4,1	0,975609756	1,951219512
	28	Not	Not	1	85	85	6	86	1,535714286	85	2,866666667	0,988372093	0,988372093
	29	1	4	2	116	232	7	143	2,553571429	143	4,766666667	0,811188811	1,622377622
	30	2	8	2	127	254	8	156	2,785714286	78	5,2	0,814102564	1,628205128
	31	Not	Not	1	70	70	9	113	2,017857143	116	3,766666667	0,619469027	0,619469027
	32	2	8	2	144	288	10	211	3,767857143	105,5	7,033333333	0,682464455	1,36492891
	33	2	8	2	80	160	11	86	1,535714286	43	2,866666667	0,930232558	1,860465116
	34	2	8	2	85	170	12	86	1,535714286	43	2,866666667	0,988372093	1,976744186
	35	2	8	2	104	208	13	102	1,821428571	51	3,4	1,019607843	2,039215686
	36	1	4	1	98	98	14	582	10,39285714	582	19,4	0,16838488	0,16838488
TOTAL		19	76	24	1482	2594		2346	41,89285714	123,4736842	78,2	0,631713555	1,10571185
32360	37	2	8	1	89	89	1	167	2,982142857	83,5	5,566666667	0,532934132	0,532934132
	38	3	12	4	76	304	2	145	2,589285714	48,33333333	4,833333333	0,524137931	2,096551724
	39	2	8	3	63	189	3	86	1,535714286	43	2,866666667	0,73255814	2,197674419
	40	4	16	4	106	424	4	131	2,339285714	32,75	4,366666667	0,809160305	3,236641221
	41	3	12	3	91	273	5	119	2,125	39,66666667	3,966666667	0,764705882	2,294117647
	42	2	8	2	87	174	6	125	2,232142857	62,5	4,166666667	0,696	1,392
	43	1	4	1	70	70	7	161	2,875	161	5,366666667	0,434782609	0,434782609
	44	1	4	1	94	94	8	280	5	280	9,333333333	0,335714286	0,335714286
	45	2	8	2	109	218	9	170	3,035714286	85	5,666666667	0,641176471	1,282352941
	46	1	4	2	45	90	10	69	1,232142857	69	2,3	0,652173913	1,304347826
TOTAL		21	84	23	830	1925		1453	25,94642857	69,19047619	48,43333333	0,571231934	1,324845148

Count. On next page

Table E.1. Count.

Building Stock No	Building No	Number of Dwelling	Population	Number of Floors	Building Floor Area	Total Construction Area	Plot Number	Plot Size	Building Coeeficient 1 = Plot (n) / minPlotsize (ex: 286/56)	A = Plot (n) / Dwelling (n)	Building Coeeficient 2 = Plot (n) / minA (ex: 286/30)	Plot Area Ratio (TAKS)	Floor Area Ratio (KAKS)
32359	47	1	4	1	118	118	1	286	5,107142857	286	9,533333333	0,412587413	0,412587413
	48	3	12	3	90	270	2	90	1,607142857	30	3	1	3
	49	1	4	1	85	85	3	176	3,142857143	176	5,866666667	0,482954545	0,482954545
	50	2	8	2	100	200	4	121	2,160714286	60,5	4,033333333	0,826446281	1,652892562
	51	2	8	3	71	213	5	69	1,232142857	34,5	2,3	1,028985507	3,086956522
	52	2	8	2	73	146	6	80	1,428571429	40	2,666666667	0,9125	1,825
	53	1	4	1	50	50	7	143	2,553571429	71,5	4,766666667	0,34965035	0,34965035
	54	1	4	1	88	88					0	0,615384615	0,615384615
	55	4	16	2	163	326	9	260	4,642857143	65	8,666666667	0,626923077	1,253846154
	56	1	4	2	30	60	10	132	2,357142857	64	4,4	0,227272727	0,454545455
	58	1	4	1	68	68						0,515151515	0,515151515
	57	2	8	2	51	102	11	133	2,375	66,5	4,433333333	0,383458647	0,766917293
	59	2	8	2	77	154	12	100	1,785714286	50	3,333333333	0,77	1,54
	60	2	8	2	66	132	13	64	1,142857143	32	2,133333333	1,03125	2,0625
	61	2	8	3	60	180	14	65	1,160714286	32,5	2,166666667	0,923076923	2,769230769
	62	1	4	1	62	62	15	113	2,017857143	113	3,766666667	0,548672566	0,548672566
	63	1	4	2	73	146	16	326	5,821428571	326	10,86666667	0,22392638	0,447852761
	64	2	8	2	73	146	17	109	1,946428571	54,5	3,633333333	0,669724771	1,339449541
	65	4	16	4	110	440	18	136	2,428571429	34	4,533333333	0,808823529	3,235294118
	66	1	4	1	52	52	19	126	2,25	126	4,2	0,412698413	0,412698413
	67	3	12	3	81	243	20	122	2,178571429	40,66666667	4,066666667	0,663934426	1,991803279
	68	1	4	1	67	67	21	144	2,571428571	144	4,8	0,465277778	0,465277778
	69	2	8	3	115	345	22	155	2,767857143	77,5	5,166666667	0,741935484	2,225806452
	70	2	8	2	62	124	23	113	2,017857143	56,5	3,766666667	0,548672566	1,097345133
	79	2	8	2	58	116	24	324	5,785714286	54	10,8	0,179012346	0,358024691
	80	2	8	2	80	160					0	0,24691358	0,49382716
	81	2	8	2	82	164					0	0,25308642	0,50617284
	71	2	8	2	80	160	25	292	5,214285714	73	9,733333333	0,273972603	0,547945205
	72	2	8	2	70	140					0	0,239726027	#SAYI/0!
	73	2	8	2	87	174	26	121	2,160714286	60,5	4,033333333	0,719008264	1,438016529
	74	1	4	2	96	192	27	106	1,892857143	106	3,533333333	0,905660377	1,811320755
	75	3	12	2	100	200	28	108	1,928571429	36	3,6	0,925925926	1,851851852
	76	3	12	2	98	196	29	125	2,232142857	41,66666667	4,166666667	0,784	1,568
	77	1	4	1	50	50	30	81	1,446428571	81	2,7	0,617283951	0,617283951

Count. On next page

Table E.1. Count.

Building Stock No	Building No	Number of Dwelling	Population	Number of Floors	Building Floor Area	Total Construction Area	Plot Number	Plot Size	Building Coeeficient 1 = Plot (n) / minPlotsize (ex: 127/56)	A = Plot (n) / Dwelling (n)	Building Coeeficient 2 = Plot (n) / minA (ex: 127/30)	Plot Area Ratio (TAKS)	Floor Area Ratio (KAKS)
32359	78	1	4	1	70	70	31	127	2,267857143	127	4,233333333	0,551181102	0,551181102
	82	2	8	2	92	184	32	124	2,214285714	62	4,133333333	0,741935484	1,483870968
	83	2	8	2	82	164	33	110	1,964285714	55	3,666666667	0,745454545	1,490909091
	84	3	12	3	100	300	34	112	2	37,33333333	3,733333333	0,892857143	2,678571429
	85	1	4	1	84	84	35	128	2,285714286	128	4,266666667	0,65625	0,65625
	86	1	4	1	117	117	36	128	2,285714286	128	4,266666667	0,9140625	0,9140625
	87	2	8	2	60	120	37	68	1,214285714	34	2,266666667	0,882352941	1,764705882
	88	2	8	3	60	180	38	60	1,071428571	30	2	1	3
	89	1	4	1	57	57	39	89	1,589285714	89	2,966666667	0,640449438	0,640449438
	90	2	8	3	75	225	40	77	1,375	38,5	2,566666667	0,974025974	2,922077922
	91	2	8	3	48	144	41	67	1,196428571	33,5	2,233333333	0,71641791	2,149253731
	92	1	4	2	70	140	42	68	1,214285714	68	2,266666667	1,029411765	2,058823529
	93	2	8	3	95	285	43	92	1,642857143	46	3,066666667	1,032608696	3,097826087
	94	2	8	3	52	156	44	60	1,071428571	30	2	0,866666667	2,6
	95	1	4	1	55	55	45	56	1	56	1,866666667	0,982142857	0,982142857
	96	2	8	2	96	192	46	123	2,196428571	61,5	4,1	0,780487805	1,56097561
TOTAL		91	364	99	3899	7842		5709	101,9464286	3456,666667	190,3	0,682956735	1,373620599

Count. On next page

Table E.1. Count.

Building Stock No	Building No	Number of Dwelling	Population	Number of Floors	Building Floor Area	Total Construction Area	Plot Number	Plot Size	Building Coeficient 1 = Plot (n) / minPlotsize (ex: 199/56)	A = Plot (n) / Dwelling (n)	Building Coeeficient 2 = Plot (n) / minA (ex: 199/30)	Plot Area Ratio (TAKS)	Floor Area Ratio (KAKS)
32358	97	3	12	3	100	300	9	199	3,553571429	66,33333333	6,633333333	0,502512563	1,507537688
	99	1	4	1	32	32	7	90	1,607142857	90	3	0,355555556	0,355555556
	100	2	8	2	100	200	6	104	1,857142857	52	3,466666667	0,961538462	1,923076923
	101	2	8	2	88	176	5	94	1,678571429	47	3,133333333	0,936170213	1,872340426
	102	1	4	1	82	82	4	103	1,839285714	103	3,433333333	0,796116505	0,796116505
	103	3	12	3	85	255	3	109	1,946428571	36,33333333	3,633333333	0,779816514	2,339449541
	104	2	8	2	100	200	2	425	7,589285714	212,5	14,16666667	0,235294118	0,470588235
	105	2	8	2	117	234	1	130	2,321428571	65	4,333333333	0,9	1,8
	106	3	12	3	139	417	19	161	2,875	53,66666667	5,366666667	0,863354037	2,590062112
	107	4	16	4	121	484	18	153	2,732142857	38,25	5,1	0,790849673	3,163398693
	108	2	8	2	116	232	17	150	2,678571429	75	5	0,773333333	1,546666667
	109	4	16	4	131	524	16	153	2,732142857	38,25	5,1	0,85620915	3,424836601
	110	1	4	1	80	80	15	158	2,821428571	158	5,266666667	0,506329114	0,506329114
	111	2	8	2	75	150	14	162	2,892857143	81	5,4	0,462962963	0,925925926
	112	1	4	1	52	52	13	132	2,357142857	132	4,4	0,393939394	0,393939394
	113	1	4	1	70	70	12	155	2,767857143	155	5,166666667	0,451612903	0,451612903
	114	1	4	1	88	88	11	158	2,821428571	158	5,266666667	0,556962025	0,556962025
	115	3	12	3	127	381	10	269	4,803571429	89,66666667	8,966666667	0,472118959	1,416356877
	116	3	12	3	132	396	8	215	3,839285714	53,75	7,166666667	0,613953488	1,841860465
	98	1	4	2	42	84					0	0,195348837	0,390697674
TOTAL		42	168	43	1877	4437		3120	55,71428571	74,28571429	104	0,601602564	1,422115385

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