THE ANALYSIS OF THE PLANNING CONSEQUENCES AND RISK OF EARTHQUAKE IN TERMS OF URBAN RENT: THE CASE STUDY OF ADAPAZARI

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ABSTRACT

General aims of the thesis were to understand the nature and causes of earthquake damage in built and social environment, to define and assess urban seismic risk in Turkey and the World, to interrogate planning regulations, policies, and implementations, and to determine the risk factors from social, economic, natural viewpoints. However, the thesis assumed that the increase of the risk as correlated to the raised rent values could be related to planning decisions. The thesis aimed to look closely to planning decisions and their causality on the increase of earthquake risk in terms of urban rent. The study assumes that there are strong relationships among earthquake damage, urban rent and planning decisions. Various risk factors related to earthquake damage were described as natural, social, economic and technical factors. But the scope of the thesis was limited to social risk factors with respect to earthquake damage in order to clarify impact of urban rent and planning decisions.

Multiple Regression and correlation analysis was used as a method in order to provide an experimental fundamental and to test claims. In this study, unit of data analysis is defined as scale of district or “mahalle” in Adapazari. Firstly, data such as population density, earthquake damage, the physical building density, and land price (urban rent) in Adapazari was assigned to unit of “mahalle”. After analysis in scale of “mahalle” was completed in 26 districts, correlation and regression analysis through variables are conducted in order to enlighten relationships among earthquake damage and urban rent and plan decisions. The study examined that what planning decisions urban rent influence and what their explanatory degree was through regression and correlation analysis. For this step land price or urban rent was analyzed with population density, distance to the city center and ground area ratio through regression and correlation. In the second step earthquake damage was analyzed with independent variables, land value or urban rent, average distance of demolished buildings to the city center and physical building density. Variables coming planning decisions and urban rent and earthquake damage in second step are analyzed through correlation and regression.

In the first step, when outcomes of analysis between urban rent (land price) and other variables were assessed, the calculated R square is approximately 52 % and relationships between dependent and independent variables were not strong. In the second step, when analysis between earthquake damage ratio and other variables were assessed, R square is approximately 63% and relationships between dependent and independent variables were not very strong.

In conclusion, my assumption related to urban rent and earthquake damage was falsified by correlation and regression analysis. However, it does not mean that there is not any relationship between earthquake damage and land price (urban rent). The goal of this study was to understand impact of mentioned factors on earthquake damage. The study suggests that future researches related earthquake damage should be focus on natural risk factors and building technology of construction.

Key words: natural disaster, urban rent, earthquake damage, planning decisions, conventional planning, risk management and contingency planning, regression and correlation analysis.

Öz

Tezin genel amaci, yapili ve toplumsal çevrede, deprem zararlarinin nedenlerini ve deprem olgusunun dogasini anlamak, Türkiye’de ve dünyada kentsel deprem riskini degerlendirmek, planlanma düzenlemelerini, politikalarini ve uygulamalarini sorgulamak, sosyal,ekonomik ve dogal açilarindan risk faktörlerini belirlemektir.

Bununla beraber, tez artan rant degerleriyle baglantili olarak, deprem risk artisinin planlama kararlari ile iliskili olabilecegini varsayarak, yüksek lisans çalismasi kapsaminda deneysel bir yaklasim sergiler. Bu yüzden, tez, kentsel rantlar baglaminda, planlama kararlarina ve deprem riski artisinin nedensellikleri üzerinde durur. Bu çalisma deprem zarari, kentsel rantlar ve planlama kararlari arasinda dolayli bir iliski oldugunu varsayar. Deprem riskleri, sosyal, ekonomik ve teknik risk faktörleri olarak gruplanabilir. Bununla beraber, tez çalismasinin alani, planlama kararlarinin dolayli etkisini kentsel rantlar baglaminda görmek için sosyal risk faktörleri ile sinirlandirilmistir.

Teze deneysel bir temel saglamak ve test edilebilmesi için istastiki bir method olan regresyon ve korelasyon analizleri kullanilmistir. Örnek çalisma alani kapsami Adapazari Büyüksehir Belediyesine bagli 26 mahalle ile sinirlandirilmis ve analiz birimi olarak mahalle idari sinirlari kabul edilmistir. Ilk olarak, Adapazarin’da her mahallede, nüfus yogunlugu, deprem zarari orani, fiziksel yapi yogunlugu ve arazi fiyati verileri elde edilerek mekansallastirildi. Mahalle ölçeginde veriler mekansallastirildiktan sonra, deprem zarari, kentsel rant ve planlama kararlari arasindaki dolayli iliski ortaya çikarmak için istastiki analizler olan regresyon ve korelasyon analizleri uygulanmistir.

Korelasyon ve regresyon analizleri araciligi ile hangi planlama kararlari, kentsel rantlari etkiledigi ve açiklama dereceleri incelendi. Analizin ilk adiminda kentsel rant ve planlama kararlari analiz edildi. Kentsel ranti belirleyen baslica planlama kararlari, taban alani katsayisi(Taks), nüfus yogunlugu, her mahallenin kent merkezine uzakligi degiskenleri kullanildi. Ikinci asamada, deprem zarari ve planlama kararlari tarafindan belirlenen kentsel rantlar regresyon ve korelasyon analizi yapildi. Bu asamada deprem

zararini belirleyen bagimsiz degiskenler olarak kentsel rant, yikilmis yapilarin kent merkezine uzakligi ve fiziksel yapi yogunluklari degiskenleri kullanilmistir. Böylece dolayli olarak planlama kararlarindan gelen degiskenler ve kentsel rant ve deprem zarari analiz edildi.

Ilk asama analiz sonuçlari degerlendirildiginde kentsel rant ve diger degiskenler arasinda zayif bir iliski oldugu ve regresyon katsayisinin % 52 oldugu görülmektedir. Böyle bir sonucun elde edilmesi veri kümesinin kisitli olmasi rol oynamis olabilir. Ikinci adimda kentsel rant ve deprem zarari arasindaki iliski degerlendirildiginde korelasyon katsayisi % 35 oldugu görülmektedir. Bu sonuçlar öne sürülen varsayimlari yanlislamaktadir.

Sonuç olarak, kentsel rant ve deprem zarari iliskisinin güçlü oldugu varsayimi analiz sonuçlariyla yanlislanmaktadir. Bununla beraber, tez çalismasi deprem zarari düzeyi iliskin gelecekte yapilacak çalismalarin, dogal risk faktörleri, bina yapim teknolojisi ve teknik uygulamalar üzerinde yogunlasmasi gerektigini göstermistir.

Anahtar Kelimeler: Dogal Afetler, Kentsel Rant, Deprem zarari, Planlama Kararlari, Geleneksel Planlama Yaklasimi, Risk Yönetimi, Sakinim Planlamasi, Regresyon ve Korelasyon Analizi.

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Chapter 1
INTRODUCTION

Earthquake is a very dangerous natural event and its damages and risks have been increasing due to ever-increasing urbanization process, most of which is said to be unhealthy developments, thus ever-increasing urban rent, population density, policies of investment, geological reasons from economic and social point of view in Turkey and Developing countries. There are a couple of reasons choosing earthquake damage as the topic; First, planning decisions and changes topic constitute a major challenge related to earthquake damage and role of planning is investigated. Another reason is that planners had not sufficiently been interested (or loosely) in mitigation of earthquake damage before 1999 and its social and economic dimensions.

Relating to earthquake damages, the role of planning is overlooked many times. Problem is that various forms of urban rents cause to rise of the risk of earthquake damage, most of which are through planning changes. Urban rent as a "transfer payment" constitutes a pressure on planning decisions, and the planning decisions are dependently changed frequently through social, administrative and economic mechanisms. Planning is not at all independent from the society and the politico-economic system. There are various contradictive interests in society, and, to a greater extent, locations of settlements are determined by those interests. Therefore, planners make decisions accordingly with the awareness of to this existing structure. Planners' tendency has been rather to address functional and aesthetical concerns of settlements in Turkey. City planner had not enough knowledge and interest about earthquake, and the authority, either. Also, they ignored disaster and risk management concepts during planning.

Planning has not led to healthy urban developments in Turkey as so far expected due to legal, institutional, economic and social structures. However, the planning has been rather an institution to legitimize illegal built- up areas, instead of eliminating them. For example, population and building density in urban areas have frequently increased through plan changes as a result of the increase of rent and demands of pressure groups. For this reason, while urban infrastructure standards have been dropping off, earthquake risk has increased through added stories and increased density. On the other hand, the existing building stock in urban areas is prone to vulnerability to earthquake risk and other disasters because technical requirements have been lacking.

Furthermore, in this study, impact of urban rent on earthquake damage is investigated. Urban growth causes rise of expectations in land value because the result of demand and supply of the land, the scarcity arise and landlords according to their locations derives excess profit. The land rent and property rent in central areas does not arise out of marginal productivity of the land but it arises out of the process resulting from application of absolute and monopoly rent that constitute majority of urban rent. However, the source of urban rent exactly can not be determined. Planning decisions play important role in determining rent due to location and property. Monopoly rents tend to be most easily established at near the center and absolute rent is the greatest at the city center of the largest metropolitan region. At these locations absolute and monopoly rents enter into the cost production. The thesis assumes that land value in the city center equal to land rents and majority of these rents consists of absolute and monopoly rents.

Exchange value and use value or both shape urban space. In Turkey, cities are shaped by exchange value that is embedded in rent value such as monopoly and absolute rents. Absolute rent is revenue of the private property that is dependent on land. In social life, absolute space comprises the fundamental of monopoly rent. Monopoly rents are crucial in the case of urban land and of private property because cities are larger and they geographically differentiate. Source of monopoly rent is scarcity of urban land. The amount of urban land that has a specific location is not increased. However, the scarcity is socially determined and neo-classic formulations such as Muth, Mills, Alanso, ignore social dimension of the scarcity. A Landlord who has this kind of land obtains an excess profit compared to others. Absolute rent raises monopoly rent of private property on the same land. Source of absolute rent is through decision-making from different people who have power and authority and organizations. For example, in development of mass housing, private people or public organizations may produce absolute rent through making plan or leaving the land vacant. However, it is important that planning decisions produce rent and distribute it. But public actions, landlords and local managers influence these decisions.

However, earthquake damages can (and might have been) be mitigated through planning guidance. Role or task of urban planners is to solve problems concerning built environment and human life. Moreover, various disciplines like geologists, engineers offer piecemeal methods and solutions related to risk mitigation. Nevertheless, urban planning must provide a comprehensive and integrated solution method for mitigation and risk management through contingency planning.

1.1. The Purpose of the Thesis

General aims of the thesis in the scope of study are to understand the nature and causes of earthquake damage in built and social environment, to define and assess urban seismic risk in Turkey and the World, to interrogate planning regulations, policies, and implementations, and to determine the risk factors from social, economic, natural viewpoints.

The thesis also aims to look closely to planning decisions and their causality on the increase of earthquake risk in terms of urban rent. Also, the thesis hypothesizes that the increase of the risk as correlated to the raised rent values can be related to planning decisions. Yet, planning decisions are affected by macro-level investment policies, pressure groups, speculative actions, urban managers' political actions. For this reason, the thesis will focus on plan decisions in Adapazari case study, where recently a greater portion of the most disastrous earthquake of the country, Eastern Marmara earthquake happened and took many lives in 1999. The development plans of Adapazari were analyzed and assessed in order to determine the reasons for earthquake damage and role of planning decisions and urban rent.

There are, in fact, various risk factors related to earthquake damage. These can be generally described as natural, social, economic and technical factors. Natural factors constitute risks related to earthquake damage including intensity and magnitude of earthquake, distance of settlements to hypocenter and epicenter of earthquake, shallow of earthquake, liquefaction areas, depth of underground water, soil types such as alluvial, clay and sandy soil.

Social factors include city and regional planning practice, illegal construction and squatter settlements, being unaware of earthquake event, form of building construction, quality of building production, insufficient control system and inspection of building construction, housing problem, urban rent and land speculation, planning changes.

Economic factors that constitute risks related to earthquake damage include policy of industrial location, urbanization process, undevelopment, economic policies and urban rent. Technical factors include codes and regulations concerning earthquake, order of building, and the number of story.

In the literature, there are some studies related to natural factors. But socio-economic and technical risk factors have been neglected. Therefore, the scope of the thesis is limited to social risk factors with respect to earthquake damage. However, in literature there is not any study with together earthquake damage, urban rent and plan decisions. The existing studies are only related to earthquake damage and role of urban rent and plan decisions on earthquake damage is ignored. Also there are some studies that took up relationship between urban rent and plan decisions but impact of these on earthquake damage has not taken into account. For this reason, there is not any study that guides to the thesis. However, it comprises of the original side of thesis because the thesis emphasizes impacts of plan decisions and urban rent on earthquake damage and contribute new viewpoint to literature.

Major sources of the thesis were scanned on internet, and investigated METU library, GAZI University, IYTE, library of the chamber of Architects and city planners and data of the case study was gotten from the greater municipality of Adapazari, and governor of Sakarya.

For understanding earthquake events, Celep and Kumbasar(1992) and Levy and Salvari' studies (2000) provided required knowledge. In those two studies, parameters of earthquake were also determined. UN Global Earthquake Safety Initiative program (GESI) (2002), and Sengezer'studies (1999) suggested that countries that faced to the largest earthquake risk in the world were developing countries and in those studies data related to vulnerability of cities in the world identified risky cities. Moreover, Sengezer'study (1999) defined earthquake risk in Turkey according to ground condition and estimated earthquake damage and losses in possible earthquake. Factors influencing earthquake damage such as building quality, ground condition, high-rise buildings were described. Demirtas' (2000), Ansal' (1999), Erdik' studies (1999, 2001) especially paid attention to mentioned factors.

Keskinok (2000) and Sengül' studies (2001) paid attention to urbanization strategy of Turkey. This strategy gave importance to industrialization and therefore, economic sources of Turkey concentrated on industry and other sectors such as healthy urbanization and housing demand were neglected and they claimed that at location of industry and cities, economic factors have played priority role and decreasing regional imbalance, earthquake risk and ecological factors have been ignored. Also, Dinler' study (1994) explained theoretical base of location of firms. Ertürk (1995) and Ratcliff' studies (1949) explained rent and emphasized role of urban rent on urban development. Harvey' studies (1973, 1985) emphasized absolute and monopoly rent in the contemporary capitalist cities. He criticized neo-classic formulations and paid attention to social actions because he claimed that rent and the scarcity were socially determined. Balamir (1999, 2001) and Ergünay (1999)'studies criticized conventional planning approach to disaster. Britton (2002) and Balamir (2002) described risk management and contingency planning approach and Erdik and Aydinoglu (2002), Erdik (2002) and Iskenderoglu (2002)' studies explained analysis of earthquake damage according to a possible scenario earthquake and described earthquake master plan for Istanbul.

1.2. The methodology of Research

It is important to use a method to prove our claims. Regression and correlation analysis is preferred as a method in order to provide an experimental fundamental and to test claims. In this study form of analysis used is similar to method used in earthquake master plan for Istanbul. Erdik (2002)'study: "Earthquake Risk Assessment for Istanbul Metropolitan Area", Aydinoglu and Erdik (2002)'studies: "Earthquake Risk to Buildings in Istanbul and A Proposal towards Its Mitigation" and metropolitan municipality of Istanbul' Earthquake master plan reports guide to data analysis. However, in those studies, natural factors are dominant such as magnitude of earthquake, liquefaction, and long of fault line although there are some social factors such as population density. On the contrary, the thesis emphasizes social factors on earthquake damage such as urban rent and planning decision. Therefore, contents of analysis is differentiates from studies in Istanbul. In this study, unit of data analysis is defined as scale of district or “mahalle” in Adapazari. Before analysis is started, classification of land value, distribution of damage, the number of story is essential to ensure a uniform interpretation of data and results. Method of the thesis comprises of two steps. Firstly, data such as population density, earthquake damage, the physical building density, and land value (urban rent) in Adapazari is assigned to unit of “mahalle”. After analysis in scale of “mahalle” is completed, correlation and regression analysis through variables are conducted in order to enlighten relationships among earthquake damage and urban rent and plan decisions

The case study includes 26 “mahalle” that takes place in the city centre. Data collected is limited to social risk factors and data is conducted in 26 “mahalle”. Data base for the case study was provided from the greater municipality of Adapazari, the governor of Sakarya, university of Sakarya and Bahar Gedikli’papers. In this study Method of the thesis comprises of two steps. Firstly, data such as population density, earthquake damage, the number of building story, and urban rent in Adapazari is assigned to unit of “mahalle”. After analysis in scale of “mahalle” is completed, correlation and regression analysis through variables are conducted in order to enlighten relationship between earthquake damage and urban rent and plan decision. At first step the study examines that what planning decisions urban rent influence and what their explanatory degree is through regression and correlation analysis. For this step dependent variable is land value or urban rent. Independent variables are population density, distance to the city center and ground area ratio. In the second step dependent variable is proportion of earthquake damage. Independent variables are land value or urban rent, average distance of demolished buildings to the city center and physical building density. Variables coming planning decisions and urban rent and earthquake damage in second step are analyzed through correlation and regression.

This study is comprised of six chapters. The first chapter is the introduction. The second chapter describes natural risk factors. The second chapter includes explanation of earthquake event and the concerning concepts, and forms of earthquake. Also, in the world, earthquake risks are explained.

In the third chapter, socio-economic and technical risk factors related to earthquake are dealt with. This chapter involves national economic policy: Location of Industry and Urban Settlement and its Economic reasons, Housing Problem and Policy, Education and Building Control System, Land Rent Theory and the Role of Urban Rent, Process of the Increase of Urban Land Value, Land Speculation as a Factor in the Increase of Earthquake Damage, Planning, Organizational and Legal Problems and Contingency Planning. This chapter assumes that choices of urban developments based on firms' production policies have determined location of settlements, and thus, external (agglomeration) economies have played important role in location of settlements.

This chapter also shows that individual construction of buildings which is generally non-technical (or poorly designed) and poor material in quality has big risk. While demand for housing is met enough for middle and upper classes, housing demand for poor people is not sufficiently met in urban areas. Therefore, illegal and squatter settlements have been prevalent in urban areas. Particularly, the concern will be over, urban land rent as a risk factor. In this context, various urban rents, characteristics of monopoly rent, absolute rent and bid rent on land value, are taken up. It is emphasized that rent is transfer payment bid by user for using its scarcity (which is most of the times artificial). Majority of the rent value is co-determined by location and private property in land.

Furthermore, in this chapter, conventional planning approach is criticized. This approach is based on post-disaster intervention and has administrative contradictions. After conventional earthquake planning is criticized, ideal risk management and contingency planning process based on pre-disaster activities like earthquake is explained. A sample to ideal risk management and contingency planning process is given. That sample is related to Istanbul that has a big earthquake risk.

The forth chapter includes the methodology of research. In literature, there is not much the same method used in the thesis but in the different context, the same methods and analysis form were used for earthquake master plan for Istanbul to calculate possible earthquake damage. In this study, unit of data analysis is defined as scale of "mahalle" in Adapazari. Before analysis is started, classification of land price, distribution of damage, the number of story is essential to ensure a uniform interpretation of data and results. Method of the thesis comprises of two steps. Firstly, data such as population density, earthquake damage, the number of building story, and urban rent in Adapazari is assigned to unit of "mahalle". After analysis in scale of "mahalle" is completed, correlation and regression analysis through variables are conducted in order to enlighten relationship between earthquake damage and urban rent and plan decisions.

The fifth chapter is devoted to the case study. A city that had experienced past earthquakes and planning changes before 1999 is needed. Three planning practices (1960, 1974, and 1985) and two destructive earthquakes (1967 and 1999) had been experienced in Adapazari. Therefore, Adapazari would be the best area to be tested as case study. With respect to Adapazari, socio-economic structure, development plans, industrial investments, geological structure, land value, urban areas damaged from earthquake in 1999, the data as the number of story, as the number of damaged building is collected. Outcomes and findings are assessed through the procedures defined in the methodology in order to determine the relationship between planning decisions, land price and earthquake damage.

In the last chapter, a general evaluation is made according to the findings and some suggestions for "earthquake-sensitive" planning take place.

If outcomes of analysis between urban rent (land price) and others variable are assessed, it is seen that R square is approximately 52 % and relationships between dependent and independent variables are not strong. However, test of F suggests that linear regression is statistically important. Moreover, when correlation analysis is assessed, relationship between dependent and independent variables is not very strong. The strongest relationship is between urban rent and distance to the city center. The weakest relationship is between urban rent and ground area ratio. Except distance variable, other two independent variables do not provide more contribution in order to explain relationship. Distance only explains land value as approximately 50% but ground area ratio and population density have not more importance on urban rent or land price. When analysis between earthquake damage ratio and other variables is assessed, R square is approximately 63% and relationships between dependent and independent variables are strong but not very much. However, test of F suggests that linear regression is statistically important. When correlation analysis assessed, relationship between dependent and independent variables is not very strong. The strongest relationship is between earthquake damage and distance (69%). The weakest relationship is between earthquake damage and urban rent (35%).

Finally, my assumption about urban rent and earthquake damage was falsified by correlation and regression analysis. However, it does not mean that there is not any relationship between earthquake damage and land value or urban rent. This study only includes socio-economic and technical risk factors. The goal of this study is to understand impact of mentioned factors on earthquake damage.

Moreover, even if natural risk factors want to be added to analysis, it is not possible because geological factors are not convenient with unit of analysis. For example, there is not data of level of underground water and depth of main rock for every district. Thus these data is not includes in analysis. The study is base on experimental approach and the weak relationship between earthquake damage ratio and urban rent is expected result. Also regression and correlation analysis reveal the weak relationship. Natural risk factors and building technology of construction are important in earthquake damage. Thus, the study especially suggests that future research should be directly focused on risk and planning process.

Chapter 2

NATURAL DISASTERS, EARTHQUAKE RISK AND FACTORS

It is a known fact that natural disasters in Turkey have caused to huge damages from both economic and social point of views. Due to the geological conditions, the most hazardous disaster is earthquake which has caused most harm to human life and material. According to the statistics, “Six hundred thousand housing has been damaged from natural disasters for last seven decade. 66 % of this damage was resulted from earthquake, 15 % from flood, 10 % from landslide, 7 % from rock-fall, and 2 % from meteorological events.”(Kiper, 2002, p: 4)

Even though the factors causing earthquake can not be controlled, the control of earthquake damage has been discussed and researched under the studies called risk management. This chapter focuses on concepts concerning disaster and earthquake, causes of natural phenomenon, damage of seismic risk and parameters of earthquake.

What is natural disaster? Urbanology dictionary describes that natural phenomenon will be disaster if it influences and disrupts general life of local communities such as earthquake, fire, flood, avalanche, rock fall (Keles, 2002, p: 639). Actually, reasons of human and loss of goods and disruption of local community’s life are about questioning the relationship with natural process.

How an Earthquake happens? According to the theory of continental drift, the continents are not fixed in position but instead move slowly across the surface of the earth, constantly changing in position relative to one another. Also, this theory suggests that present day continents had once been one large continent that had broken up into pieces which drifted apart. Borders of these plates slide according to each other or overlap each other (Z.Celep, 1992, p: 4). the modern theory of plate tectonics has developed from the theory of continental drift. The theory of plate tectonics suggests that the crust of the earth is divided into six large and many small, tectonic plates that drift on the lava that composes the inner core of the earth. These plates consist of ocean floor and continents that quite probably began breaking up and moving relative to one another more than 200 million years ago(Levy and Salvari, 2000, p: 31). Figure 1 provides plates on the world.

Figure 2.1: Plates on the World (http://www.sayisalgrafik.com.tr/deprem/index.htlm)

Plate actions and getting cold liquid magma press below the crust of the earth and other press change factors cause to accumulate stress below the crust of the earth. Furthermore, the crust of the earth is cut many places with faults. Accumulating stress below crust of the earth on weak line suddenly cause to slide along faults. Therefore, in along time, accumulation of stress results from discharge of energy of shape change through slide action. These events cause to slacking on the crust of the earth. If earthquake does not often occur, on fault line stress starts to accumulate again (Z.Celep, 1992, p: 4)

Not only slide region can place near the ground but also it can place depth of the ground. Focal point of the earthquake is called hypocenter whose depth gives important information about damage. Although deep earthquakes show less impact concerning damage on built environment, they are felt widespread field. On the contrary, shallow earthquakes show more impact on epicenter and their effects are felt a narrower field. Point on the hypocenter is called epicenter which is the most important region that earthquakes are felt the strongest. Magnitude is one of the basic parameters of earthquake concerning damage in built environment.

Distance from hypocenter to epicenter is defined as depth of focal that is also measure of earthquake depth. If the depth is less than 60 kilometers, it is defined shallow earthquakes. If the depth is between 60 km and 300 km, it is defined as middle deep earthquakes. If the depth is more than 300 km, it is deep earthquakes. While deep earthquakes influence less on surface, it is felt in extensive environment. On the contrary, while shallow earthquakes impact large on surface, it is felt in less extensive environment. In Turkey, shallow earthquakes generally occur and their depth varies between 10 km and 30 km. Frequency of earthquake decreases according to the depth. As pointed out before, the most hazardous and destructive earthquakes are shallow ones (Z.Celep, 1992, p: 8).

Figure 2.2: Normal fault

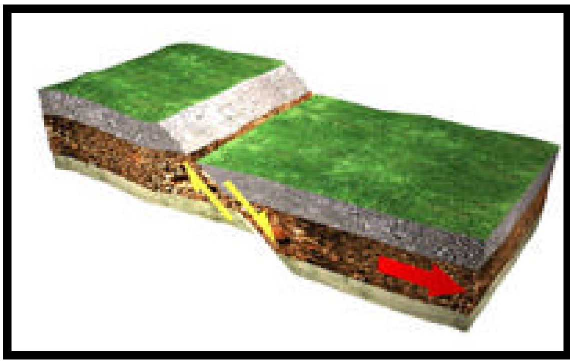


Figure 2.3: Reverse fault

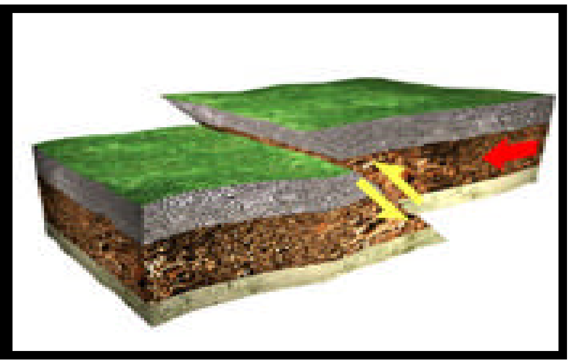
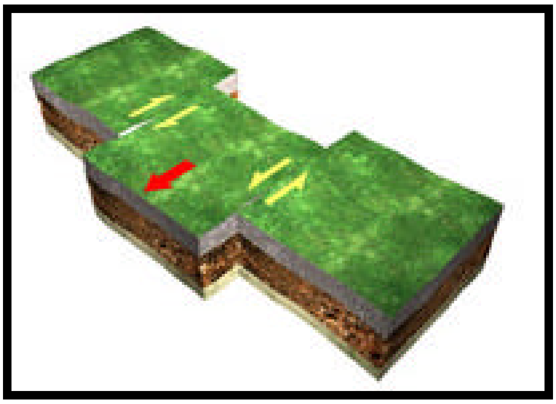


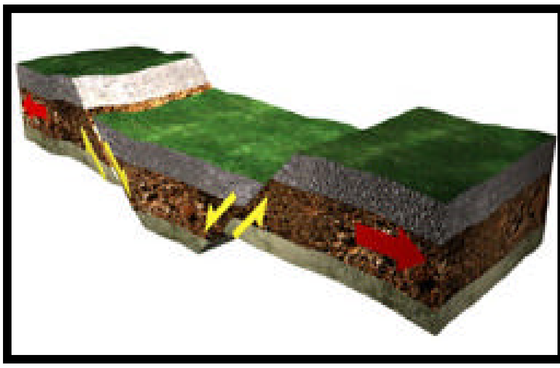
Figure 2.4: Lateral fault

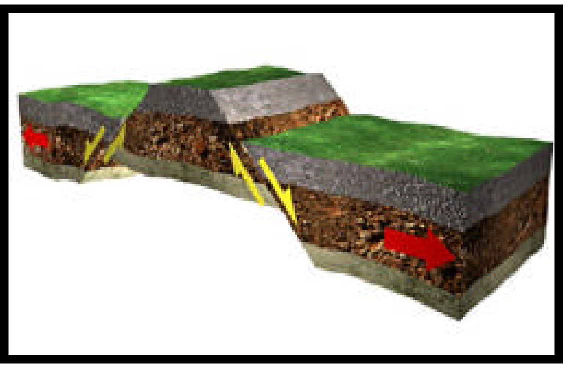


Source: http://www.sayisalgrafik.com.tr/deprem/index.htlm

There are two kinds of fault. One of them is defined as normal or reverse fault and the other is defined as lateral fault. Figure 2.2 provides action of normal fault and figure 2.3 provides action of reverse fault. In normal or reverse fault, each block move to down or up according to one to another. Figure 2.4 provides action of lateral fault. In lateral fault, each block usually move to different ways and seldom the same ways according to one to another (Bilim ve Teknik 382, 1999, p :). Figure 2.5 provides subsidence of land and figure 2.6 provides elevation of land.

Figure 2.5: Normal Fault   Figure 2.6:Reverse Fault, Elevation type of land





Source: http://www.sayisalgrafik.com.tr/deprem/index.htlm

Actually, there are a lot of factors concerning earthquake damage. It is the most important fact that human being has intervened into nature in wrong ways. Therefore, earthquake damage increases. When it is assessed the damage, it must be looked at from a wide perspective. This perspective must contain from large scale to small scale.

Moreover, there are some risk factors related to earthquake damage in Turkey. These can be generally described as natural, social, economic and technical factors. Natural factors that constitute risks related to earthquake damage include intensity and magnitude of earthquake, distance of settlements to hypocenter and epicenter of earthquake, shallow of earthquake, liquefaction areas, depth of underground water, soil types such as alluvial, clay and sandy soil.

Social factors that constitute risks related to earthquake damage include city and regional planning practice, illegal construction and squatter settlements, unaware of earthquake event, form of building construction, quality of building production, insufficient control system and inspection of building construction, housing problem, urban rent and land speculation, planning changes.

Economic factors that constitute risks related to earthquake damage include policy of industrial location, urbanization process, undeveloped and economic policies, urban rent, population and building density in built environment in major cities.
Technical factors that constitute risks related to earthquake damage include codes and regulations concerning earthquake, order of building, number of floor, resonance between ground and building period.

2.1. Overview Earthquake Risk on the World

When earthquake risk assesses on the world scale, the risk varies according to the level of magnitude development scale of countries, per capita income in countries, population and building density, settlements on continental plate or fault line.

The earthquakes intensify along active fault line or plate borders on the earth. There are two major earthquake belts on the earth. One of them is pacific earthquake belt which surrounds Pacific Ocean and especially impacts on Japan. The other is Alp-Himalayas belt which starts from Cebeli Tarik to islands of Indonesia. The latter especially impact on Turkey (Science and Technique 382, 1999, p: 21).

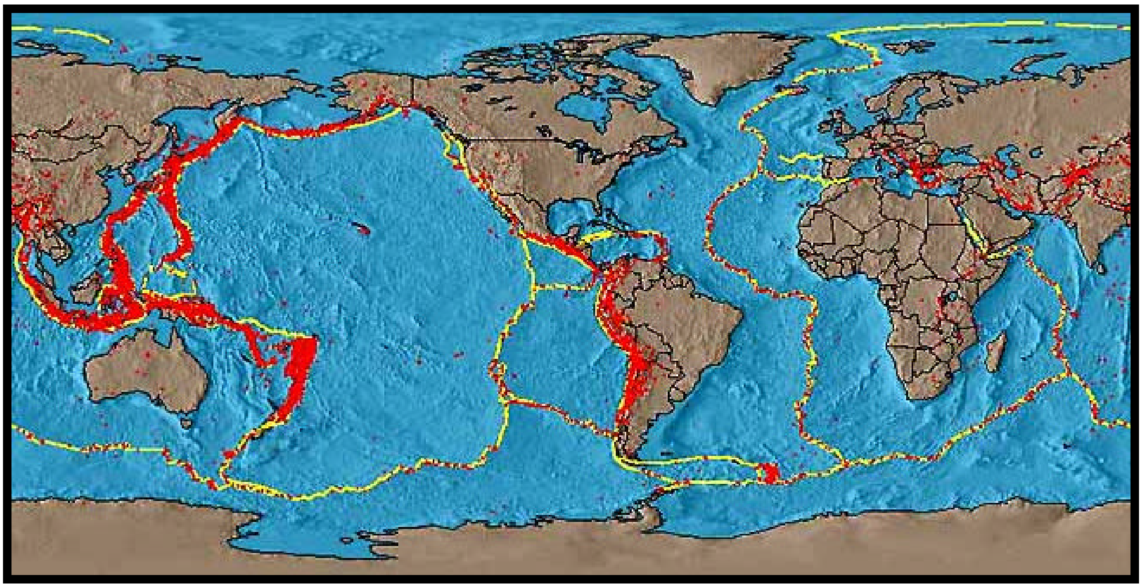


Figure 2.7: Fault **L**ines in the World Map **(http://hum.amu.edu.pl/~zbzw/)**

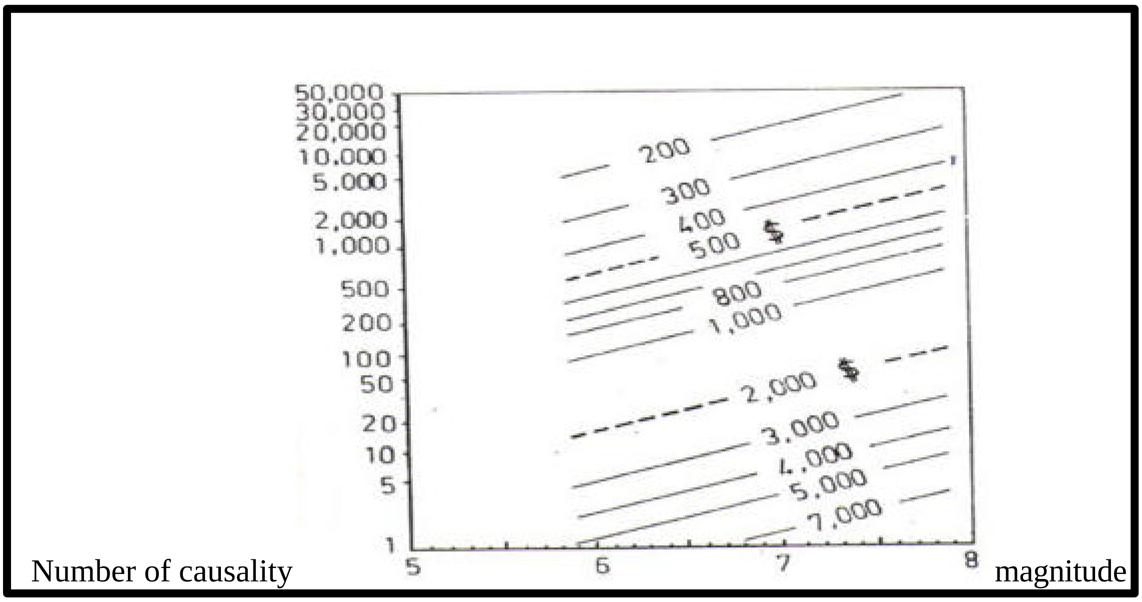
While large earthquakes take place along coast, small earthquakes take place along borders of divergent plates in middle of ocean. 70% of continental earthquakes occur

surrounding of pacific plate, 20 % of them occur along alp-Himalaya range belt and 10% of them distribute on the earth (Levy and Salvari, 2000, p: 31).
Main reason for high vulnerability in Developing countries is that they aim to reach to a level of industrialized countries in short run. For this reason, they overlook environmental and social risks. In the world, impact of earthquakes is especially significant for mega-cities which have vulnerable physical elements and more socioeconomic problems arise. “Natural disaster, especially earthquake risk in urban centers of both developed and developing countries have increased. The increase in developed countries is due to aging urban systems and population, greater dependence on technology and simply, having more value exposed to risk. Whereas in developing countries the main sources of the increased seismic risk can be attributed to overcrowding, faulty land use planning and construction, inadequate infrastructure and services and environmental degradation. Furthermore, the mega cities in developing countries are comparatively more vulnerable to earthquakes than those in developed countries since scarce capital resources of the former do not generally encourage construction practices to the same degree of earthquake safety (Erdik, 1999, p: 363)

Cities are complex economic activities other than agricultural. Industry and service provide economic base. A lot of activities take place together in limited space. These activities and the density are resource of risk and hazard. Risk is sometimes taken as synonymous with hazard. Hazard is an inevitable part of life. An earthquake or an accident can happen in any time but risk has the additional implication of the chance of particular hazard actually occurring. Thus we may define hazard as a potential threat to humans and their welfare and risk as the probability of hazard occurrence. Vulnerability is the factor which determines the severity of risk (Ilgen, 1999, p: 563).

There are some elements at risk in urban areas from socio-economic, infrastructure point of view. These elements include urban demographic structure, building stock and its classification, lifeline and infrastructure such as major roads, railroads, bridges, overpasses, public transportation, power distribution, water, sewage, telephone, and natural gas distribution systems including their nodal points such as stations, pumps, switchyards, storage systems, transmission towers, treatments plants, airport, marine port etc, major and critical facilities such as dams, power plants, major chemical and fuel storage tanks (Erdik,1999, p: 364).

Figure 2.8: Relation of GNP ($), Magnitude and Causality according to data of 1972



Source: Sengezer, 1999

If GNP (Gross National Product) of a country is high, in a probable earthquake, causality and material losses decrease. Figure 2.8 and table 2.1 shows that between developing countries and industrialized countries, dimensions of earthquake damage summarizes.

Table 2.1: Comparison of Developing and Industrialized Countries from Earthquake Damage Point of view

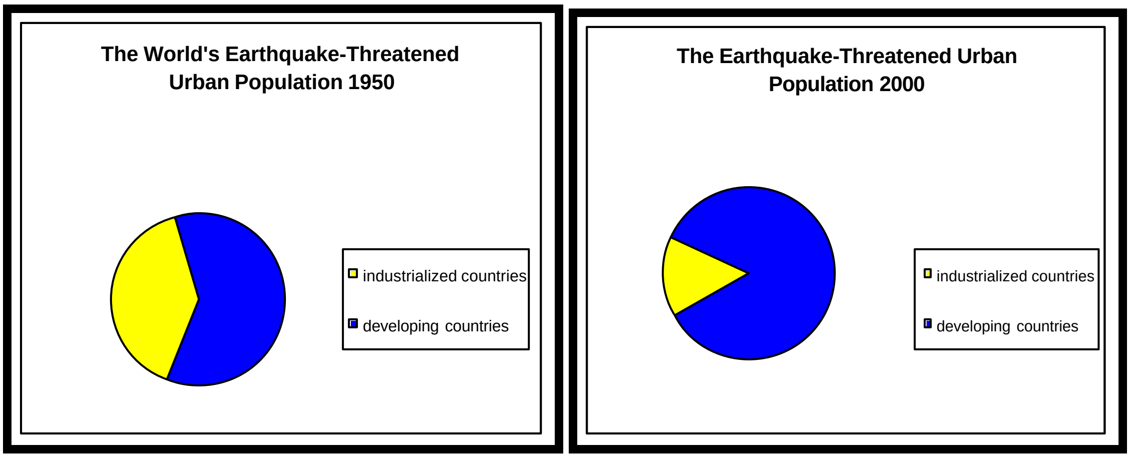
	Countries	Date of earthquake	Magnitude	Number of dead people	Homeless People	Injured People
Developing Country	Turkey	17 /08/1999	7.4	18.000	600000	32.000
Developing Country	Algeria	10/10/ 1980	7.3	2.590	330.000	
Developing Country	India	30 /09/ 1993	6.4	22.000		
Developing Country	Philippines	16 /07/ 1990	7.7	2.000	148.000	3.500
Developing Country	Iran	21 /06/ 1990	7.7	35.000	500.000	100.000
Developing Country	Armenian	7 /12/ 1988	6.9	25.000		18.000
Developed Country	Italy	23 /11/ 1980	7.2	2.735		7.500
Developed Country	Japan	17 /01/ 1995	7.2	6.500	300.000	20.000

Haphazard urbanization, population movement from rural areas to urban areas, and population concentration in several urban areas or regions increase the disaster vulnerability in illegal, uncontrolled urban areas and low income urban dwellers. However, if the existence legal building stock is not inspected enough, vulnerability can be high for legal stock.

The population of the world in urban area has been increasing and therefore, building and population density are increasing. However, the increase in density and population is imbalance between developed and developing countries. In 1995, 2.4 billion people were living in cities, out of the world's total population of 5.7 billion. The number of urban dwellers will double by 2025 to nearly 5 billion people. Urbanization is more rapid in developing countries. Cities over one billion people increased six folded between 1950 and 1995 from 34 to 213. The number of people affected by disasters has been growing 6% each year since 1960. Of these victims 90% have been affected by natural disasters in many urban areas (Ilgen, 1999, p: 564).

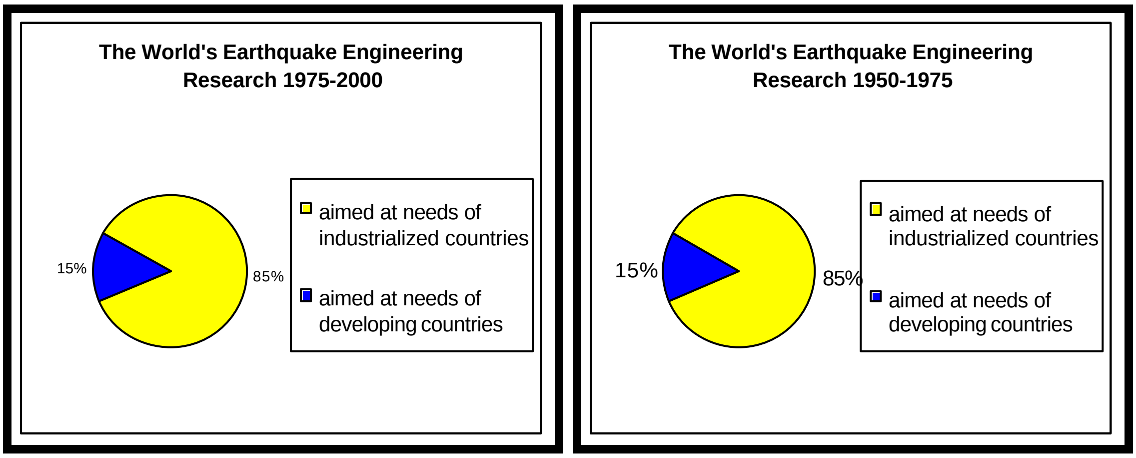
According to United Nations data, urban earthquake risk is the greatest and rapidly growing in developing countries. Figure 2.9 shows the world's urban population is becoming more earthquake threatened, particularly developing countries. While more than half the urban population at risk from earthquake lived in developing countries in 1950, in the year 2000, that number increased to more than 85%. Furthermore, while developing countries bear disproportionate burden of earthquake risk, they have been spending less than industrialized countries on earthquake engineering research which is aimed at their needs. Figure 2.10 provides that the portion of earthquake engineering research in developing countries remains small (http://www.geohaz.org/project/gesi/gesilintro.htm).

Figure 2.9: The World's Earthquake-Threatened Urban Population between 1950 and 2000.



Source: http://www.geohaz.org/project/gesi/gesilintro.htm

Figure 2.10: The World's Expenditures on Earthquake Engineering Research between 1950 and 2000.

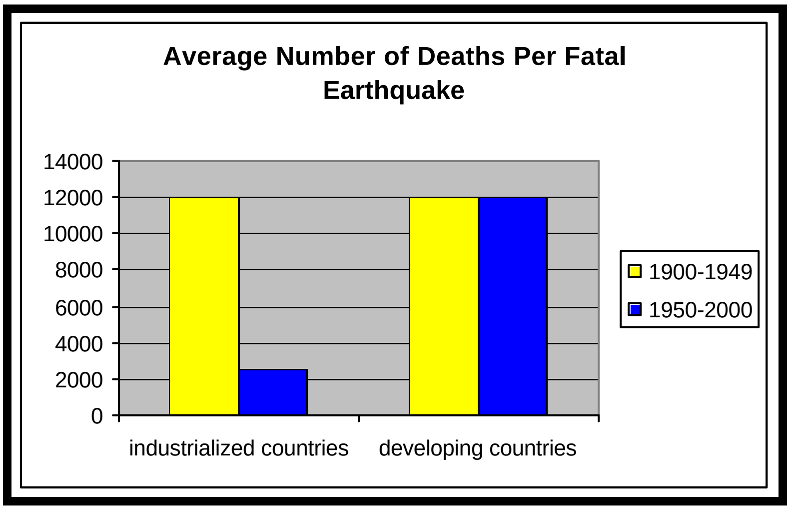


Source: http://www.geohaz.org/project/gesi/gesilintro.htm

Tucker (1994) estimated that over the last 50 years, the portion of the world's annual earthquake engineering research focused on the needs of developing countries has remained fixed at about 15 %. Moreover, the consequences of this difference are not surprising. Over the last century, the average deadly earthquakes in USA and Japan decreased while the average deadly earthquakes in developing countries remained high level. According to the office of US foreign Disaster Assistance (Labat-Anderson 1991), both developing and industrialized nations suffered nearly twelve thousand deaths per lethal earthquake in the first half of 20th century. In the latter half, the number of deaths per earthquake in industrialized nations dropped by an order of magnitude, with no corresponding decrease for developing nations (http://www.geohaz.org/project/gesi/gesilintro.htm).

Figure 2.11 provides during the last century, the lethality of earthquakes in industrialized country has decreased by a factor ten (presumably as a result of better construction design and practice, urban planning and emergency response), while the lethality of earthquakes in developing countries has remained high.

Figure 2.11: Average Number of Deaths per Fatal Earthquake in developing and industrialized countries between 1900 and 2000



Source: http://www.geohaz.org/project/gesi/gesilintro.htm

It is clear that something should be immediately done to alleviate the urban earthquake risk of developing countries because it seems earthquake will continue to cause greater human and economic losses in developing countries. United Nations Centre for Regional Development (UNCRD) initiative some program for risk cities in order to reduce disaster effects. It includes design of community based projects for disaster management planning, school earthquake safety project and Disaster management capacity building to introduce best practices case studies on disaster management in developing countries. For this reason, some cities were selected in order to reduce disaster risks. Program includes Antofagasta- Chile, Bandung- Indonesia, Delhi- India, Guayaquil- Ecuador, Islamabad/Rawalpindi- Pakistan, Istanbul- Turkey, Izmir- Turkey, Jakarta- Indonesia, Kathmandu- Nepal, Kobe- Japan, Manila -Philippines, Mexicali- Mexico, Mumbai- India, Nagoya-Japan, Quito- Ecuador, San Salvador- El Salvador, Santiago- Chile Tashkent- Uzbekistan, Tijuana- Mexico, Tokyo- Japan, Vancouver- Canada.

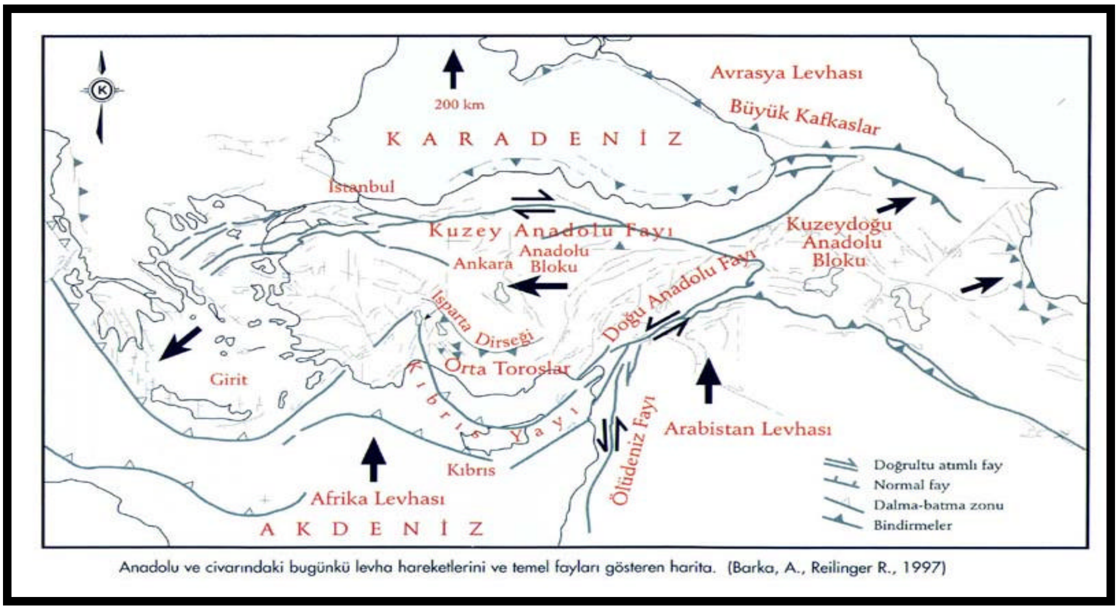
Furthermore, over 85% of the world's urban population at risk from earthquakes lives in developing nations, yet, the study notes, only 15% of research in earthquake engineering is focusing on problems in these regions of the world. This imbalance reflects the rapid urbanization of poor countries as well as the higher investment in modern architecture and disaster response among nations that are already industrialized.

Over 95 million people live in the 21 cities studied so far. In addition to beginning the two studies now funded in Mexico and Central Asia, UNCRD wants to extend this work to hundreds more communities. There are over 380 cities with populations over one million that are at high risk from earthquakes. UNCRD suggests that this risk is knowable, and in each city UNCRD recommends specific solutions to reduce the risk. Furthermore, consequences of school earthquake safety project show that death probability of a school child in developing country is higher than a school child in developed country. For example, in Kathmandu, Nepal is 400 times more likely to be killed by an earthquake than a school child in Kobe, Japan and 30 times more likely than a school child in Tashkent, Uzbekistan. In Latin America, a school child in Mexicali, Mexico is 1.5 times more likely to be killed than a school child Quito, Ecuador and about 30 times more likely than a school child in Antofagasta in Chile. However, with activities of mitigation and preparation such as retrofitting or rebuilding key buildings, emergency response plan, effect of earthquake and other disasters can be reduced. Also, mitigation does not cost much than post-disaster operation and it has the potential to save thousands of lives. The cost of rebuilding after an earthquake such as those in India and El Salvador is vastly higher than the cost of mitigation and preparation (http://www.geohazard.org).Also the UN report shows that city of Tokyo in Japan, which is one of the most prepared cities in the world, ten thousand people will die in a probable earthquake and city of California in the USA during traffic congestion, fifteen thousand people will die and fifty thousand people will be injured in a probable earthquake. City of Istanbul in Turkey, estimations show that fifty-five thousand people will die in a probable earthquake. (Radikal, 14/10/2002, http://www.radikal.com.tr).

2.2. Earthquake Risk in Turkey

Turkey is on one of the two most dangerous faults on earth called Alp-Himalaya fault. Earthquakes in Turkey are ground movements along active cracks depending on the tectonic process between Arabic-Africa and Eurasia continents. According to the annual statistic taken in the last two thousand years, Turkey is one of the most risky countries where a destructive earthquake occurs in every 1.1 years (Kirbas and Ermez, 1999, p: 606). Figure 2.12 provides plates and faults impact on Turkey.

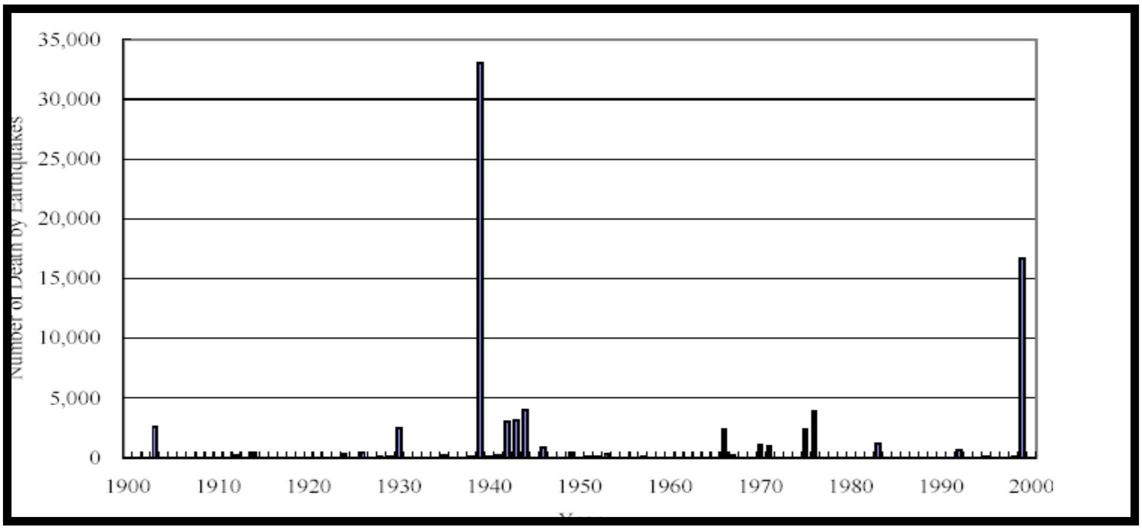
Figure 2.12: Plates and Faults on Surrounding of Turkey



Source: Levy and Salvari, 2000

Turkey had suffered losses of life and property due to earthquakes over many centuries. So far in this century there have been earthquakes that caused loss of life in Turkey with total of over 110,000 deaths, about 250,000 hospitalized injuries and close to 600,000 destroyed housing units (Erdik, 2001, p: 1). Figure 2.13 provides alteration of number of death by earthquakes in last century. At the last decade, cities that have high urban population have extensively damaged from earthquakes, from housing unit, lives lost and economic losses point of view. Table 2.2 provides losses in last decade.

Figure 2.13: number of death by earthquakes in last century in Turkey



Source: IBB, 2003, P: 2

Table 2.2: Earthquake losses in Turkey: 1992-1999

Earthquake (Date,dd.mm.yy)	Lives Lost	Housing Units Damaged	Housing Units Collapsed or Razed	Number of Persons Left Homeless	Estimated Total Economic Loss, in $B
Erzincan (13.3.1992)	645	8000	1450	8000	0.75
Dinar (1.10.1995)	100	6500	2043		0.25
Adana-Ceyhan (28.6.1998)	150	21,000	2000	24,000	0.5
Kocaeli (17.8.1999)	>18000	320,000	26 000	600,000	>20
Düzce (12.11.1999)	812	10,100	800		1

Source: Gülkan (2002)

Turkey has been settlement area for civilizations and human being since beginning of human history. Reasons for settlement area have had appropriate conditions for living. "At the macro level, choice of settlement locations in Turkey for instance, has historically favoured fertile valleys that take place in between major geological formations, which are rich in accumulative organic material, but weak in structural carrying capacity, and are the worst places to be at the incidence of an earthquake. Availability of water sources and warm springs are additional attractions to these zones where major geological faults prevail. Most settlements and investments are made at such locations instead of avoiding these weak soils for construction and keeping them at agricultural production only. With the alignment of roads and public infrastructure alongside these valleys and plains, such nodes become economically more attractive, concentrating further all human and productive resources at vulnerable lands collectively generating high risk"(Balamir, 2001, p: 2).

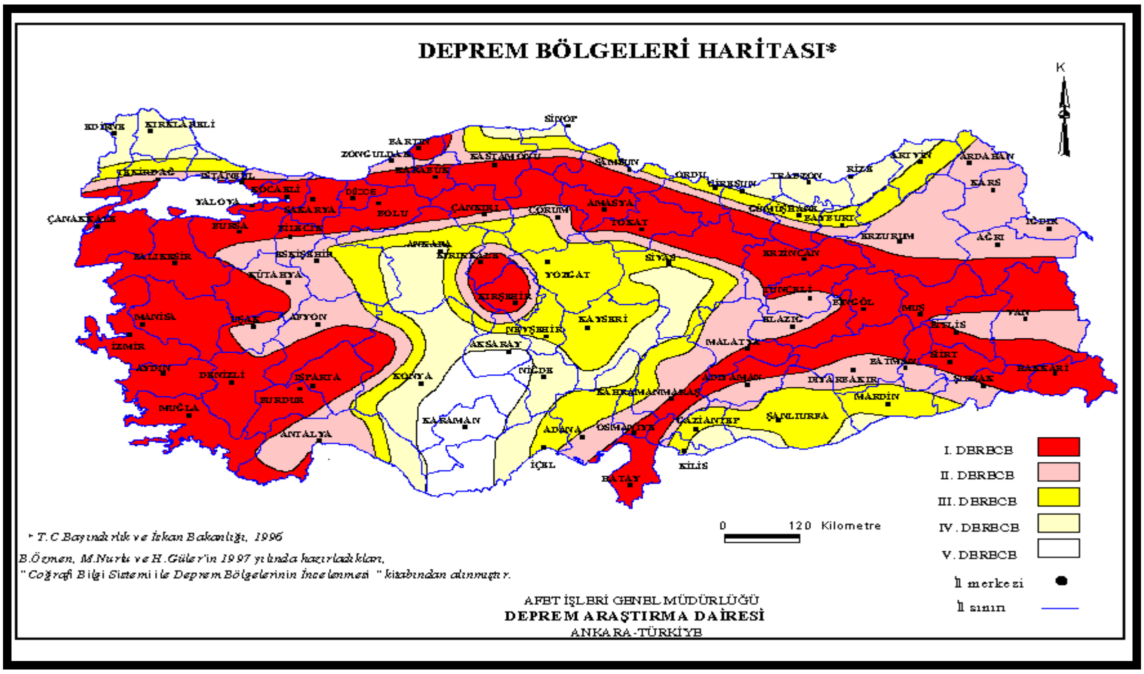
Table 2.3: Population, Area and Power Central Distribution According to Earthquake Zoning Map

Earthquake zone	Field ($km^{2)}$	%	Population in 1990	%	Number of power central	%
1st degree earthquake zone	328.995	42	25.052.683	44	65	52
2nd degree earthquake zone	186.411	24	14.642.950	24	28	23
3rd degree earthquake zone	139.594	18	8.257.582	15	15	12
4th degree earthquake zone	97.894	12	7.534.083	13	14	11
5th degree earthquake zone	32.051	4	985.737	2	2	2
Total	784.985		56.473.035		124	

Source: Kiper, 2002, p: 4)

Moreover, 96 % of Turkey is located in first, second, third and fourth degree earthquake zone and percent 98 of the population is living in these four earthquake zones. Figure 2.14 provides earthquake zone map of Turkey. Also majority of power central, 75%, is taking place in first and second degree earthquake zones. Table 2.2 provides population, area and power central distribution according to earthquake zoning map.

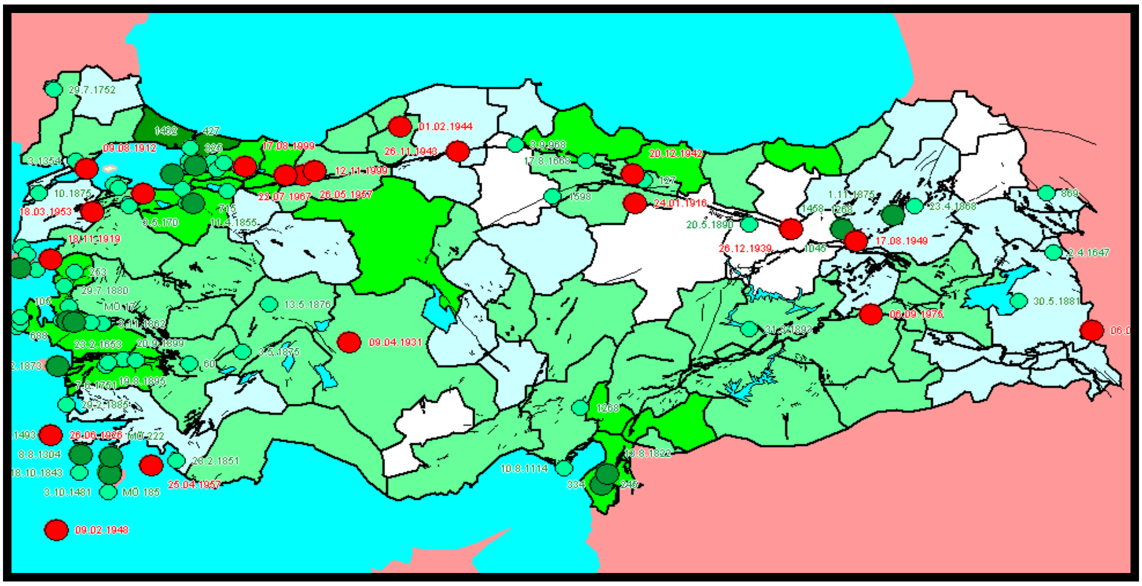
Figure 2.14: Earthquake Zoning Map of Turkey



Source: General Directorate of Disaster Affairs Earthquake Research Department

Earthquake zone map of Turkey was constituted by the statistical occurrence of seismic events and Turkey was divided into five macro-level regions according to earthquake probability. In each region, various design standards are applied for engineering design safety of buildings through a regulation of the Disasters Law. The map assumes that a building with engineering design, which has 50 years of economical life, may not be exposed larger than these expected maximum acceleration values with 90% probability (http://www.deprem.gov.tr). The earthquake zone map of Turkey which prepared in 1972 was used until 1996 and it was updated in 1996. Between two maps there are some differences. Earthquake Zone degree of Mugla, Antalya, Bay of Edremit, Aegean and Mediterranean shores was changed in 1996. Also, earthquake zone degree of Istanbul was changed form second degree to first degree earthquake zone (Sengezer, 1999, p: 329). While 63 % of population of province and county including census 1990 center took placed in 1st and 2nd degree earthquake zone According to Earthquake zoning map of Turkey in 1972, 60 % of population of province and county including census 1990 center took placed in 1st degree earthquake zone, 14.7 % of population in 2nd degree earthquake zone, 12.3% of population in 3rd degree earthquake zone, 11.8 % of population in 4th degree earthquake zone and 0.9 % of population in 5th degree earthquake according to Earthquake zoning map of Turkey in 1996. Map of 1996 show that other important and big cities except Ankara, Kayseri, Konya, Erzurum, Trabzon, Ordu, Sivas, Gaziantep and Urfa take place in 1st and 2nd degree earthquake zone (B. Sengezer, 1999, p: 334).

Figure 2.15: Fault Line, Big Earthquakes and Population Density of Provinces

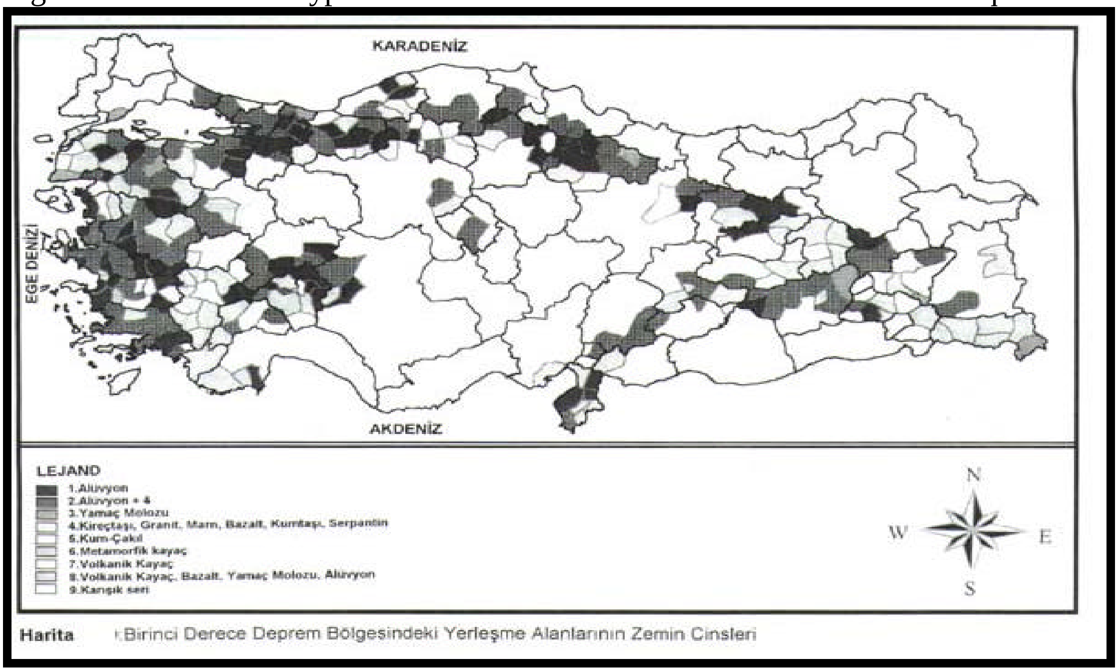


Source: http://www.sayisalgrafik.com.tr/deprem/statik/cerceve.htm

In Turkey, for buildings at risk, vulnerability is not exactly calculated because majority of building stock consists of illegal, non- engineering construction and also the existence legal building stock exactly do not meet the earthquake design codes.

Moreover, Varying land condition and ground condition cause to differentiate in impact of earthquake. Earthquake engineering shows that buildings which have solidity elements are stronger than others. Because of haphazard and unplanned urbanization, areas which are selected for settlements have been productive agricultural lands. These agricultural and alluvial lands are sensitive areas for the earthquake. The earthquake is felt stronger than usual in these areas. Different earthquake observations and experiences show that intersection areas of near of lateral discontinuity areas and different ground formations have been more earthquake damage and intensity (Erdik, 1999, p: 17). Figure provides ground types at the first and second degree earthquake zone. It shows that many cities locate on both alluvial ground and the first and second degree earthquake zone.

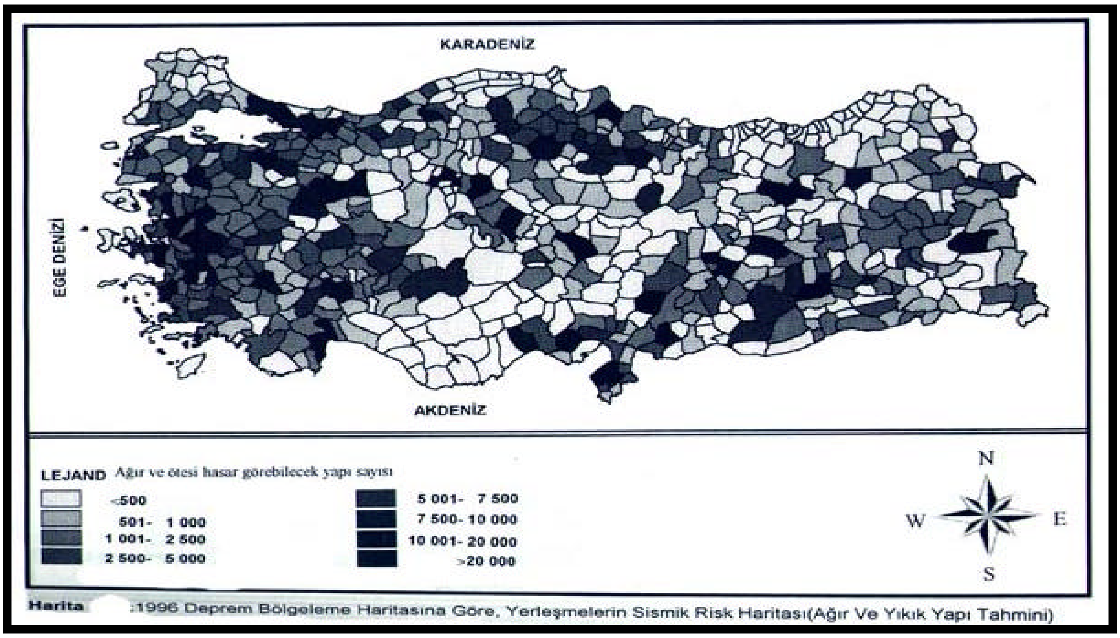
Figure 2.16: Ground Types of Settlements at the First and Second Earthquake Zone



Source: Sengezer, 1999

According to seismic risk map of Turkey including census 1990, which reflects loss estimation in Turkey, the map (figure 2.17) shows heavy and destroyed buildings in expected earthquake at the same probability. In this seismic map, İstanbul has the highest risk and estimations show that 130.000 buildings will be damaged heavily or destroyed and Izmir follows Istanbul. Estimations show that 86.000 buildings will be damaged heavily or destroyed in Izmir. After Izmir, Bursa has high risk. Estimations show that 56.000 buildings will be damaged heavily or destroyed in a probable earthquake (Sengezer, 1999, p: 334).

Figure 2.17: Estimation of Heavy and Extensive Building at seismic risk map of settlements in Turkey according to earthquake zone map



Source: Sengezer, 1999

Although, cities like Konya, Gaziantep,Diyarbakir, Antalya are not located in dangerous regions in the seismic risk map, these cities have more risk than small cities or less population cities. It results from population and building density.In Turkey, the biggest magnitude earthquake at some settlements is in Table 2.4 in last century

Table 2.4: The biggest Earthquakes in last century in Turkey

Settlements	Year	Magnitude	Causality
Düzce	1999	7.2	860
Izmit	1999	7.4	18.000
Adana-Ceyhan	1998	6.3	145
Erzincan	1992	6.3	486
Erzurum-Kars	1983	7.1	1.300
Çaldiran	1976	7.9	4.000
Lice	1975	6.8	2.300
Bingöl	1971	6.8	755
Gediz	1970	7.4	1.100
Adapazari	1967	7.5	89
Pülümür	1967	6.0	97
Varto	1966	6.9	2.500
Manyas	1964	6.6	23
Fethiye	1957	7.1	67
Abant	1957	7.1	25
Gönen	1953	7.2	1.200
Karliova	1949	6.7	450
Varto	1946	6.0	839
Gerede	1944	7.4	3.959
Niksar	1942	7.3	3.000
Erzincan	1939	7.9	30.000
Sivas	1929	6.5	64

Source: Levy and Salvari, 2000, p: 86

2.3. Local Ground Condition, Quality of Building and Material and High-rise Building

Local ground, earthquake and building features have important roles in increasing of human and good losses. “Changing thickness and sort of ground layers and underground water level cause damage in short distance in different regions at different levels”(Ansal, 1999, p: 50).

Ansal summarized damaging influence of ground condition in four items.

- ? Enlarging earthquake features of ground
- ? Collapsing and sliding in ground layers
- ? Liquefaction of ground
- ? Losing stability in slope of a hill (Ansal, 1999, p: 50).

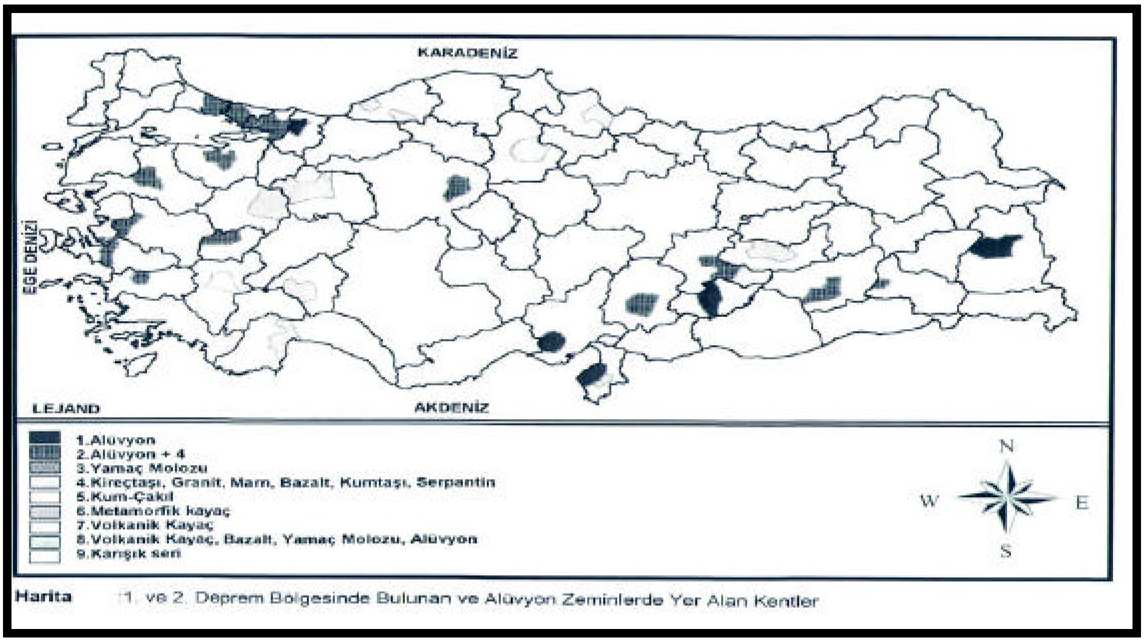
Furthermore, according to observations of peak ground acceleration, on rocky lands, earthquake intensity is less than percent 40, but on the soft area, intensity is more than percent 40 and on the stiff and middle stiff areas, intensity is not important (Erdik, 1999, p: 17).

Lithology, geological age, depth of underground water, data of standard penetration test gives important knowledge about sensitive of liquefaction. Lands which underground water level below 3 meter and younger river accumulation more than 1000 years and including sand have the most sensitive areas. Depth of underground water is the most important parameter for sensitive and this parameter is influenced from development condition, raining, using underground water. Criterions of Liquefaction sensitive are the fallowing:

- ? Saturated alluvial sand layers starting from surface of ground in first 20 meters
- ? Underground water starting from surface of ground in first 10 meters
- ? D50 value changing grain of sand in accumulation curve between 00.2 and 2 millimeters
- ? Stroke number of Standard penetrations test, N30. Moreover, the most sensitive materials to the earthquake are that soft sands, cracked rocks, unsaturated soft sand, sensitive clay layers and small stone (Erdik, 1999, p: 18).

In Kocaeli, most of earthquake damage took placed on the shore, alluvial sands, and filled ground. These filled and alluvial grounds against the earthquake are the weakest areas. Similar damage took placed Mariana regions located on dried marsh in Loma Prieta in 1989. Also, in 1995, similar damage took placed these kinds of ground at Kobe earthquake. For this reason, differentiations of ground bring together differentiations of damage. Along shore, buildings on filled areas from the sea completely collapsed at Kocaeli earthquake. However, remote areas from the sea and rocky ground lessened the damage. Similar events took placed in Adapazari. Settlements located on high, rocky ground and out of downtown did not consist of damage (Demirtas, 2000, p: 192).

Figure 2.18: Cities Located On both First and Second Degree Earthquake Zone and Alluvial Ground



Source: Sengezer(1999)

According to map prepared by Ahmet Tabban, number of cities which are exceeding 100.000 people, located first and second degree earthquake zone and alluvial ground is eighteen(figure 2.18). And these cities must first be investigated. The number of the cities with the population growth rate above the national average is fourteen. These cities are Van, Siirt, Diyarbakir, Malatya, Adiyaman, Adana, Usak, Aydin, Izmir, Manisa, Balikesir, Bursa, Kocaeli and Istanbul. Van, Malatya, Adiyaman, Adana, are completely located on alluvial ground (Sengezer, 1999, p: 366).

Liquefaction and weakness of ground carrying capacity play important role on building damage. Nevertheless, a lot of demolished buildings in Kocaeli earthquake collapsed by also additional factors. For example, ground improvement was not done for the purpose of minimizing building cost and convenient ground system was not used. Durable performances of high- rise concrete framework buildings in Turkey are quite worse than industrialized countries. In Erzincan earthquake in 1992, 50% of 4-6 floors reinforced concrete buildings completely must have been demolished or repaired seriously. This proportion in Erzincan earthquake is nearly four times from Hanshin earthquake in Japan in 1995 and twelve times from Northridge earthquake in USA in 1995. Moreover, observations show that poor concrete and iron in quality are used in carrying system in order to minimize building cost. Actually, cost of concrete and iron has 10% shares in total cost of construction (Demirtas, 2000, p: 192)

Table 2.5: Karot Pressure Durable of Buildings demolished by Kocaeli Earthquake

buildings in Bagcilar	Karot pressure durablity	buildings in Avcilar	Karot pressure durablity	buildings in Adapazari	Karot pressure durablity
A	11.4	A	12.7	A	10.3
B	7.7	B	11.4	B	9.2
C	9.6	C	4.5	C	32.6
D	4.0	D	6.2	D	18.8
E	6.4	E	7.5	E	

Source: Yapi Rehberi, 1999

After Kocaeli earthquake, observations in Bagcilar, Avcilar and Adapazari showed that some buildings did not have necessary value of pressure durability. Even though at some specific regions and buildings, value of pressure durability of buildings were necessary at level of BS16 (standard of concrete) or BS20, observations were less than usual. Above Table 2.5 shows value of pressure durability of buildings. According to the table, average pressure durability in Bagcilar is 7.8 (N/mm^2) and average pressure durability in Avcilar is 8.4(N/mm^2). These are not enough pressure durability (Yapi Rehberi, 1999, p: 212-214).

Table 2.6 summarizes that earthquake intensity, ground acceleration, velocity of ground vibration impact on the sort of building and according to those parameters, it estimates expected damage on building types such as reinforced concrete, good wooden building, sun-dried brick, brick building.

Table 6: Relations among intensity, ground acceleration, speed and damage in sort of building (http://www.deprem.gov.tr)

Intensity	Ground acceleration (gal) (for 0.1-0.5 sn period interval)	Ground shake (for 0.5-2 sn period velocity cm/sn interval)	Sort of building*		
			Ax	Bx	Cx
V	12-15	1.0-2.0	5 % light damage	-	-
VI	25-50	2.1-4.0	5%moderate damage 50% light damage	5% light damage	-
VII	50-100	4.1-8.0	5 % ruins 50% heavy damage	5% moderate damage	5% light damage
VIII	100-200	8.1-16.0	5% much ruins 50 % ruins	5% ruins 50% heavy damage	5% heavy damage 50% moderate damage
IX	200-400	16.1-32.0	50% much ruins	5% much ruins %50 ruins	5% ruins 50% heavy damage
X	400-800	32.1-64.0	75% much ruins	50% much ruins	5% much ruins 50 % ruins

*Type A: rural housing, sun-dried brick building, rubble stone buildings mixed with lime or mud.

Type B: brick building, hewn stone, concrete brick and light prefabricated building.

Type C: reinforced concrete building, good wooden building

Causes of huge damage in buildings can be summarized the following those:

? When building is constructed, underground drainage is not done

? Being short at Intersection point of Iron of Joist and colon

? Changing application of colon place at upper floor

? Breaking colon at Basement or ground floor

? Using sand of the sea etc

? Resonance between adjacent buildings because of inadequate empty space (TMMOB, 2000).

Chapter 3

REASONS OF HUMAN LOSS AND ECONOMICAL DAMAGE OF EARTHQUAKES

In this chapter, social and economic risk factors related to earthquake damage will be explained. These factors include location of industry and urban settlement and economic reasons, housing problem and policy in Turkey, role of urban rent and land speculation on urban development and conventional planning process and organizational problems.

Geologic map, tectonic map and earthquake zone map in Turkey were essentially prepared and published between 1940 and 1950 by Ministry of Construction and Settlement and Association of Mining and Technical Search. Also, investigations about structure of cities and regions such as Kocaeli, Zonguldak, Kozlu, Kilimli, Catalagiz and Marmara region were made in 1960s by Iller Bankasi. However, scientific findings have not attracted full attention and consequently, Turkish people have given huge economic, social and physical losses.

3.1. National Economical Policies: Location of Industry and Urban Settlement and Economic Reasons

One of the main reasons of earthquake damage in Turkey is the preferred development strategy. This strategy gives importance to industrialization and therefore, economic sources of Turkey have concentrated on industry and other sectors such as healthy urbanization and housing have been neglected. since1950, at location of industry and cities, economic factors have played priority and decreasing regional imbalance, earthquake risk and ecological factors have been ignored. As a result of these preferences, locations of industrial firms have only founded in the most profitable and productive places. There are two factors in the choice of these places. The first is transportation expenditure and the latter is external economies.

If transportation expenditure increases in general cost, firms change their location in order to decrease cost. If a firm is not located optimally such as to minimize transportation expenditures, its competing on power will decrease or face to close down

(Dinler, 1994, P: 51). A firm must locate on optimum place. Therefore, a firm must locate the most advantage place which has minimum cost. There are five types for firm from the total transportation expenditure point of view when optimum location is defined. These are: access to raw material, source of energy, semi –processing product, market and free firm.

The second factor which explains the optimal location is external economies. External economies are stated as agglomeration of industry or total advantage that firms take advantage of proximity to other related industries.

External economies have importance from increasing or decreasing production cost point of view when optimum location is determined. This factor has two sorts. The first is external economies which arise as result of activities of other firms. The latter is external economies which arise as result of activities of public. Advantages which are formed out of market or as result of activities of public are infrastructure service, local tax and investment incentives (Dinler, 1994, P: 59). These incentives include transportation, cheap electricity, and water for industry, sewage, social housing, fire department and professional associations. When industries develop and increase in specific region, cost of firm can decrease and some advantages can arise. These advantages are semi-processing product, skilled people, and advantage of marketing and possibility of easy credit.

There are differences between developed and developing countries from location point of view. Expenditure of transportation is important in developed countries but in developing countries, external economies are more important. Factors outside of expenditure of transportation are similar in different regions in developed countries. Therefore, firms locate in place of minimizing total expenditure of transportation. In developing countries, expenditure of transportation has an importance but external economies have more importance than the other one because infrastructure services are imbalance among regions in developing countries and external economies converged on most developed regions. For this reason, firms generally prefer to agglomerate in developed core including external economies (Dinler, 1994, P: 58).

Developing countries especially started development and industrialization after the Second World War. These countries applied model of import substitution in order to accumulate capital and improve industry. As a result of this choice, firms located on metropolitan areas, for density of population, which is the domestic demand, readily established infrastructure facilities and skilled labor can be found in metropolitan cities. For this reason, in Turkey, agglomeration of industry in regions of Marmara should be assessed as a part of model of import substitution. “Agglomeration of industry in Istanbul and western regions show that importance of minimizing expenditure of transportation protects but firms prefer regions of external economies” (Dinler, 1994, P: 76).

When theoretical knowledge is assessed, it is easy to understand why western Anatolia and Marmara regions have both superior capital and labor advantages. “Both Istanbul and Marmara region have historically been a point of attraction for capital investments. Capital accumulation and investments have concentrated in this region because of developed infrastructure, access to market and skilled labor. If one region has privileged position, capital and investments start to concentrate more than usual in this region” (Sengül, 2001, P: 27).

These urbanization and industrialization strategies have cause a huge income inequity and source to industry and whether other sectors have neglected or society found solutions in other sector. For example, in housing sector, government has not allocated enough financial sources and therefore, housing demand has not met by people. Nevertheless, these solutions resulted formation of illegal settlements and the gecekondu.

This urbanization and industrialization process cause to density of population and industry in regions of Marmara and Aegean. Especially, Marmara region, 8% of land area of Turkey, shelters 26% of total population. While according to census of 1997 average density of population in Turkey is 82 persons/ km^2, average density of population is 322 persons/ km^2 in Marmara region. This density is four times more than Turkey’s density. Therefore, there has been increased demand for housing and cities became large in horizontally and vertically because of pressure of population (TMMOB, 2000, P: 58).

According to report of State Planning Office in 1999, share of seven provinces in GNP which are influenced by Kocaeli earthquake was 34.7 %, value-added of industry was

46.7 %. Provinces which were influenced at most by Kocaeli earthquake had 6.3 % in share of GNP and 13.1 % in production of industry. Region of Marmara has an important share in raw material of textile, oil-chemistry refining, main metal of industry, montage, repairing and manufacture of transportation vehicle, and industry of tire (DPT, 1999).

According to data of State Planning Office in 1999, influence of Kocaeli earthquake was estimated to cause the loss of 9- 13 billion dollars on accumulation of capital and GNP. Financing load at foundation of public infrastructure and production for repairing and tax delays was estimated 6.2 billion dollars. Also, specialist estimated that Kocaeli earthquake was going to impede - 1 % the progress of growth speed of Turkey.

The earthquake scenario prepared for Istanbul indicates that the direct property losses would amount to 50 million dollars, equal to 20% of the GDP in 1997. The local and the national economy will further suffer due to transportation infrastructure and business interruption (Erdik, 1999, P: 371).

3.2. Housing Problem and Policy in Turkey

Housing problem in Turkey like other developing countries is the result of migration from rural area to urban area and inequity in income distribution. For this reason, the housing need of lower class determines dimensions of housing problem. Housing stock in Turkey is not physically safe and durable against earthquake and other disasters. Also, in last ten decades earthquakes showed cities of Turkey have poor housing stock in quality. Past earthquakes and other disasters has negatively influenced national economy and has caused to slow down Turkey' economic growth. Ground condition, system of construction, building quality, illegal settlements and location of settlements have played important role in earthquake damage.

Central government encouraged individual housing supply in Turkey. However, social housing, public housing and rented hosing supply were neglected and housing need of poor people was not met. Although, enough public investments have been allocated to housing sector but inspection system has not been installed. Therefore, housing stock is not safe. After 1980, public investments and credit was allocated to housing sector. In this duration, Administration Office of Mass Housing, Real Estate Bank, developers and

Cooperatives produced housing stock. However, middle and upper class people mainly took advantage of these housing stocks and upper class people having housing have tended to make speculation and take advantage of urban rent.

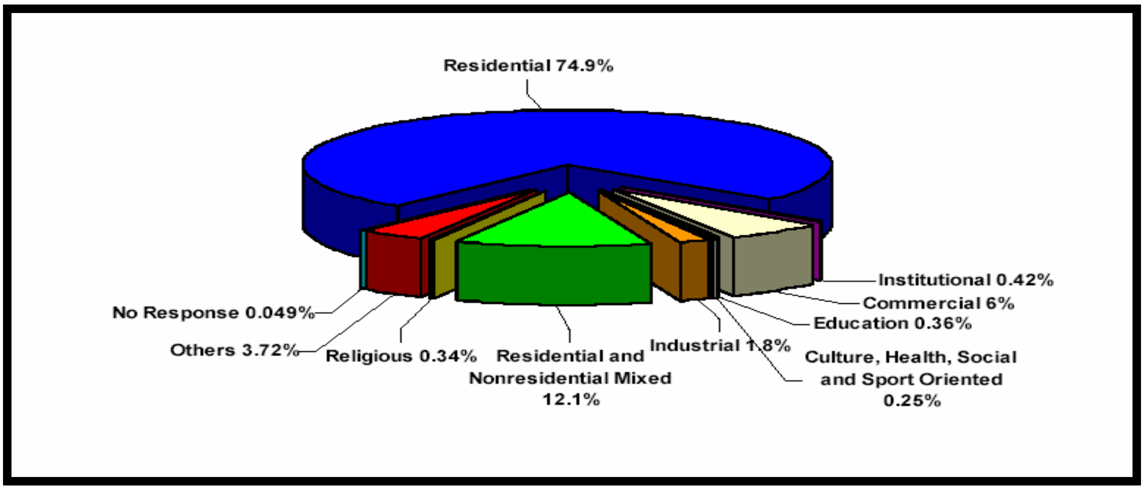
Table 3.1: Distribution of House owning in 1994 According to Property of Housing

Property of Housing	Turkey		Urban Area		Rural Area	
	Total	%	Total	%	Total	%
	13.342.055	100	7.487.766	100	5.854.289	100
Landlord	9.411.921	70.54	4.355.719	58.17	5.056.202	86.37
Tenant	2.791.374	20.92	2.351.391	31.40	439.983	7.52
Public Housing	221.098	1.66	114.317	1.53	106.781	1.82
Others	917.662	6.88	666.339	8.90	251.323	4.29

Source: DIE, Statistical Annual of Turkey, 1998

Table 3.1 shows that 30 % of total household has not any housing in Turkey. Proportion of People who has not any house is more in metropolitan cities like Ankara, Istanbul, and Izmir. Proportion of People who has house is 70 % in Turkey and this proportion is 45 % below average of Turkey. It can be assumed that demand for housing and land will continue from both renters and home owners more than one point of view. Moreover, demand for housing results from both need and some advantages in Turkey. Housing for people in Turkey provides social security because high inflation is prevalent in Turkey and other sectors are risk to investments. For this reason, housing or land investments are attractive for people and exchange value replaces use value.

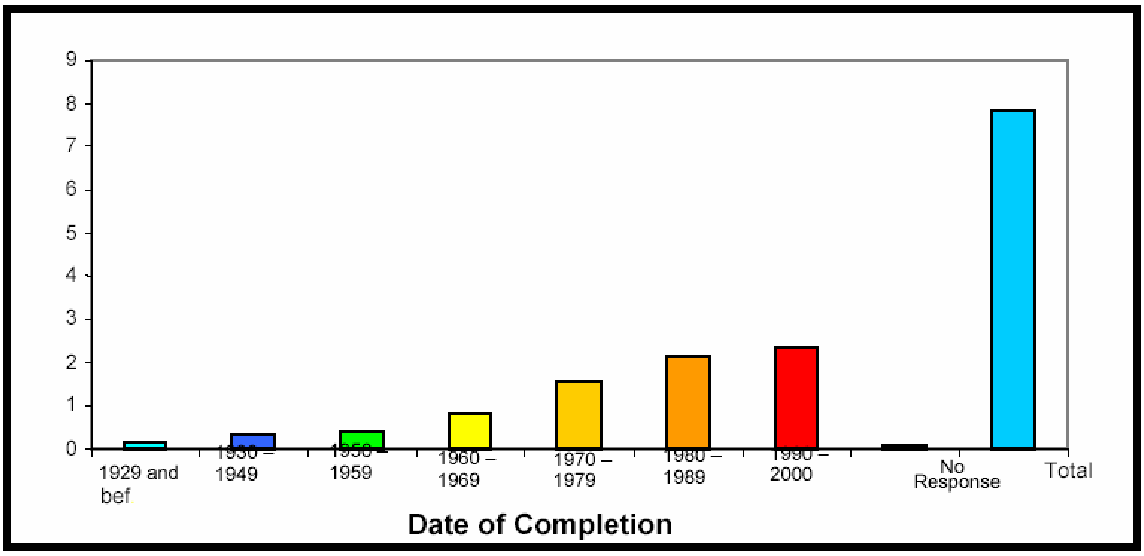
Figure 3.1: Distribution of Buildings with Respect to Use in Turkey, (2000)



Source: Polat Gulkan, 2002

Figure 3.1 shows that three-quarters of the existing building stock is residential. It suggests that especially poor buildings in quality such as the squatter settlement and illegal housings are prone to vulnerability in urban areas. If years of construction for buildings are examined in last 80 years (see figure 3.2), majority of the existence building stock is seen to be built last 20 years. It provides that quality of buildings has transformed. However, individual entrepreneurs of building sector constructed housing and other building types and they are called as build and seller. They actually have scarce source but they produce housing to minimum cost. However, this minimum cost results from poor material and inconvenient form of construction. Also construction of individual buildings is not exactly inspected and the technical requirements seldom follow. This process cause to be had unsafe and vulnerable building stock.

Figure 3.2: Years of Construction for Buildings in Turkey



Source: Polat Gulkan, 2002

Figure 3.2 suggests that years of construction of building stock and codes and design standards changed so, big part of that stock is risky. For this reason, it is necessary to take measures in order to mitigate risk and strengthen housing stock. Conventional planning has to be left and strategic planning must guide to the new plans. For risky settlements, detailed contingency plans must be prepared in urban areas.

3.3. Land Rent theory and the effect of Urban Rent on Urban Development

Urban rent constitutes a lot of risks related to quality of built environment and it is socially determined. For this reason, urban rent is a social risk factor. There are two kinds of interests and perspectives in Cities. Firstly, urban space is received as living space. Therefore, urban area is determined by use value. Secondly, urban area is mean of accumulation of capital and deriving rent. Urban area is thus determined by exchange value. While at the former perspective, city is a concrete living space, at the latter one, city is an abstract space which is bought and sold. Quality of cities and livable of built environment provide some answers to what values determine urban space. Eastern Marmara earthquake shows that cities which are determined by exchange value are not safe areas. For this reason, we must understand the nature of rent, land speculation and exchange value because they have been shaping built environment. The thesis assumes that land value in the city center equals to urban rent and these rents majority results from absolute and monopoly rent. However, urban rent only results from mentioned rent types. Actually it is impossible to know that what kind of rent consists of urban rent. But planning decision especially influence location and ownership of land therefore absolute and monopoly rent are important for urban area.

Under the land rent title, neo-classical rent and land use allocation and Marxist rent concepts are taken up. In urban areas residential, commercial and industrial differentiations have been explained in the context of social, ecological process, consumer preferences, utility-maximizing behaviors on the part of individual and the like. Although neo-classic' formulations provide useful and empirical possibility in rent theory, they are not interested in how the scarcity arise. Harvey suggests that land is fixed both location and aggregate supply and the neo-classical fiction that it is neither (accepted completely by Muth for example) innocent trap which can easily lead us into a misinterpretation of the forces determining urban land use. We neglect the realities of absolute, relative and relationally determined space and time at our peril (Harvey, 1973, p: 178).

On the other hand, the scarcity is socially determined. This study is based on urban rents. Furthermore, in this study, impact of urban rent on earthquake damage is investigated. Urban growth causes rise of expectations in land value because the result of demand and supply of the land, the scarcity arise and landlords according to their locations derives excess profit. The land rent and property rent in central areas does not arise out of marginal productivity of the land but it arises out of the process resulting from application of absolute and monopoly rent that are result from planning decisions. Monopoly rents tend to be most easily established at near the center and absolute rent is the greatest at the city center of the largest metropolitan region. At these locations absolute and monopoly rents enter into the cost production.

Essentially, there are a lot of reasons for individual, firm or institution in order to pay more for one site than another. For example, in urban or rural area, space to use may be highly desirable due to its mineral resource, soil quality, water supply, climate, topography, environment, good input-output access to supply of labor, supply of public service, prestige, status etc.

Rent has various meanings in land economy and urban location theory. “The word ‘rent’ originally referred only to the factor of production land –classical economist releasing that the comparative scarcity of land produces a return quite different in character from that normally earned by labor or capital (Ractliffe, 1949,p: 6)”.

Rent may vary from one place to another because for many reasons including its location, or distance from a market place, or its productivity. Location Rent can be explained as the advantage of one parcel of land over another because of its location.

Land rent was firstly explained by Ricardo. According to Ricardo rent has those features. Rent arise fertility of land. For this reason, on land which has the lowest cost, rent is not derived. Rent arises in scarcity of fertile agricultural land. Rent is not a cost factor in production because rent arises due to unfertile agricultural land (Erturk, 1995, p: 155). Also Ricardo considered that rent was that portion of the produce of the earth which is paid for the use of the original and indestructible powers of the soil. Rent can be changed because land is scarce and in total is completely inelastic in supply (Ractliffe, 1949, p: 7).

Relation between rent and spatial organization firstly took up by Von Thünen. According to Von Thünen rent arise due to different transportation cost in distance of agricultural land to the market place and at the near market place, landowners obtain location rent. Von Thünen assumed that around a central town, rural land of constant fertility assumed different forms, land use diminishing intensively in inverse relationship to increased distance from the town. The land use outward would comprise the following concentric belts: horticulture and dairying, sylviculture, intensive arable rotation, arable with long ley, three-field arable and ranching. Although the Von Thünen model has been criticized because he assumed unlikely conditions such as taking place around an isolated market and soil being of constant fertility, However, Von Thünen contributed to rent explanation and urban location theory with establishing a distance – cost relationship((Ractliffe, 1949, p: 18).

According to Marx, rent is a value which is paid landlord to use land due to private property in land. Also, rent is something that is filched by the landlords. Therefore, it is an undeserved return. Marx defined three kinds of rent, Differential rent based on monopoly of using land in, absolute based on monopoly of private property in land and monopoly rent based on ability of consumer to pay and buy.

Differential rent arises because producers on superior soil or superior locations receive excess profits relative to production cost on the worst land in the worst location. Rent is simply a payment for the use of land and its opportunity (Harvey, 1985, p: 93). Differential rent takes on its meaning in relative space which is structured by differentials in productive capacity at different locations and which is integrated spatially through transport cost relationships.

Monopoly rent arise because it is possible to charge a monopoly price determined by the purchaser's eagerness to buy and ability to pay, independent of the price determined by the general price of production as well as by the value of product. Marx's sense, this kind of rent is not important in agriculture but monopoly rents are crucial in the case of urban land and property and if there is only one center in the city, the peaking of land values particularly in densely populated areas in which house and land rents are only explicable as monopoly rent.

Absolute rent is revenue of the private property that is dependent on land. In social life, absolute space comprises the fundamental of monopoly rent. Monopoly rents are crucial in the case of urban land and of private property because cities are larger and they geographically differentiate. Landlords who have that urban land obtain excess profit than others. Source of monopoly rent is scarcity of urban land. The amount of urban land that has a specific location is not increased. However, the scarcity is socially determined and neo-classic formulations such as Muth, Mills, Alanso ignore social dimension of the scarcity. A Landlord who has this kind of land obtains an excess profit compared to others.

Harvey says that monopoly and absolute rent can be distinguished by regarding the former as operating at the individual level (a particular owner has something which particularly wants or needs) and the latter as something which arises out of the general condition of production in some sector (it is a class monopoly phenomenon which affects the condition of all agricultural landowners, all owners of low income housing etc) (Harvey, 1973, p: 182).

Harvey says that the level of absolute rent can be attributed to the relative scarcity of land compared to other factors of production and from this we can arrive at the neo-classical position. Monopoly rent can be interpreted in the neo-classical tradition as arising through the artificial manipulation of scarcity through producer's manipulations of the supply of land (Harvey, 1973, p: 185). Actually scarcity is socially determined.

Absolute rent arise monopoly of private property in land. The level of absolute rent depends upon supply and demand condition as well as upon the area of new land taken into cultivation. Source of absolute rent is through decision-making from different people who have power and authority and organizations. For example, in development of mass housing, private people or public organizations may produce absolute rent through making plan or leaving the land vacant. However, it is important that planning decisions produce rent and distribute it. But public actions, landlords and local managers influence these decisions.

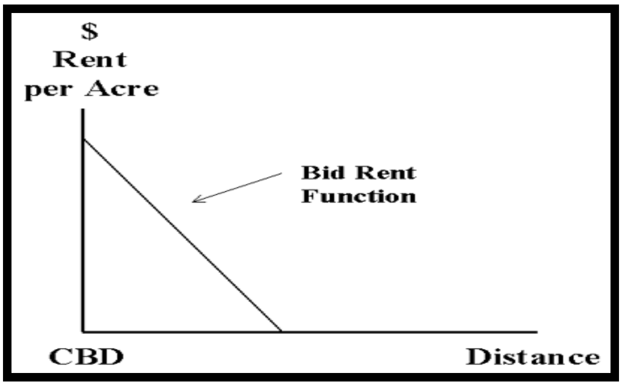
In the central cities the high rental value should not necessarily be interpreted as a reflection of differences in marginal productivity of land (as Mills suggest). Absolute and monopoly rents at these locations enter into the cost of production. Differential rents do not. If absolute and monopoly rents are dominant in the determination of land value at central locations then it is land value which determines use. If differential rents dominate then it is use which determines land value. In practice, of course, rent arises out of all three circumstances and it is difficult to determine what portion of the overall rental value arises out of which circumstances (Harvey, 1973, p: 188).

In central locations use intensity of land is high due to demographic, retail potential and service. Also, in the city center, land parcel occupies a unique location and there is not any land parcel that occupies that location. Therefore, land and property value in the city center or close to the city center tend to be peak. Absolute rent arises out of private property and Harvey says that absolute rent will be greatest at the centre of the largest metropolitan region if we appeal the system of Lösch and monopoly rent arises out of location and the scarcity of land. For this reason, at central location absolute and monopoly rent values tend to be easily established. Harvey criticizes neo-classic formulation and he says that the assumption of the centricity gives the appearance of empirical relevance to those formulations. Although he find that competitive bidding is significant, he does not accept that land use determines value. On the contrary he says that value determines land use and it is valid in most contemporary cities (Harvey, 1973, p: 189). If we accept Harvey' claims, absolute and monopoly rents play important role to determine land value in the city center due to private property and location.

Harvey says that in our society, private property arrangements are crucial, rent is, in effect, a transfer payment realized through the monopoly power over land and resources conferred by the institution of private property. And he asks what rent is payment for. The simplest answer is that it is a payment made by user for the privilege of using a scarce productive resource that is owned by somebody else. Moreover, if rent is a transfer payment to a scarce factor of production, then the urbanization process has multiplied the opportunities for realizing rent. If rates of return are high in the real estate and property markets, investment will shift from the primary productive circuit of capital to this secondary circuit (urban property market) (Harvey, 1985) .

In 1960s Alonso developed a new approach to urban location theory based on the principle that rent diminish outward from the centre of a city to meet both lower revenue and higher operating costs not least transport costs. A rent gradient would emerge consisting of a series of bid –rents which would exactly compensate for falling revenue and higher operating cost. Different land uses would have different rent gradient (see figure 3.5) (Ractliffe, 1949, p: 19). Bid Rent is explained as the amount of money is offered to purchase a piece of land. According to level of bid-rent, user makes competition for space and location among different uses (commercial, industrial, residential etc). Figure 3.3 describes how rent decline with distance from the CBD and this is called the bid rent function. Within concentric zones theory, patterns of land use are determined by land values that are related to transportation costs.

Figure 3.3: The Bid Rent Function

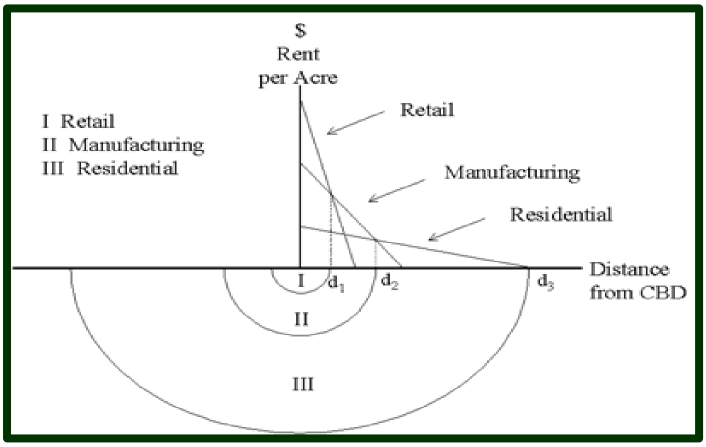


Source: htpp://www.uncc.edu/hscampbe/landuse/b-models/c-bidrent.htlm

According to Alonso's model, there are three types of users of urban land: retail, manufacturing and residential. Concentric zones model which aims to explain residential location is developed through Alonso's model which explains optimal location of firm. According to the model, each activity (commercial, industrial, residential) pays bid rent at different value in order to close the city center. For this reason, it is possible for different user to draw different rent gradient (Ertürk, 1995, 175). In order to realize bid rent and allocation of land use, Alonso assumes various conditions. Firstly the city is comprised of many identical producers that operate in a perfectly competitive environment. Private property in land is secondly prevalent in all urban area. Since all firms are identical and sell in competitive markets, each firm generates a normal rate of profit and they faces the same set of production costs as all other firms. The market place for goods and services is located in the center of city such that all goods and services must be sold there. Consequently, for a firm to sell its product it must be transported to the market located at the city's center.

Figure 3.4 provides the bid rent functions for retail and manufacture and residential. It is important for retailer to be access to consumer more than manufacturers and population density is more in the city centre. Moreover, there are clustering possibilities and agglomeration economies for retailers in the city centre. Therefore, retailers will pay bid-rent more than manufacturers and bid rent gradient show a steep slope and retailers locate the centre up to point d_1. It is important access to markets and labor for manufacturers, but less important than for retailers. For this reason, the slope of the bid rent function for manufacturing will be flatter than the bid rent function for retailers and therefore, manufacturers locate between point d_1 and d_2. Households compete for land in the same manner as firms. Residential land for households takes place between point d_2 and d_3. Beyond d_3, industrialists locate. Beyond industrial uses, urban users do not value land and its value falls to the value of agricultural land (Ertürk, 1995, 177).

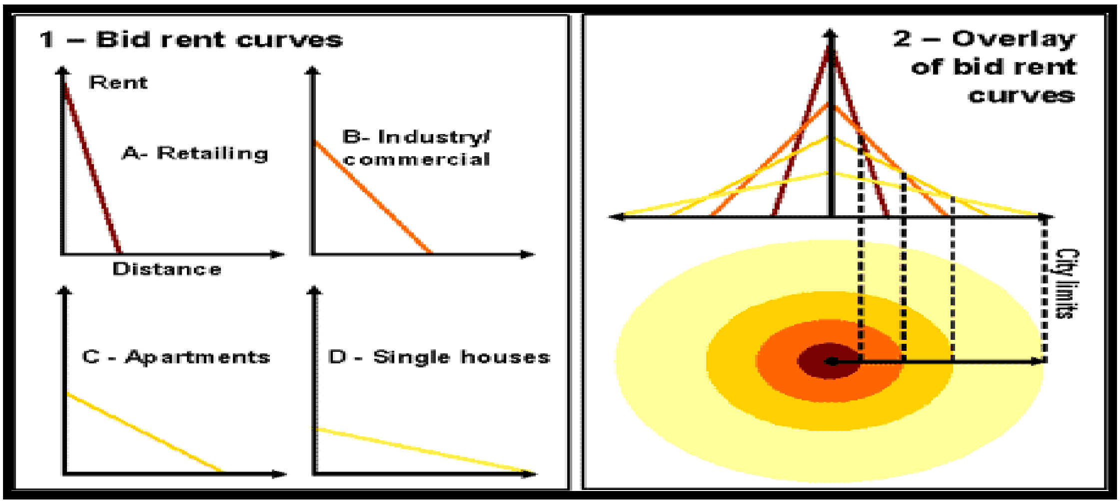
Figure 3.4: Allocation of Land between Three Uses



Source: htpp://www.uncc.edu/hscampbe/landuse/b-models/c-bidrent.htlm

Moreover, residential location rent has been used in order to explain intensity of urban land use and the increase of urban land value. Residential location rent is identified as alternative use cost of land. Residential location rent includes payment in return of decrease in transportation cost for household located anywhere in urban area. For this reason, while residential location rent is the highest in the city centre, it decreases distance from central business district and it disappear at the furthest point. Transport cost increases distance from CBD. Household locating anywhere in the city suffers as sum of transport cost and residential location rent as a cost. Therefore, those costs are same as every point in the city. However, at near the city center residential location rent increases and distance from CBD transport cost increases. They prefer residential location rent to pay instead of transport cost due to tendency of household to close the city centre. Residential location rent is equal to decrease of transport cost in every region (Ertürk, 1995, 179).

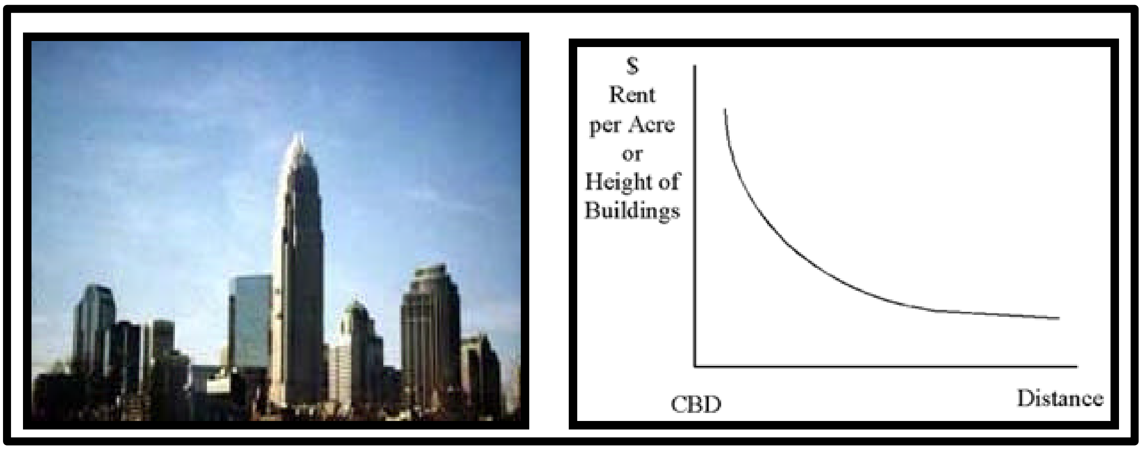
Figure 3.5: Different bid rent curves



Source: http://www.people.hofstra.edu/geotrans/eng/ch6en/landrent.htlm

Each type of urban activity (retail, manufacturing, residential and industrial) will have its own bid rent function and the combination of several bid rent functions will define the rent gradient. Figure 3.5 provides bid rent curves for different uses. The higher value of land at the CBD reflects the capitalization of transport cost savings into the price of land. This feature of urban land use theory causes land values to decline with distance from the center city. Also all people involved in the bidding process have complete information about costs at alternative locations and no one will bid more for land than the land is worth, the bidding process continues until bid rent exactly equals location rent. It is also important to not forget that land prices increase closer to the CBD because centrally located land will be tend to be used more intensively. The intensity of urban land use is correlated with the height of buildings (generally taller buildings being located on higher valued land) which helps explain why tall buildings are found in central business districts. When one moves away from the CBD, both the value of land and its intensity of use decline. It is also acceptable to the height of structures. The image of the downtown Charlotte in North Carolina, CBD provides a good illustration for height of buildings and land value. The tallest building in the image is the corporate headquarters of Nations Bank located in the heart of the CBD.

Figure 3.6: Generalized Urban Rent and Downtown Charlotte, NC, the steep rent Gradient implied by the height of buildings

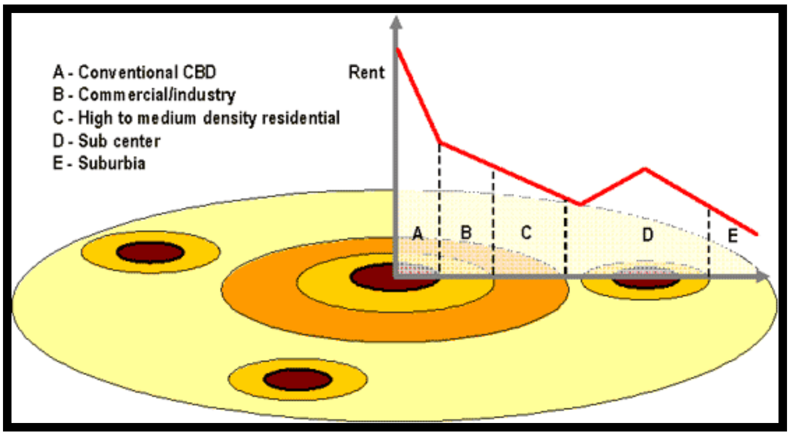


Source: htpp://www.uncc.edu/hscampbe/landuse/b-models/c-bidrent.htlm

So far, urban land use with one center model in urban area has been discussed. Transport facilities and other technological reasons provide some condition in order to arise multiple nuclei model in urban areas. Although traditional core areas of cities have lost some of their functional importance, they continue to be the symbolic center of the city. The multiple nuclei model can be thought of an urban form that has several nodes, or centers of commerce with each node surrounded by a set of rings of different land uses. Residential land use occupies the largest portion of land in urban area.

Figure 3.7 provides change of rent gradient in multiple centers in urban area. Land rent theory with one central is not valid every city. However it continues prevalent in most contemporary cities. In Multi nuclei model there are some modifications. In this model the downtown area is not necessarily to most accessible place.

Figure 3.7: Contemporary Modifications to the Land Rent Theory



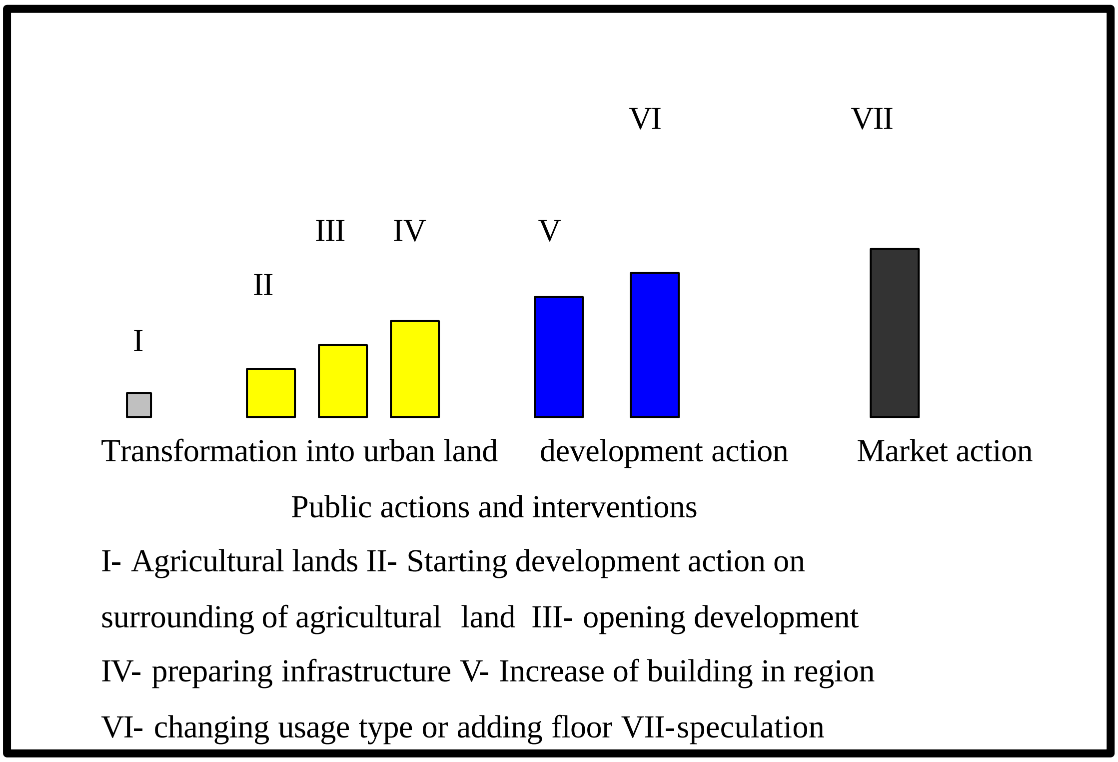
Source: http://www.people.hofstra.edu/geotrans/eng/ch6en/landrent.htlm

The rapid extension of metropolitan areas has put a lot of areas very far from the CBD, notably in suburbia (e). This has favored the emergence of sub-centers (d) having a concentration of retailing, commercial, distribution and industrial activities. Improvements in transportation and telecommunications have made several activities far more tolerant to distance, but still dependent on accessibility. The urban land use pattern thus tends to be far less coherent, more specialized and dispersed.

3.3.1. Process of Increase of Urban Land Value

The increase of land value results from the scarcity of the supply and the increase in the demand it. However, the scarcity is socially determined. While migration and population growth continue in cities, agricultural lands convert to urban lands through infrastructure and development rights. Keles and others (1999) dealt with process of increase of urban land value through a case study. The process includes transformation from agricultural land to urban land. It is following phases:

Figure 3.8: Process of increase of urban land value



Source: Keles, 1999

Phase I: at first, we should think an agricultural land in long distance from city whose value was determined by fertility. In this condition, value of land should be S1. Landowner can change value of land through actions.

Phase II: city or built environment spreads on to this land and urban settlements are seen near this land. On surrounding of this land, public or private foundation starts to settle. This process increases the land value and this increase of value should be shown with A1. Landowner does not contribute to increase of value. Moreover, we add extra value to A1 because of change in urban and country such as inflation and migration. This general increase of land value should be shown with G1. For this reason, in this phase, value of land is that

SI + [A1 + G1]

Phase III: Urban settlements increase around the land. In this case, the land is included within the borders of municipality and development plan. Agricultural land converts to urban land. Therefore, its value increases. The value is shown with A2. Also, when general value is added, in this phase, value of land is that

S1 + [(A1 + G1) + (A2 + G2)]

Phase IV: Municipality starts to build infrastructure near the land such as road, water pipe, sewage pipe, electricity. Therefore, value of the land increases due to the infrastructure and municipality services. Value of the land is as following:
S1 + [(A1 + G1) + (A2 + G2) + (A3 + G3)]. In this phase, agricultural purposes are totally abandoned the land after all. The land is empty.

Phase V: in adjacent parcel and neighborhood, construction of buildings increases. Lands are occupied by housings, services and trading start to settle in neighborhood. Therefore, value of the land is as following:
S1 + [(A1 + G1) + (A2 + G2) + (A3 + G3) + (A4 + G4)]

Phase VI: The land is in built environment but, the land is empty. Even if change does not take place in neighborhood, value of the land continuously increases because of change in city. Landlord awaits for such a value of land that he opts not to build until the local authorities allows a building with five- story in the plot instead of three-story finally.
S1 + [(A1 + G1) + (A2 + G2) + (A3 + G3) + (A4 + G4) + (A5 + G5)]

Landowner does not contribute to increase of land value in all six phases. But the rent that arises so far could not be transferred to a public use because of private use over the land. All these stage public and other actions gains rent to landlord. In this study public actions and planning decisions cause rent to come out due to location and monopoly in private property.

3.4. Land Speculation as a Factor in the Increase of Earthquake Damage

Urban rent and speculation are the biggest handicap in order to control urban development. Resource of Urban rent and speculation is private property in land. Urban land speculation is explained as people who have land leave the land vacant or buy land for speculation. Urban growth cause to increase value of land and if real estate and property markets are more profits than other sectors, people and institutions make investment to urban land for speculation. Reason of leaving the land vacant is the increase of land demand and expectation of the increase of land price. “The roles of speculator-landlord and speculator developer are crucial to the dynamics of urbanization and therefore, to the maintenance of effective demand and a structure of submarkets through which class monopoly rents can be realized provide the necessary incentive to play these roles with profit. But at the same time, the potential to realize these rents provides the possibility for rapid accumulation of capital out of land and property markets when occasion demands it. When industrial demand lags and industrial profit decline, financial institutions will compensate by moving into the land and property markets (Harvey, 1985)”.

While urban land speculation provides excess profit to landowners in process of increase of value, other parts of society are negatively affected. These negative effects are that extreme increase in the price of land and real estate and pushing the poor out of legal land and real estate markets and haphazard urban growth.

If urban land speculation is much in cities and number of speculator-landlord and speculator developer increase, speculators are dominant in decision of urban settlements. Therefore, development plans are not shaped with scientific and objective data but they are shaped with demand of speculators. In Turkey planning decisions have been changed through revision plans, update plan and Development amnesty by local and central administrators. Earthquake risk increases due to changing the existing uses and the number of story. For example, in 1984, in Erzincan, while the number of story was limited to four-story, until 1992 the number of story was increased six-story through revision plans. Also, after Dinar earthquake, researches showed that two-story and brick buildings were added third and fourth floor and these buildings with three and four story heavily damaged in Dinar earthquake. The same process is valid for Adapazari. In 1985, Development plan increase population density and the number of story.

Speculation in urban land is not only done by leaving the land vacant and also in available residential area, speculative profits are obtained through transition to new use type or the increase of story. In Kocaeli earthquake, on ground floor, destroying walls and columns of building for car park, store, and restaurant caused to collapse buildings and thus earthquake damage increased. Moreover, commercial facility 95 % of buildings which had trade usage on the ground floor and destroyed their inter-wall collapsed in Adapazari. Buildings with four and seven storey heavily damaged in Adapazari.

Urban land speculation almost causes to be used land completely for construction. Also, the increase of story increases density in per unit area. Therefore, inadequate green area, infrastructure, poor in quality, high dense urban area and unsafe urban pattern form. In Kocaeli earthquake, domino effect of adjacent buildings increased heavy damage because there was not any vacant space between two buildings and buildings completely occupied plots. Furthermore, unsymmetrical buildings and wrong technical design increase losses.

If urban land speculation is much in cities, urban land is divided into small plots and profit is maximized. Buildings on those plots are completely occupied plot and therefore, during earthquake, urgent intervention is done because collapsing buildings prevent transportation. Furthermore, this event results from added story in order to obtain excess profit.

While the increase of land price causes to separate more resource to land for construction of housing, less resource is separated for other materials in construction of housing. In Kocaeli earthquake, use of inadequate concrete and iron even caused buildings to collapse within legal and planning areas.

3.5. Planning, Organizational and Legal Problems and Contingency Planning

Under this title, firstly problems are identified in conventional planning and then in the context of earthquake, ideal risk management and contingency planning process are defined. After all that, a sample earthquake master plan is submitted. The sample is related to Istanbul.

3.5.1. Organizational and Legal Problems

There are two implementation components for disaster management and mitigation in Turkey. One of them is Disaster Law (7269) and the other is Development Law (3194). With their relevant regulations they constitute the fundamental components of general system of development and disaster management in Turkey. A comprehensive approach to disaster management in Turkey was developed in 1959 through Law no: 7269, Measures and Assistance to be put into effect regarding Natural Disasters affecting the life of the general public, whose basic aim is to provide the administrative structure of the government to manage disasters in a timely and efficient way, so that losses and human suffering are minimized and rehabilitation can be implemented effectively (Ergünay, 1999, p: 2).

Disaster management in Turkey is the responsibility of the central government but not local government, so disaster management system is highly centralized. The head of disaster management is the governor of province employed by the ministry of interior. The role of governor is not an operational status but coordinates and mobilizes the other actors. The law ignores role of the mayors in disaster management. Moreover, according to Disaster Law, the governor is to have to draw a plan of relief operations in order to become effective immediately after disaster. This clarifies that the governor makes preparation of tents and blankets operation than any form of risk analysis such as estimation of losses and master plan for pre-disaster monitoring. (Ergünay, 1999, p: 2; Balamir, 1999, p: 101)

Moreover, while disaster management system is highly centralized, there is no single national coordinating agency for disaster management in Turkey. Rescue and relief operations are the direct responsibility of provinces or districts with assistance provided by the central government or externally and the central government is responsible for reconstruction and rehabilitation through ministry of construction and settlements. Local governments are responsible for mitigation such as the implementation of earthquake resistant building code in construction within their jurisdiction (Ergünay, 1999, p: 3). Ministry of Interior through Director of Civil Defense and Governor, Ministry of Construction and Settlements through Director of Public Works, the Turkish Red Crescent Society and armed forces play a major role in rescue and relief operations.

From preparedness operations point of view, there is no explicit national plan for Turkey. For different disasters there are not national regional and local plans. Also, between plans prepared by ministries, provinces, districts, local governments, there is no unifying mechanism. Ministry of Construction and Settlements makes declare disaster according to objective criteria.

Disaster Law includes a special fund in order to meet or make compensation the cost of disaster. The source of the fund comes from national budget with annual allocation and the amount of this fund can be supplemented by Ministry of Construction and Settlements and the Ministry of Finance. Furthermore, the fund has generally been used for post-disaster relief and compensatory operations than for mitigation activities. On the contrary this fund must be used for mitigation and possible losses must be minimized.

When the relief was distributed through the Disaster Law, there was no discrimination between legal and illegal or authorized and unauthorized building construction. Therefore, in this system, building owners who remain strictly with legal system are punished and in the other words, the owners of unauthorized buildings are awarded. Also new obligatory earthquake insurance must be included all vulnerable stock. The existing system only includes people having ability of payment.

Moreover, Development Law no: 3194 has no direct reference to natural disasters and there is not required connection between Development Law and Disaster Law. Although procedures and organs are determined in Disaster Law, its implementation components take place in the Development Law. Disaster Law has no enough content related to determination of unsuitable land for development, a system of evaluating the existing stock of buildings and procedures of control of construction but Development Law includes those. All these realities cause the Disaster Law to focus on the post-disaster activities and alienate it from mitigation against disaster (Balamir, 1999, p: 99).

Moreover, Individual construction of buildings is extensive in Turkey and Physical development of settlements is growing haphazard and majority of buildings do not meet earthquake resistant codes. For this reason, the ordinary practices of and construction of individual buildings seldom follow the technical requirements, even if these were strictly regulated. Also, there are a lot of foundations and ministries that apply and make plan but between ministries and local governments in context of planning, there is not exactly coordination. Frequently they intervenes domain of the other. Especially Ministry of Environment and Ministry of Construction and Settlements struggles for sub-region planning.

Balamir(1999) claims that those organization and structure create fatalist society due to focusing on post-disaster and he defines two extreme models of disaster management, fatalist and risk society models. The former focuses on the post-disaster intervention (saving strategy), disorganized information, political operations, extraordinary response to disaster and umbrella disaster funds and risk minimization/sharing (crisis planning). The latter focuses on the pre-disaster conduct (protection strategy), information system, self-relying organization, technical issues, routine procedures, specialized funds and risk avoidance (contingency planning). In the former, conduct of the state is defined as Healer and in the latter, conduct of the state is defined as protector (Balamir, 1999, p: 98; 2001, p: 5).

Although the government has taken three significant steps after 1999, such as obligatory earthquake insurance, the control of construction processes, and improved proficiency in construction, they are not enough for establishing comprehensive and ideal disaster management. However, at the first time in Turkey, mentioned regulations emphasize a change in macro-politics related to disaster management which has been converted from conventional post-disaster activism towards pre-disaster mitigation regulation.

3.5.2. Inspection of Construction of Buildings and Development Plan and Problem of Education

The increase of earthquake risk or alleviating it could not only be explained by natural and technological dimensions. This phenomenon has also economic and social dimensions. So, this is much complicated process. Most of the buildings in Turkey have not been inspected at various control level: planning, construction and maintenance phases. Cities in Turkey, especially metropolitan cities which has huge earthquake risk, consist of squatter and illegal housing stock. These stocks have not been thoroughly inspected. However, inspection should not be only thought as inspection of building. Moreover, plans which are approved by local governments play important role in alleviating the risk of earthquake damage. For this reason, inspection must include inspection of construction and plan as legal procedures. “Planning process and inspection complete inspection of building. Plans are prepared with inadequate geological reports in Turkey, but plans must be prepared with integrated disaster map and all sectoral decisions must pay attention to the integrated disaster map” (Gülkan, 1999, P: 107).

Erzincan, Dinar, and Kocaeli earthquakes show that problems of conventional planning and construction of building mostly results from human and system errors of inspection. Furthermore, building workers have not had formal education. Therefore, their wrong applications cause damage to increase. However, other factor is that individual construction and builder-sellers does not usually follow technical procedures and they use poor material in quality for minimize cost of building.

According to the Development Law, municipality is responsible for building inspections. While Development director of Municipality does inspection of project, it is conducted by an ordinary technician in the municipality in the name of municipality. Nevertheless, municipalities have not enough technical staff in order to inspect the project. Furthermore, there is not enough civil engineering in order to apply earthquake regulations. After 1984, there is not any structure which inspects plans approved and applied by assembly of municipality. Specialist of technical application takes fee from owner of inspected building. This fact is weak point of inspection of building. After builders sell building, builders are not judged because of indefinite responsibility but through indirect law they may be judged.

3.5.3. Planning, Planning System and Contingency Planning

Planning is described as a process of human thought and action based upon forethought, thought for future and planning is future oriented and thus optimistic, for it assumes man’s ability to control his own density, at least within certain limits. Therefore, planning includes man closely with nature and life. Moreover, planning is done by human beings for human beings. Urban and regional planning involves the arrangements of spatial patterns (Chadwick, 1971). Aim of physical planning is to provide required space for human activity and welfare and to reflect goals of social and economic development to space. Furthermore, this aim involves healthy and safety spatial patterns for human beings. Planning process consists of three stages, analysis (research), planning (make decision and design), implementation and control (monitor and review). These stages are closely related to each other and have feed-back structure.

The role of planning is overlooked many times relating to earthquake damages. Urban rent as a “transfer payment” constitutes a pressure on planning decisions, and the planning decisions are dependently changed frequently through social, administrative and economic mechanisms. Planning is not at all independent from the society and the politic-economic system. There are various contradictive interests in society, and, to a greater extent, locations of settlements are determined by those interests. Therefore, planners make decisions accordingly with the awareness of to this existing structure. Planners’ tendency has been rather to address functional and aesthetical concerns of settlements in Turkey. City planner had not enough knowledge and interest about earthquake, and the authority, either. Also, they ignored disaster and risk management concepts during planning.

Planning intervenes to all human life such as changing living reality, haphazard actions and the flow of actions. There are three stages for mitigation of disaster (earthquake) damage and disaster management from planning point of view, firstly pre- disaster (or earthquake), secondly after earthquake, emergency aid and rescue and permanent shelter and thirdly post-earthquake (rehabilitation and rebuilding). Essentially, Role of urban planning and planner especially involves the first and third stages.

Past earthquakes, especially Kocaeli and Duzce earthquakes in 1999, show that the majority of existing building stock in meeting the earthquake design codes even at project stage in Turkey is deficiency. This state is valid for the authorized stock but other part of the total stock is unauthorized. Every two state constitutes uncertainty due to both production faults and negligence for unauthorized stock and not meeting the earthquake design codes for the authorized stock. For this reason, urban risk and vulnerability increase and it requires a new planning process in terms of disasters such as earthquake. This planning approach includes risk management.

Risk management process is generally following that establish context within which the risky activity operates, communicate and consult with key stakeholders about issues (hazards), identify all risks concerning the issues, analyze all risks in terms of the likely causes and consequences, evaluate the risks in terms of which feasible options will meet the most appropriate solution for the greatest number of stakeholders, treat risk after confirming with stakeholders what the most appropriate option is, monitor and review the entire procedure continuously, especially the context and evaluation options (Britton, 2002, p: 2). The alignment of research tasks with risk management process is shown in Table 3.2.

Moreover, it is important to focus on identifying key stakeholders and continuously communicating with them because risk management is a technical activity which operates in social context. Effective communication strategies throughout all phase of decision process are necessary. If the wider social, economic, political and cultural conditions are not provided, technical decisions are not successfully implemented (Britton, 2002, p: 2).

If it is assumed that risk management is established context of earthquakes, process is following phases that, to determinate goal set for mitigation of earthquake damage, identified earthquake hazards, assessed existing controls, prioritized risks, managed key issues, agreed objectives, applied actions in place. Also, in this process, at each step, it is communicated, consulted with stakeholders and monitored applications and reviewed goals.

Not only urban risk management must pay attention to the single building but also physical and social process. Urban areas have different ground conditions and complicated underground features. At the same time, urban areas which have building stock are formed different times and conditions. Therefore, they have great risk and they are continuously changing from social, economic and administrative existence point of view. Distribution of risks at urban areas is tied to a lot of factors. Moreover, urban shortcomings and weakness determined in framework of contingency planning are observations of today. Nevertheless, these shortcomings are timely changing. Also, logic of the market cause to increase risks because it exploits natural and social resource and ignores its negative effects (Balamir, 2002, p: 27).

Table 3.2: the alignment of research tasks with risk management process

RESEARCH TASKS	RISK MANAGEMENT PROCESS
Problem Definitions	**Establish the Context** - Identify issues and establish risk management framework - Identify strategic and organizational issues - Develop risk evaluation criteria
Stakeholder Identification	**Communicate and Consult** - Initiate Stakeholder analysis - Establish dialogue with key stakeholder groups - Develop joint planning strategy
Research	**Identify Risks** - Identify and describe hazards, community and environment - Scope and analyze vulnerability - Establish risks
Analysis	**Analyze Risks** - Determine likelihood - Determine consequence - Estimate level of risks
Decision Making	**Evaluate Risks** - Meet with stakeholders to discuss options - Compare against criteria - Identify prevention, preparedness, response and recovery options Set risk priorities
Implementation	**Treat Risk** - Advise on option selection - Assist and/or advise stakeholders develop an implementation framework for the chosen treatment options
Monitor and review	**Monitor and review** Conduct regular assessments and reviews against project criteria

Source: Britton (2002)

Contingency planning involves rational methods and process against earthquake hazard in order to establish for more safe settlements or built environment. Strategic decisions at this planning process must be taken including determination of risks and their avoidance, mitigation and sharing. Priorities in risk management are shown in figure 3.9 Priorities in risk management consist of three phases, the avoidance, minimization, and sharing of urban risks and their implementation tools include micro-zonation, banning and removal of development, lowering of densities, degrading of land uses, compulsory retrofitting, transfer of development rights, etc. also their implementation are supported with financial apparatus such as zone-based compulsory insurance, rent control, and property taxation.

Figure 3.9: Priorities in Risk Management

1
RISK AVOIDANCE
Avoidance (avoiding areas of natural hazard for settlement)
Distancing (specifying minimum distances from nodes of hazard)
Refusal (prohibiting existing uses with high risks and source of chain-disasters)
PLANNING SERVICES
Risk zoning; plan preparation, implementation, control and up-dating services
2
RISK MINIMIZATION
Discarding Risks At Source (*eg*. flood reservoirs, induced avalanches or land-slides)
Upgrading Resistance At Location of Effect (*eg*. levees, building codes, retrofitting)
ARCHITECTURAL AND ENGINEERING SERVICES
Higher standards in disaster-resistant design and construction;
Inspection of construction; building-retrofitting services
3
RISK SHARING
Aids and Subsidies (credits, rent subsidies for dwellings and business premises)
Donations (national/ international, voluntary/ organized, cash/ in kind donations)
Taxes (extra burdens on others than those suffered losses in the disaster)
Insurance (compulsory building insurance)
FINANCIAL MANAGEMENT SERVICES
Building up funds for pre-disaster and post-disaster requirements; efficient allocation of funds; maintaining equity between fund-providers and between fund-users

Source: Balamir(2001)

From earthquake hazard point of view, urban risks are natural, physical and social resources and there are their obligatory and effective combinations. Urban risks can be classified as dependent on ground (ground condition etc.), dependent on system (infrastructure, transportation, communication etc.), dependent on physical units (power central, fuel warehouse etc.), dependent on facilities (education, housing, office, hospital etc.). From contingency planning point of view, disaster management and risk management are firstly differentiated with concept and implementation. Right approach in these two fields is to perform activities at different organizational structures but condition of corporation. The most appropriate scale for implementing risk management is not national, regional and single building scale but is scale of settlement (Balamir, 2002, p:35).

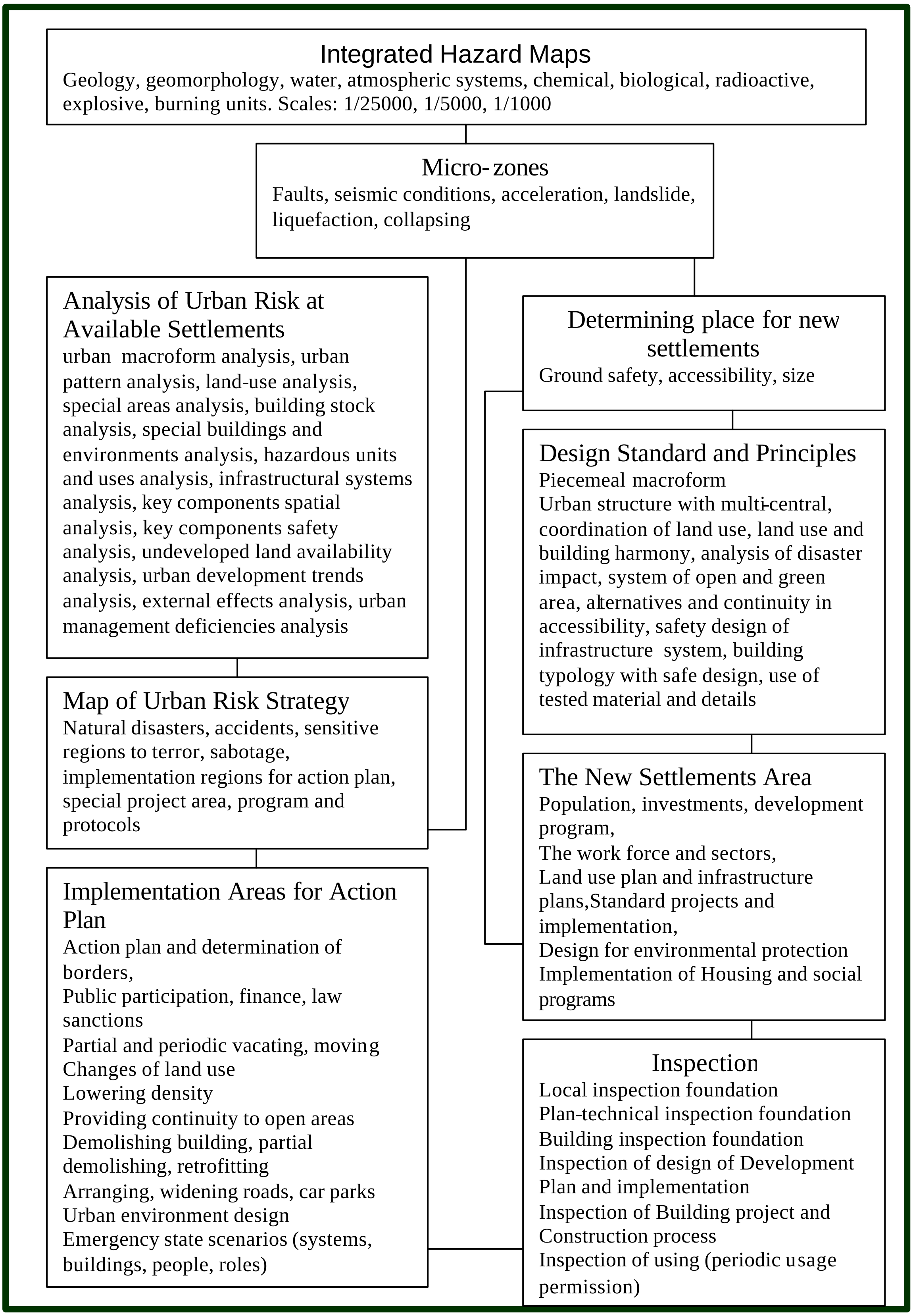
Integrated natural hazard and micro-zoning maps: The first stage of risk determination is to know earthquake features about settlements and sub-regions. Ground hazard and micro-zoning maps including new settlements area and the existing settlements constitute base for determination of contingency planning and decisions of risk management. Those maps should be prepared on scale of 1/25000 or 1/5000 in big cities and they need to show places of all resource of natural hazard and to involve required explanation about hazard.

In the other words, there is no limit to collect data about ground and natural conditions. Therefore, scope of research should be limited with enough content in order to produce plan decision and also it is necessary to limit its cost. This limit of content can differentiate from one settlement to another. According to microzonation, in land use, construction of building can be banned and also restrictive decisions can be taken according to using types and conditions of inspection. Construction of building can be restricted through specifying distance from nodes of hazard due to fault line and ground condition. Restriction of population and building density is powerful inspection methods according to distance from micro-zones and faults. (Balamir, 2002, p: 38).

Furthermore, it is important that geological data do not anytime replace planning decision and planning decisions although geological data can be taken due to social and economic reasons or planning anxiety. With geological data, the short run decisions which determine how many story building will be built in special region have not any validity from technical and legal point of view.

The task of contingency planning and process is to determine component and factors of vulnerability. Nowadays, some works and researches is far from contingency planning. There are two kinds of faults. Firstly, predictions based on earthquake scenario are not to make plan, it is important to show that how many buildings will be destructed in specific earthquake magnitude and it is useful knowledge that how many people will be died.

Figure 3.10: Diagram of earthquake risk management and contingency planning process at settlements (Balamir, 2002)



However, it should not overlook that recognition and identification based on prediction and estimation only constitute diagnosis. According to the prediction, duty distribution can be done at crisis planning but these constitute contingency planning. Contingency planning supplies integrated physical arrangements by law sanctions and implementation component in order to consider mitigations. Geological data and maps is not a plan even if it has detailed and right content. Contingency planning must set off with geological data but planner only passes from knowledge of hazards to risks. Planner determines physical and social alternatives according to urban data and risk distribution and supplies to decision of urban managers (Balamir, 2002, p: 40).

Actions, components and implementations of engineering, architectural and other disciplines except planning do not supply alone a comprehensive framework for mitigation of earthquake damage. Their implementations do not include integrated content and they are often biased to emphasize particular aspects of intervention. In many studies, the distinct nature of post-disaster rebuilding activities and the management of disaster-safe cities are often overlooked. Scenario analyses are often assumed as the only possible method of approach for the latter context. Much remains to be developed however, within the body proper of urban planning theory and methods of implementation (Balamir, 2002b). Contingency planning involves integrated and operational approach to urban seismic risk management.

At the existence settlements analysis of urban risks will include urban macroform analysis, urban pattern analysis, land-use analysis, special areas analysis, building stock analysis, special buildings and environments analysis, hazardous units and uses analysis, infrastructural systems analysis, key components spatial analysis, key components safety analysis, undeveloped land availability analysis, urban development trends analysis, external effects analysis, urban management deficiencies analysis.

Moreover, another phase of contingency planning is to investigate the performance of urban systems under different disaster scenarios. This phase includes emergency urban performance analysis, emergency service units' capacity analysis, emergency urban management capability analysis of city administrations, emergency service structures internal risk analysis etc. these are necessary for building up safer cities. Contingency

Master Plan of cities would then be based on such analyses, and risk assessment information could be inputs for all further forms of urban management (Balamir, 2002).

3.5.4. A Sample Mitigation Study for Earthquake and Planning Process: Istanbul

Analysis form of earthquake master plan for Istanbul is the same as this thesis. At each working data is analyzed in the scale of “mahalle”. Also, master plan emphasizes natural risk factors and earthquake damage is determined by possible earthquake, building and population density. While earthquake master plan aims to calculate possible earthquake damage based on scenario earthquake in Istanbul, the thesis investigates role of planning decisions and urban rent on earthquake damage. Therefore, variables of the thesis differentiate from master plan. However, earthquake master plan for Istanbul is submitted as a sample and guidance to planning workings. Analysis maps of earthquake master plan for Istanbul in scale of “mahalle” are submitted in the end of this chapter (see figures 17- 22).

Earthquake master plan for Istanbul includes three steps. It is necessary to be prepared comprehensive geological, geophysical data and to be had scenario earthquake. Then, first step is contingency planning. The second step is action plans. The third step is research and activity program. This planning approach is a process planning and thus it is different from conventional planning process.

In Turkey, the first preparation of the earthquake loss assessment and earthquake master plan for the city of Izmir was prepared by Bogazici University in connection with the RADIUS project of the UN-IDNDR (International Decade for Natural Disaster Reduction) in 1999. Source of the increased risk in Istanbul is the unprecedented increase of the probability of occurrence of a large earthquake (which stands at about 65% during the coming 30 years). The inevitability of the occurrence of such a large earthquake in Istanbul makes it imperative that certain preparedness and emergency procedures be contrived in the event of and prior to an earthquake disaster, which in turn requires the quantification of effects of the earthquake on physical and social environment (Aydinoglu and Erdik, 2002, p: 3). Istanbul is the second sample for mitigation of earthquake damage. Some Institutes, foundation and universities such as American Red Cross (ARC), Japan International Cooperation Agency (JICA), Bogazici, Istanbul Technical, Middle East Technical and Yildiz Technical Universities with The metropolitan municipality of Istanbul have simultaneously made researches related to micro-zones and earthquake risk. Istanbul Basic Plan for disaster mitigation including seismic micro-zones started in 2001 and finished in 2003. The metropolitan municipality of Istanbul (IBB) and Japan International Cooperation Agency (JICA) carried out. This plan covered border of the metropolitan municipality of Istanbul, Silivri, Çatalca and Büyükçekmece and it constitute basic source for earthquake master plan. The project identified vulnerability of infrastructure and buildings, number of causality etc in probable earthquake in Istanbul according to the earthquake scenario. Aims of the research are to integrate and develop seismic micro-zone research with plan of disaster mitigation, to define building damage and infrastructure damage, constitute data base, to define priority concerning update, retrofitting and development, to calculate earthquake hazard and to offer mitigation programs. Data collected various institutes, foundation and municipalities was used on Geographic Information Systems (GIS). Content of GIS map included elevation, slope, geology map, analysis of damage, distribution of population within districts, distribution of population within districts, distribution of buildings according to districts, distribution of buildings according to date of construction, distribution of buildings according to number of floor, transportation lines, bridges of highway and railway, water lines, sewage lines, natural gas lines, electricity line with high voltage, accessibility of roads, resource of rescue and emergency aid, map of ground classification, distribution of earthquake ground motion, map of liquefaction and slope sensitive. Analysis of ground was based on existing geologic map and data of drilling well. Analysis of buildings includes date of construction, number of floor, quality of buildings and type. For this reason, in 35 districts, 20.000 buildings were inspected through sampling. After collecting and mapping data, earthquake hazard through analysis of data and maps was estimated. In context of micro-zone project, in six regions, new seismographs were placed and several earthquake scenarios related to main Marmara fault were developed (Iskenderoglu, 2002, p: 228-241).

Bogaziçi University, the Department of Earthquake Engineering was sponsored to develop a sub- district level earthquake risk assessment for the Istanbul metropolitan area. The project is focused on the following objectives:

1. Development of an Istanbul metropolitan area risk model.

2. Development of estimates for human and social impacts as a result of such a scenario earthquake, including: Building damage, Casualties and People left homeless. Damage to infrastructure and lifelines are only dealt in general terms based on the intensity levels.
3. Public provision of the results via the Internet to enable disaster response planning (Erdik, 2002a, p: 2).

Development of the project involves earthquake hazard and risk analysis, Development of urban earthquake damage scenarios, Characteristics of strong earthquake ground motion, Site and soil response analysis, Earthquake response of buildings, industrial facilities, bridges and dams; Soil-structure interaction; Dynamic testing of small scale model and prototype structures, Retrofitting and post earthquake strengthening of structures; Damage evaluation and earthquake insurance; and the Development of earthquake resistant design codes. The first ingredient of this loss scenario is the assessment of the earthquake hazard, quantified in terms of spatial distribution of site-specific intensities or spectral accelerations. The vulnerabilities and the damage statistics of buildings, lives and other facilities constitute the second ingredient. Urban earthquake loss scenarios are based on the intelligent consideration and combination of the hazard and these vulnerabilities.

The metropolitan municipality of Istanbul (October, 2002) signed a memorandum of agreement with the Bogaziçi, Istanbul Technical, Middle East Technical and Yildiz Technical Universities to develop a comprehensive earthquake risk mitigation master plan which includes technical, legislative, administrative, social and economical issues and strategies of large scale retrofit, renewal and relocation campaigns (Aydinoglu and Erdik, 2002, p: 2). Earthquake risk mitigation master plan includes following phases:
1. Assessment of existing building stock, urban and public space and infrastructure facilities in terms of earthquake in order to make safe.
2. To determine short and long run decisions, measures and implementations related to Istanbul
3. To develop priority strategies in order to rebuild Istanbul and to perform implementations and determine pilot areas. Zeytinburnu was selected as Pilot project area and simultaneously started to perform together with earthquake master plan. Then pilot implementations will be extended (IBB, 2003, P: 2).

Erdik says that Earthquake master plan should be seen as a guide to take all measures before earthquake. Content of methodology which was used for earthquake master plan involves following steps:

To select the city area to be studied

To specify the scenario earthquake with potential fault breaks,

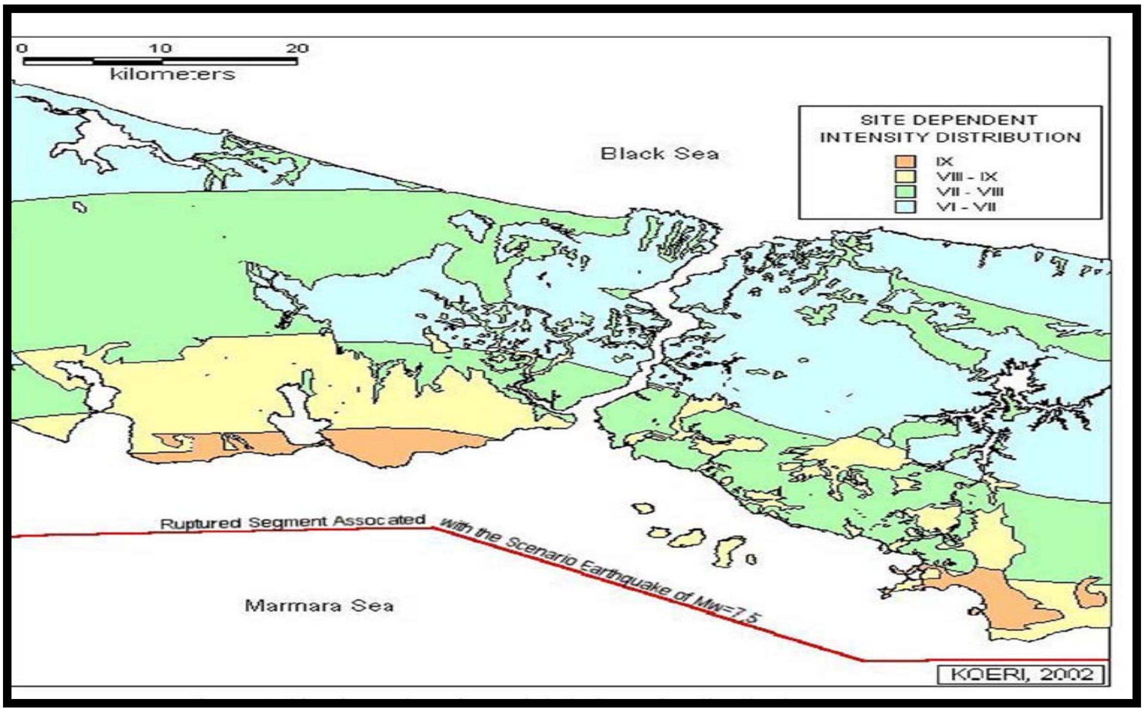
To collect/compile information for delineating local soil conditions,

To collect/compile information of inventory of building classes and other lifelines,

To compute earthquake hazard information in the form of site-specific ground motion,

Using vulnerability data embedded in the software (or externally provided) assess damage to different classes of buildings and casualties (Erdik, 2002a, p: 5)

Figure 3.11: Site Dependent Intensity Distribution According to the Scenario Earthquake



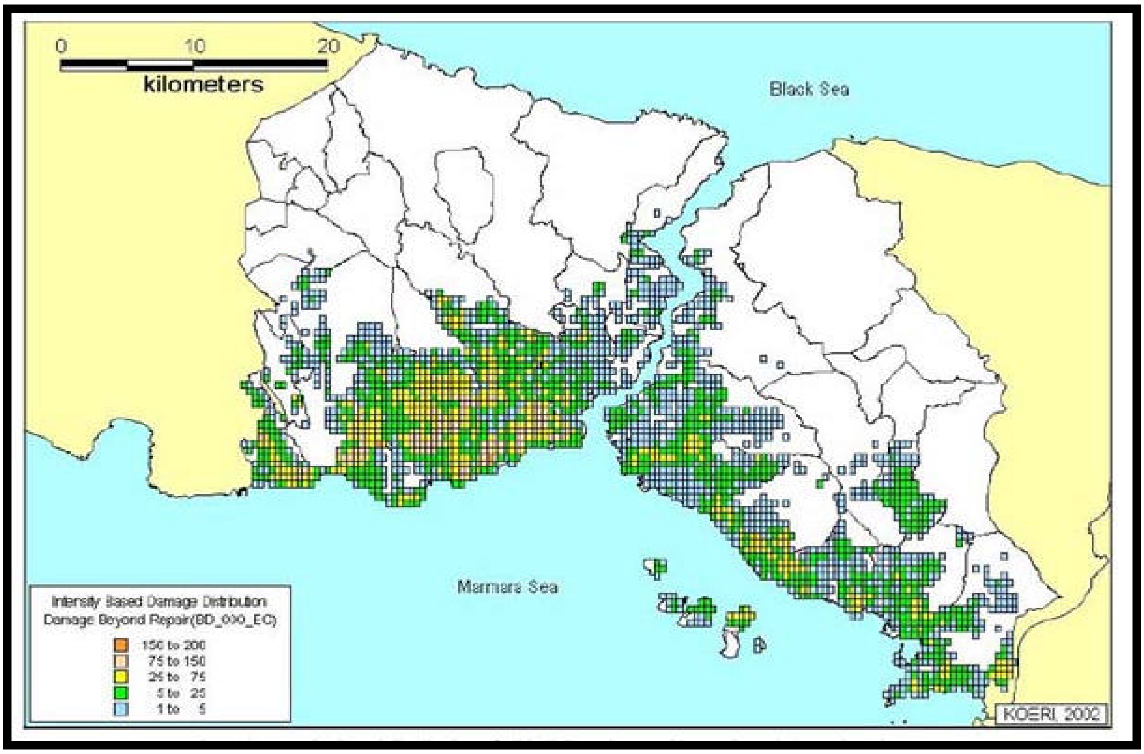
Source: Erdik, 2002

Erdik(2002a,b) described process and consequences of comprehensive earthquake risk mitigation master plan for Istanbul. At first, Earthquake Hazard for Istanbul, a worst-case scenario earthquake of Magnitude 7.5 was assumed to take place on the Main Marmara Fault. Figure 3.12 provides site dependent deterministic intensity distribution for Istanbul as a result of earthquake scenario. The project team collected data about Building and other lifeline systems from Istanbul Metropolitan Municipality, State

Statistical Institute, Turk Telekom analog maps, imagery from helicopter flights and aerial and satellite imagery. According to data and results, the building inventory is classified. Each category is further subdivided into groups to yield 24 different building classes. Istanbul Metropolitan Area was divided into grids as 0.005° x 0.005° (approximately 400 m x 600 m) cells for aggregation of hazard and physical inventory data.

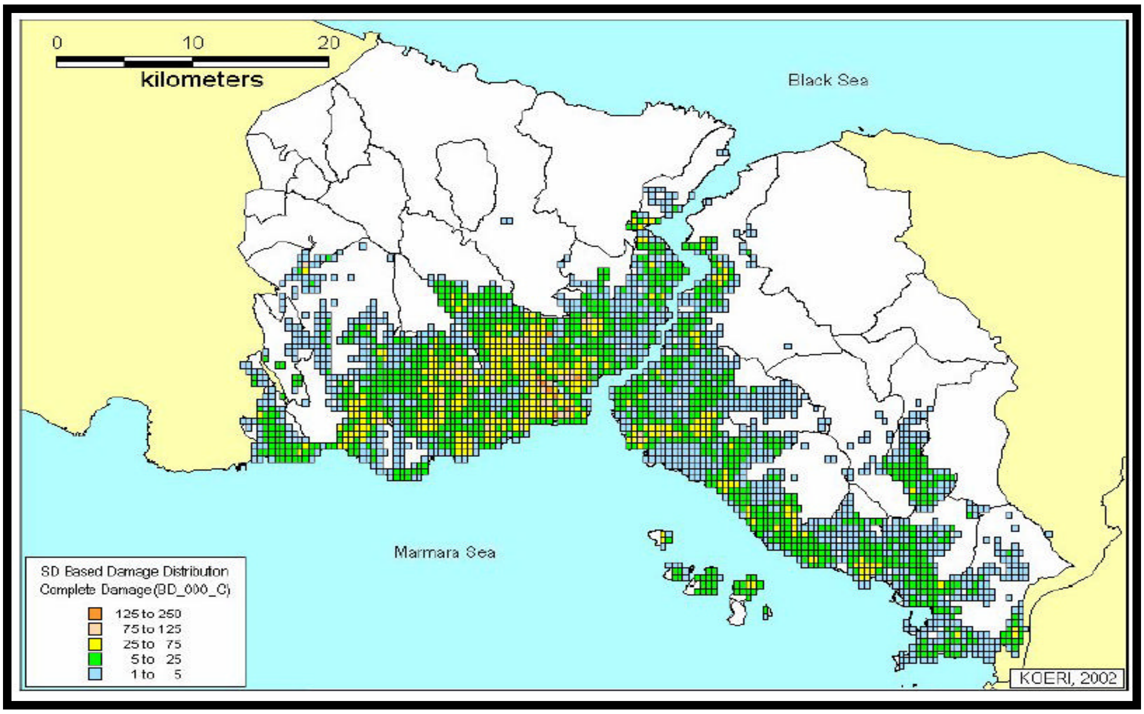
The day and night time population of 26 districts were determined, and then assigned to the geo-cells in order to calculate the human losses in Istanbul due to a major earthquake. The population and building data for Istanbul were obtained from the State Statistics Institute. For the determination of day population, Istanbul Transportation Master Plan was used.

Figure 3.12: Intensity Based Distribution of All Buildings Damaged beyond Repair (complete damage)



Source: Erdik, 2002

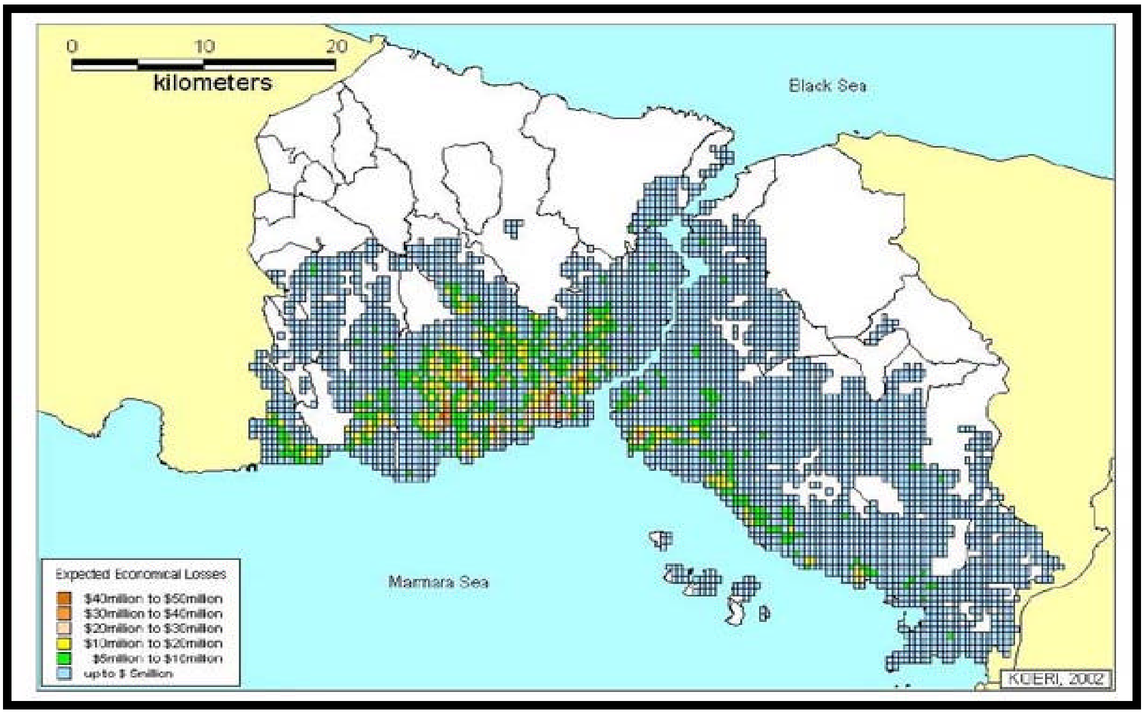
Figure 3.13: Spectral Displacement Based Complete (beyond repair) Damage Distribution



Source: Erdik, 2002

In the earthquake loss scenario for Istanbul, two methods were used in order to determine vulnerability of buildings. These are intensity-based vulnerability (see figure 3.12) and spectral displacement-based building vulnerability (see figure 3.13). Results of two figures showed that a total of about 35,000 to 40,000 buildings (about 5% of the total building stock) were estimated to be damaged beyond repair (complete damage). Most of casualties are expected in this damage group, especially in a subset of this group where the collapse will be of the worst "pancake" form. In pancaked buildings the floors pile up on top of each other rendering very difficult conditions for search and rescue. Estimation for collapsing pancaked buildings will be in the vicinity of 5,000 to 6,000. Furthermore about 70,000 buildings will receive extensive damage and about 200,000 buildings will be moderately damaged. Both of these damage groups are repairable. The total monetary losses due to building damages caused by the scenario earthquake are estimated to be in the range of about USD 11 Billion (see figure 3.14).

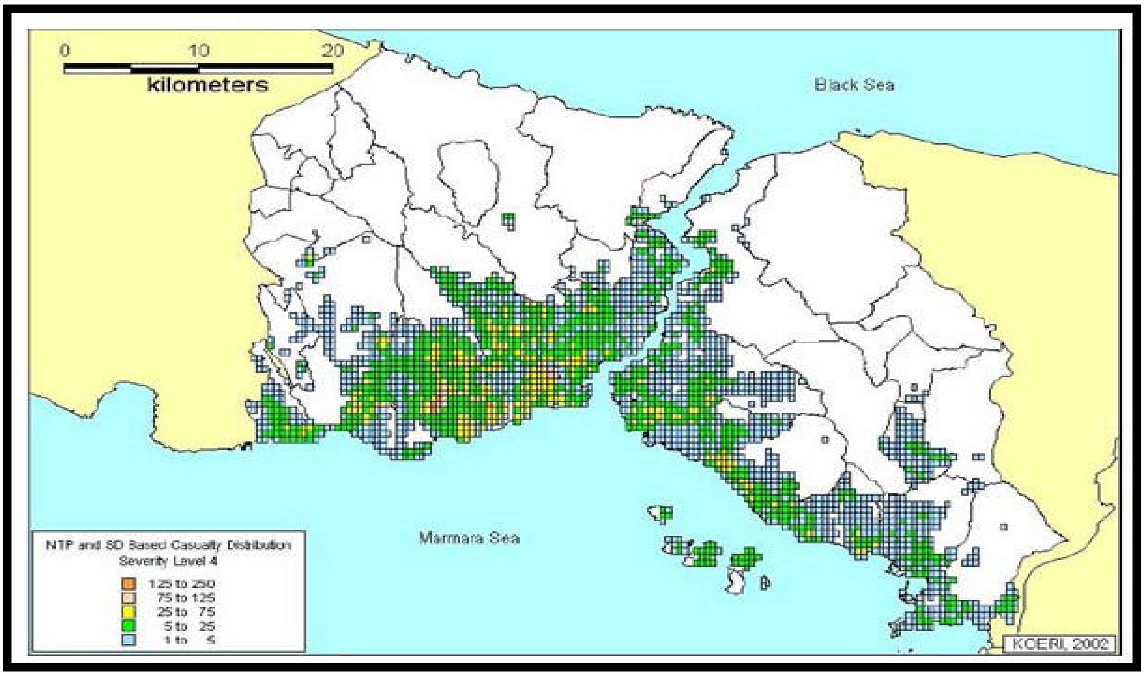
Figure 3.14: Distribution of Direct Financial Losses due to Building Damage



Source: Erdik, 2002

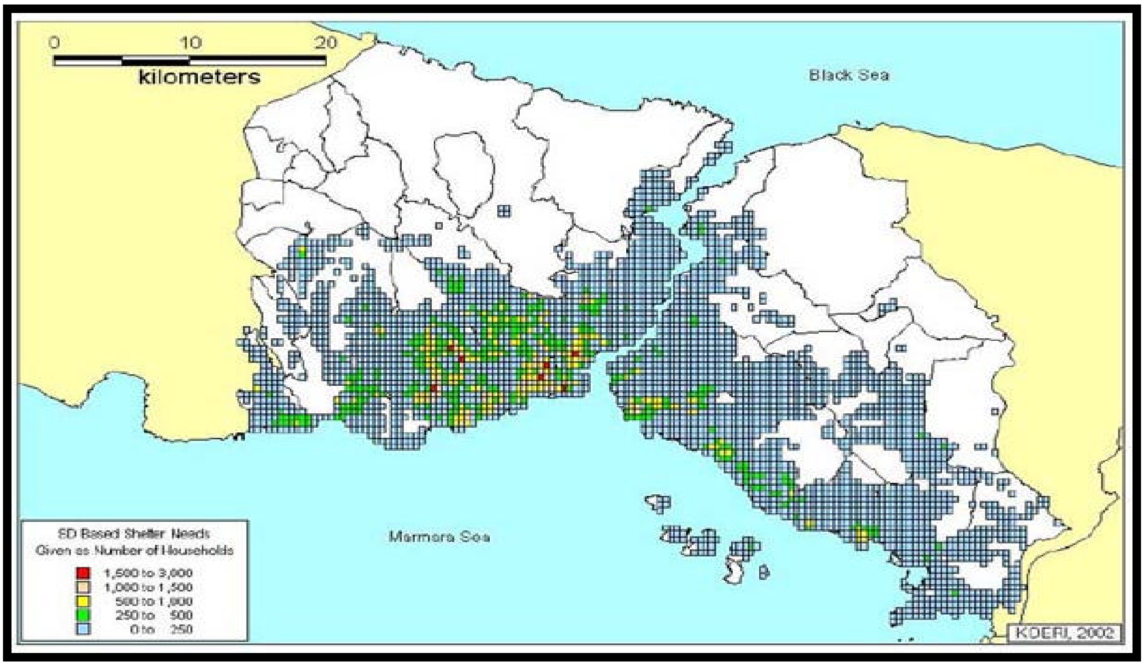
According to consequences of earthquake scenario, Building damages are mostly concentrated in the densely populated districts located in the southwestern part of the city, such as Eminönü, Fatih, Zeytinburnu, Bakirköy, Bahçelievler, sourhern part of Kücükcekmece and Avcilar, and to a lesser degree, in districts such as Kadiköy, Maltepe and Kartal located on the southeastern part of Istanbul. Even though some districts situated in relatively farther locations from the main Marmara fault, due to the building density and vulnerability conditions, districts of Beyoglu, Eyup and Bayrampasa are also expected to undergo high levels of damage. As the result of the analysis conducted for various structure types, the mid-rise reinforced concrete structures constructed before 1980 are found to constitute the most vulnerable building class. The research shows that the most vulnerable building group is found to be medium-rise (4-7 story) reinforced concrete frame buildings built prior to 1975 because these buildings do not meet existing standard of codes and regulations. In majority, the ground floors are often left open for shops and irregular plan shapes are common due to irregular land lots and urban congestion. These features increase their vulnerability. Number of death in earthquakes arises mostly from structural collapses and to a lesser degree from collateral hazards. Estimations show that number of the death would vary between 30000 and 40000(see figure 3.15). As the result of the intensity based analysis a total of about 600,000 households and from the spectral based analysis a total of about 430,000 households were assessed to be in need of shelters following the scenario earthquake(see figure 3.16).

Figure 3.15: Distribution of Deaths for a Night-Time Scenario Earthquake



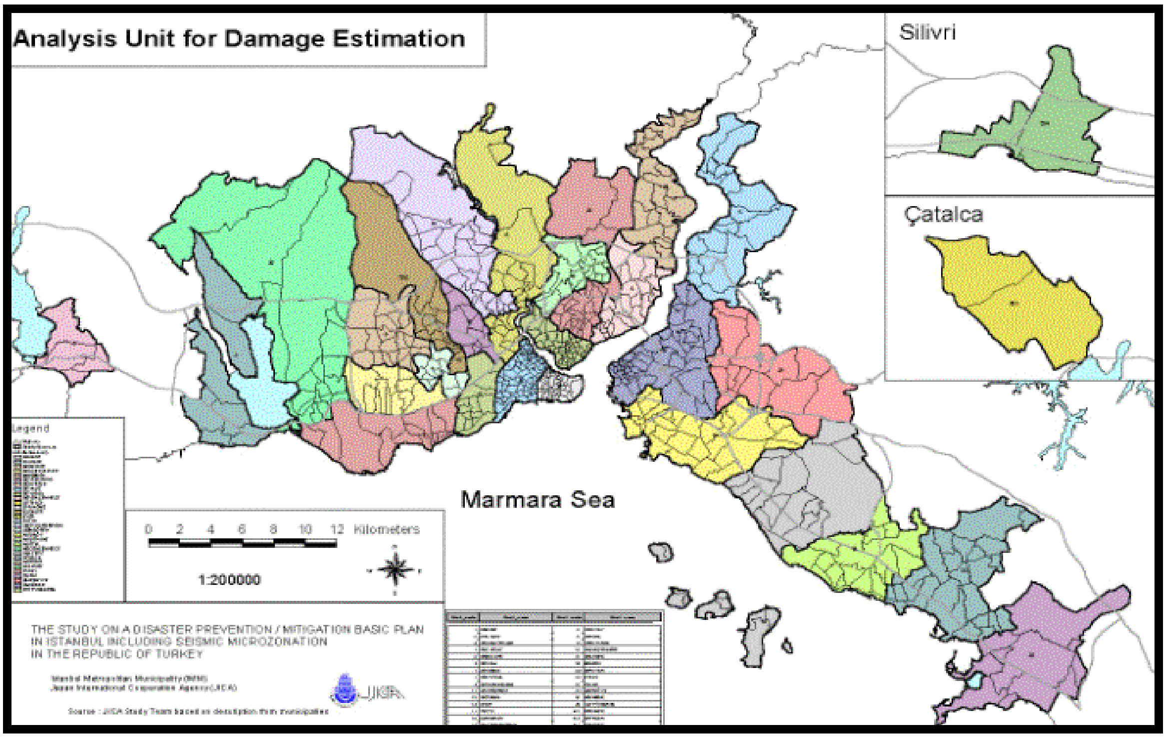
Source: Erdik, 2002

Figure 3.16: Distribution for Families in Need of Emergency Sheltering



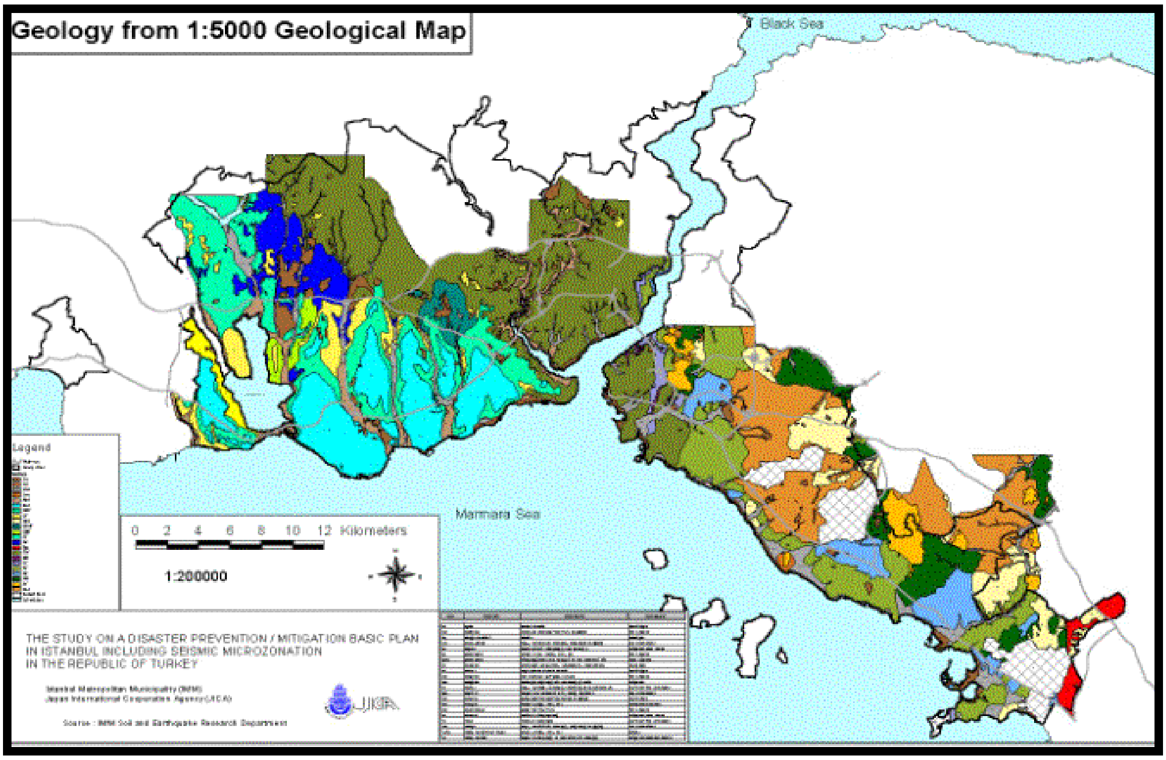
Source: Erdik, 2002

Figure 3.17: Analysis Unit for Damage Estimation



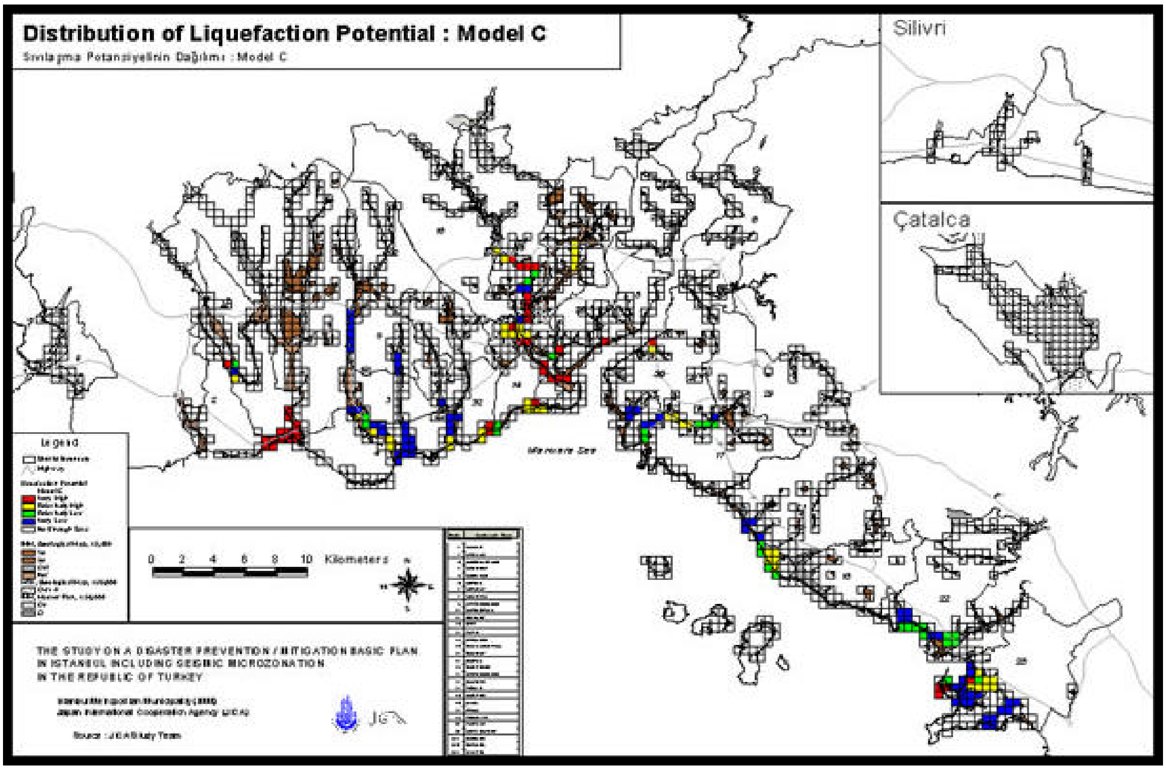
Source: The Greater Municipality of Istanbul, 2003

Figure 3.18: Geological map of Istanbul



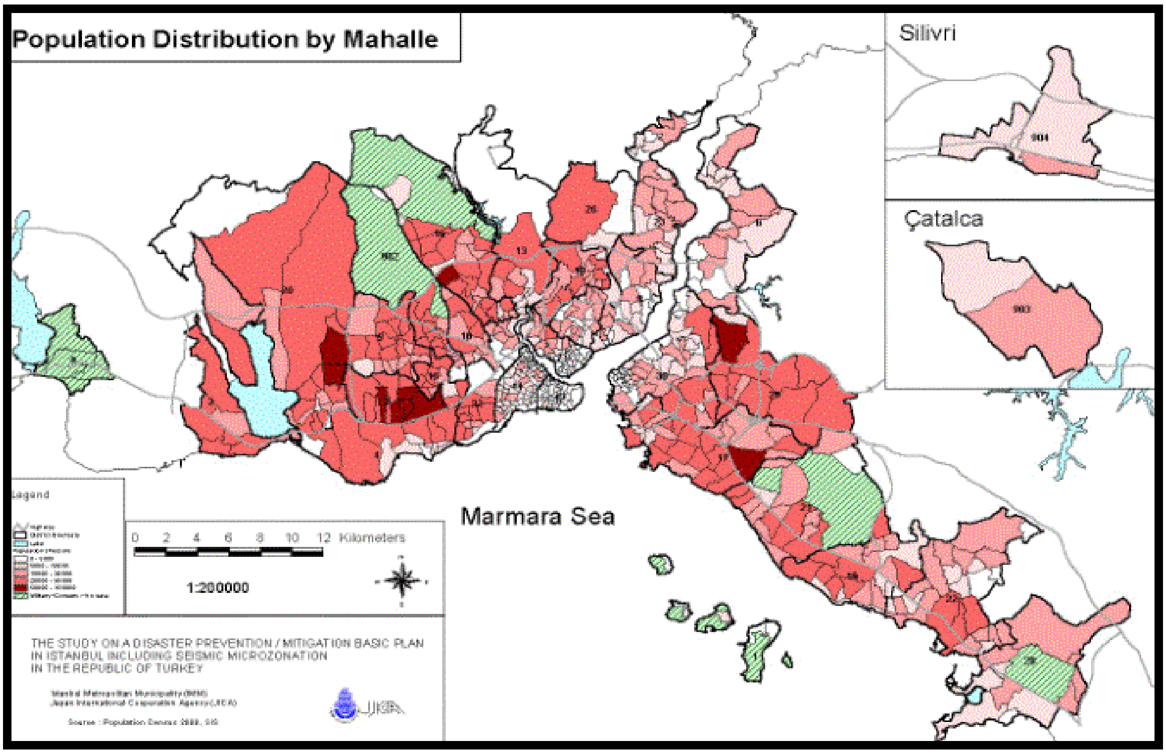
Source: The Greater Municipality of Istanbul, 2003

Figure 3.19: Distribution of Liquefaction Potential According to Model C



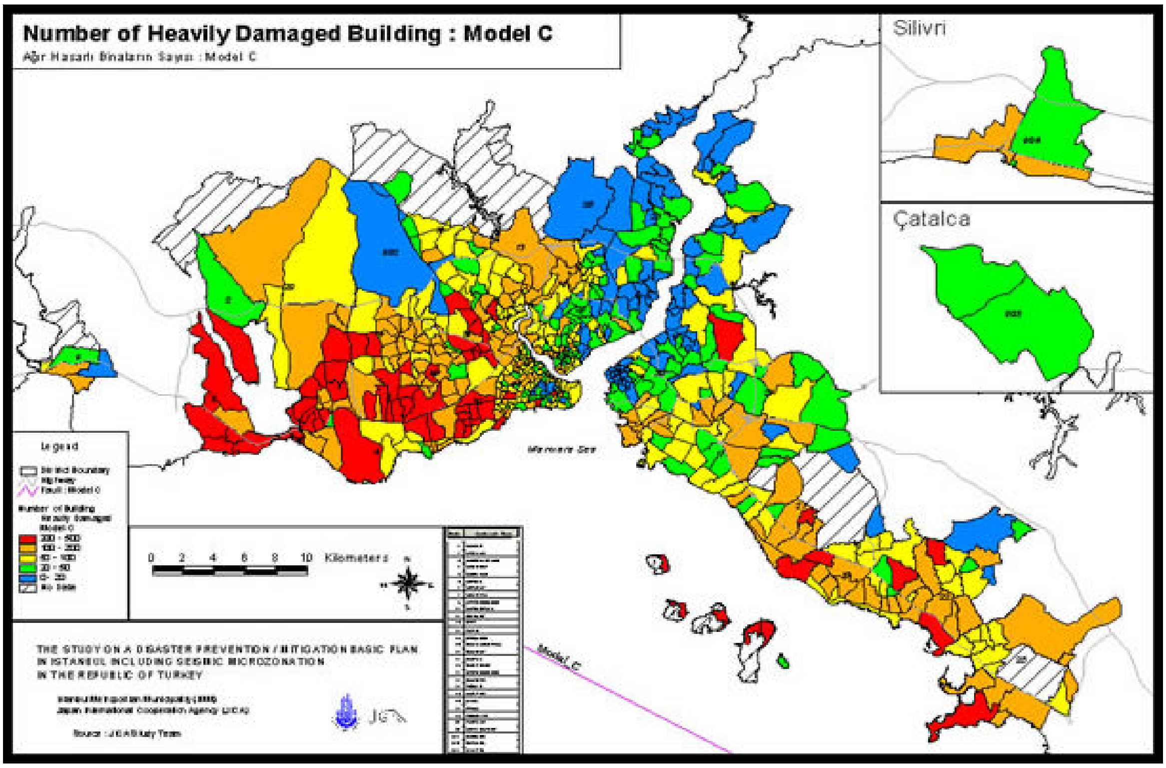
Source: The Greater Municipality of Istanbul, 2003

Figure 3.20: Population Distribution by "Mahalle"



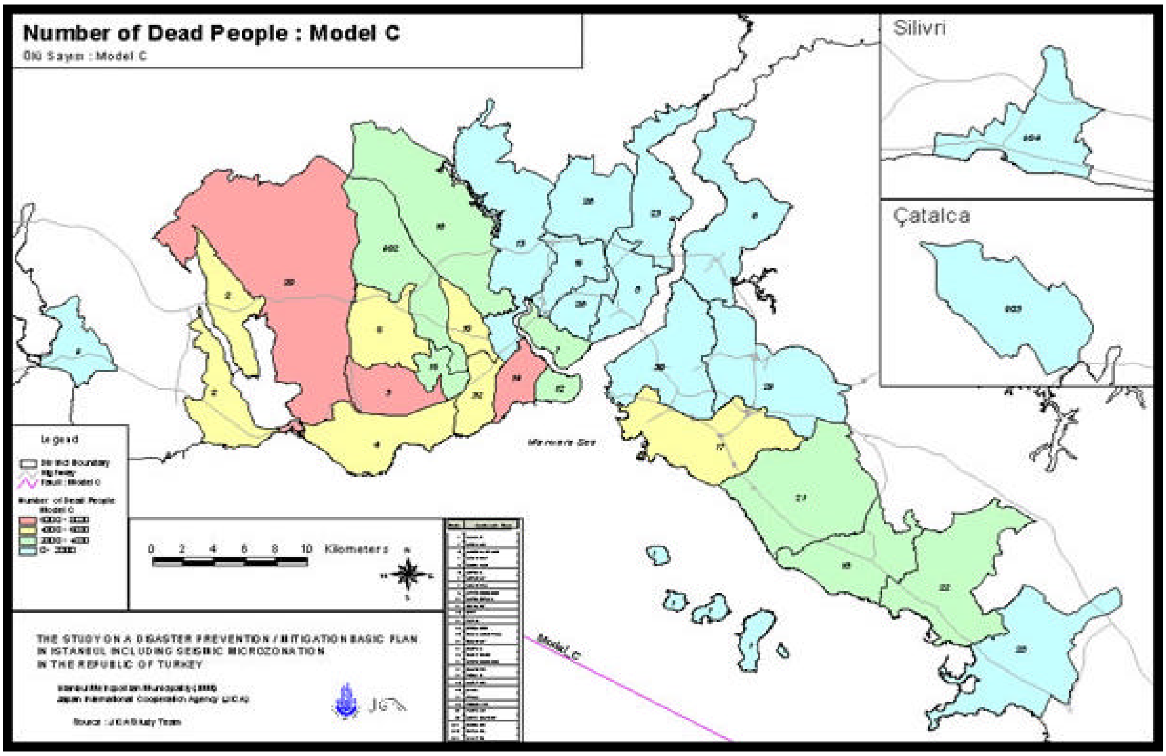
Source: The Greater Municipality of Istanbul, 2003

Figure 3.21: Number of Heavily Damaged Building According to Model C



Source: The Greater Municipality of Istanbul, 2003

Figure 3.22: Number of Dead People According to Model C



Source: The Greater Municipality of Istanbul, 2003

Chapter 4
METHODOLOGY

4.1. Defining Methodology: Determining parameters of Earthquake Damage and Urban Rent

The study describes risk factors as natural, socio-economic and technical risk factors but focuses on socio-economic risk factors and their impact on earthquake damage, especially planning decision and urban rent related to earthquake damage. The study indirectly discusses relationships among earthquake damage, urban rent and planning decisions. For this reason, the influence of planning decisions on urban rent is researched in firs step analysis and in second step analysis relationship between urban rent and earthquake damage. The study should be seen as experimental approach.

This chapter includes the methodology of research. In this study, the research methodology is briefly comprised of the following steps:

? Literature survey
? Problem definition within the context of earthquake damage, urban rent and planning decisions: problem is that various forms of urban rents cause to rise of the risk of earthquake damage, most of which are through planning changes and planning decision
? Defining the study area (Adapazari) and gathering data about Adapazari and the variables for method, defining the method (correlation and regression analysis). All data is to be converted to numerical values
? Assessing outcomes, findings and testing the hypothesis
? Deriving out the major conclusions

In literature, there is not much the same method used in the thesis. Method used in the thesis is unique because previous workings has not taken into account together with planning, earthquake damage and urban rent but in the different context, analysis form used similar to earthquake master plan for Istanbul to calculate possible earthquake damage. It is important to use a method to prove our claims. In this study analysis form used is similar to analysis form used in earthquake master plan for Istanbul. Erdik (2002)'study: "Earthquake Risk Assessment for Istanbul Metropolitan Area", Aydinoglu and Erdik (2002)'studies: "Earthquake Risk to Buildings in Istanbul and A Proposal towards Its Mitigation" and "Metropolitan municipality of Istanbul' Earthquake master plan reports" guide to data analysis. However, in those studies, natural factors are dominant such as magnitude of earthquake, liquefaction, and length of fault line although there are some social factors such as population density. On the contrary, the thesis emphasizes social factors on earthquake damage such as urban rent and planning decisions. Therefore, contents of analysis is differentiates from studies for Istanbul.

In this study, unit of data analysis is defined as scale of district or "mahalle" in Adapazari. Before analysis is started, classification of land value, distribution of damage, the number of story is essential to ensure a uniform interpretation of data and results. Method of the thesis comprises of two steps. Firstly, data such as population density, earthquake damage, the physical building density, and land value (urban rent) in Adapazari is assigned to unit of "mahalle". After analysis in scale of "mahalle" is completed, correlation and regression analysis through variables are conducted in order to enlighten relationships among earthquake damage and urban rent and plan decisions. After all that, if expected results are obtained and independent variables in regression and correlations analysis strongly explain dependent variable, possible earthquake damage can be calculated in future through independent variables of social risk factors.

The case study includes 26 "mahalle" that locate in the city centre. Data collected is limited to social risk factors and data is conducted in 26 "mahalle". Data base for the case study was provided from the greater municipality of Adapazari, the governor of Sakarya, university of Sakarya and Bahar Gedikli'papers. In this study Method of the thesis comprises of two steps. Firstly, data such as population density, earthquake damage, floor area ratio ("Kaks"), ground area ratio ("Taks") and urban rent in Adapazari is assigned to unit of "mahalle".

4.2. Regression and Correlation Analysis

There are two steps in analysis. At first step the study examines that what planning decisions urban rent influence and what their explanatory degree is through regression and correlation analysis. For this step dependent variable is land value or urban rent. Independent variables are population density, distance to the city center and ground area ratio. In the second step dependent variable is proportion of earthquake damage. Independent variables are land value or urban rent, average distance of demolished buildings to the city center and physical building density. Variables coming planning decisions and urban rent and earthquake damage in second step are analyzed through correlation and regression.

In regression analysis R square is between 0 and 1. If R square is 0, there is not any relationship between dependent and independent variable. If R square is small than 0.5, relationship between dependent and independent variable is weak. If R square is big than 0.5 and it is near 1, there is a strong relationship dependent and independent variable.

Correlation analysis provides information about degree of variables' relation. In correlation analysis, r is between -1 and 1**(-1<r<1)**. If value of r is near 0, relationship between variables is weak. If value of r is near -1 or 1, there is a strong relationship between variables.

Regression analysis is used when the researcher wants to determine what variables contribute to the explanation of the dependent variable and to what degree. In this study there are more than one variable. Therefore, multiple regression analysis is used. Multiple regressions are conducted by SPSS package program. For determining impact of independent variables on dependent, stepwise, backward and forward method will be used.

Stepwise method: the best independent variables correlated with the dependent variable are included in the equation, the remaining independent variable with the highest partial correlation with the dependent variable, controlling for the first independent variable, is entered.

Backward method: independent variables are removed one at a time and the effect on R is evaluated.

Forward method: independent variables are entered one at a time to analyze how much each one adds to the explanation of the dependent variable

Model Specification: Y, the dependent variable, is a function of one or more of the explanatory variables. This function could be written as:

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e,$

where $b_0, b_1, b_2, b_3,$ (coefficients) are estimates of $?_0, ?_1, ?_2, ?_3,$,(fixed but unknown parameters of the model), e is the estimates of $?$ (error or residual), $Y, X_1, X_2, X_3,$ are the variables of the model. Ordinary Least Squares (OLS) method could be used to estimate these coefficients. In order to calculate these coefficients, computer packages can be used such as SPSS.

Next step is analyzing the variance of accounted by the model (regression, residual, and total sum of squares which are accounted by the model) in order to recognize full model's explanation power to account model validity. Analysis of Variance (ANOVA) table displays information about the variation that is accounted or not accounted by the model.

The formulation of F Tests measures the effect of independent variables on dependent variable. Because of this, these equations are used in order to test the regression model.

$$H_0: ?_1 = ?_2 = ?_3 = ?_4 = \ldots\ldots\ldots = ?_k = 0$$

$$H_1: ?_1 \; ? \; ?_2 \; ? \; ?_3 \; ? \; ?_4 \; ? \; \ldots\ldots\ldots ? \; ?_k \; ? \; 0$$

F > F? , k, n-k-1, we may reject H_0 and linear regression model is consistent. X independent variables can explain the dependent variable y.

F < F? , k, n-k-1, we may not reject H_0 and linear regression model is not consistent. X independent variables can not explain the dependent variable y.

The t statistics can help to determine the relative importance of each variable in the model. The t values of the table are calculated by unstandardized coefficients' ß values divided by standard error value of the same variable. This test is used to determine that (1)do the coefficients confidence intervals contain zero and (2)how stable these coefficients are. If the coefficients t value contain zero value (first aspect), then it may be removed from model in parallel of the other coefficients fluctuate values. If there is high correlation between two or more variables, it is possible to have very unstable coefficients. This problem is called as multicollinearity. Models with too many variables are often over fit and hard to interpret. Identifying any multicollinearity between variables is important to model validity.

First step: It assumes that population density, distance to the city center and ground area ratio determine urban rent or land price.

a) *Dependent variable*: In twenty-six districts urban rent is dependent variable of this step.
b) *Explanatory variables or determinants:*

Population density(X_1): If population density is high in urban area, land price or urban rent usually is higher than other districts in the city center. Population density show that space use of desire determines so in higher population density in the city center people pay more than usual. But also it is possible that in prestige housing area or upper class housing area, population density is less than other places but land price is higher. In those areas, urban service determines land price or urban rent. However, in central business district, land price or urban rent is usually highest.

Distance to the city center(X_2): land price or urban rent has the highest rate in central business districts (CBD). People want to be close the CBD due to urban service. Thus people want to use vicinity of CBD and pay more than usual near the CBD. Land price or urban rent decreases from CBD towards fringe of the city.

Ground area ratio(X_3): if construction area of building on ground is higher, for different uses in the city center desire of payment increases. Thus land price or urban rent can increase.

Floor area ratio(X_4): it represents total construction area of building. If floor area ratio is high, landlord can obtain revenue or income and usage advantages increases. Thus people want to pay more than usual in those areas.

After relationships between dependent and independent variables are examined through regression and correlation analysis, required adjustment is done. Variables are assessed and pass to second step.

The second step:

a) *Dependent variable:* In twenty-six districts earthquake damage ratio is dependent variable of the second step. Earthquake damage ratio is found by dividing the number of demolished building on the parcel in each district to total parcel in each district area.

b) Explanatory variables or determinants

Land price or urban rent (X_1): It is assumed that if land price or urban rent is high, earthquake damage become high ratio. If in developing countries land price is high, builders want to decrease cost of construction due to the scarcity of capital and so quality of building on the highest land value does not resist against earthquake.

Distance to city center(X_2): This variable is calculated through demolished buildings with distance to the city center and average distance of demolished buildings is measured in each district. Land price or urban rent, population density and physical building density have the highest rate in central business districts (CBD). Those variables decrease from CBD towards fringe of the city. Thus earthquake damage ratio usually decreases in fringe of the city.

Physical building density or Floor area ratio(X_3): it represents total construction area of building. If floor area ratio is high, in possible earthquake, building damage may increase together with other factors. For example, buildings with adjacent order influence each other and demolishing rate increases due to high building density. Also high rise buildings influence their surrounding and damage ratio can increase.

Chapter 5
THE CASE STUDY

5.1. Why Adapazari is as a case study?

There are three reasons for selecting Adapazari as a case study. First, three planning practices took place (1960, 1974, and 1985) between the two destructive earthquakes (1967 and 1999) in Adapazari before Kocaeli earthquake. Third, Adapazari has data based on GIS. Moreover, the last decisions of master plan (1985) have been an important factor in population increase and building density and in the last earthquake the highest damage took place in those dense areas. Those data to verify or falsify my claims is needed. Therefore, Adapazari was determined as case study. With respect to Adapazari, socio-economic structure, development plans, industrial investments, geological structure, land value, urban areas damaged from earthquake in 1999, the number of story, the number of damaged building, data were collected.

5.2. Historical background of Adapazari and Socio-Economic Development

Municipality of Adapazari founded in 1869. Sakarya became province in 1954. The greater municipality of Adapazari was founded in 2002 and has 330 ha area. The greater municipality of Adapazari consists of 12 municipalities made up of 47 districts in total. Only 28 districts are within the borders of Adapazari County (The greater municipality of Adapazari, 2003).

Between 1923 and 1945, there were two investments, railcar factory of TCDD and agricultural machine factory of TZDK in Adapazari. Between 1940-1950, Sakarya' growth became 3.9% and Adapazari' growth became 4.1% due to public investments. Between 1946 and 1960, investments of sugar factory (1953), niskoz factory (1955), Arifiye glass factory (1957) and industry of acid (1959) took place.

In this period, in Adapazari and Sakarya the fastest development took place and Sakarya' population growth became 3.9% and Adapazari' population growth became 6.7% due to public investments. Between 1963 and 1983, investments continued in

Sakarya and Adapazari such as Feed factory (1969), tank and track factory, Uniroyal tire factory (1964), Istanbul segman industry, Kimak Machine As, etc. between 1960 and 1970 population growth in Adapazari and Sakarya decreased due to earthquake in 1967 according to the preceding period of time.

After 1980, industrial investments in Istanbul headed towards Tekirdag, Izmit, Bursa, and Sakarya due to rise in land value in Istanbul, and organized industrial regions. Between 1980 and 1990, population growth in Adapazari became 3.4% (B. Sengezer, 2000, p: 38-41).

Population of Adapazari as a city center reached to 74225 in 1955, 111064 people in 1970, 195069 people in 1980, 297759 in 1990 and 331431 people in 1997(TMMOB, 2000). Sakarya has potential for agricultural and industrial developments due to transportation advantages and access to the market and big consumption center such as Istanbul. For this reason, in 1960s, while the eastern Marmara regional plan was prepared, industrial firms in Istanbul and new industrial investments were predicted to move to Izmit, Bursa and Adapazari. Population and building density increased due to Industrial investments. Therefore, for the last three decades, population of Sakarya has grown four times.

Table 5.1 provides distribution of urban and rural population according to years. While urban population has been increasing, rural population has decreased. At the same time, proportion of urban population increased from 25% to 45% in Sakarya (B. Gedikli, 2002, p: 55).

Table 5.1: Alteration of urban - rural population in Sakarya

years	Total population	Growth proportion	Urban population	Rural population	Proportion of urban pop.	Proportion of rural pop
1955	297078		74255	222823	%25	%75
1960	361992	%18	111064	250928	%31	%69
1965	404078	%10	124936	279142	%31	%69
1970	459052	%12	152277	306775	%33	%67
1975	495649	%7	172210	323439	%35	%65
1980	548747	%10	195069	353678	%36	%64
1985	610500	%10	227625	382875	%37	%63
1990	683281	%11	297759	385302	%44	%56
1997	731800	%7	331431	400369	%45	%55

Source: Governor of Sakarya, 2003

In the meantime, population density in Sakarya increased from 114 people/ km^2 in 1980 to 127 people/ km^2 in 1985, 142 people/ km^2 in 1990 and 152 people/ km^2 in 1997. Population density in Adapazari was 490 people/ km^2 in 1990(B. Gedikli, 2002, p: 55).

The number of industrial factories and population density increased due to migration from rural area to urban area in Adapazari and the foreign and domestic investments. As a result of this situation, in various sectors the number of firms has approximately reached to 300(Governor of Sakarya, 2003).

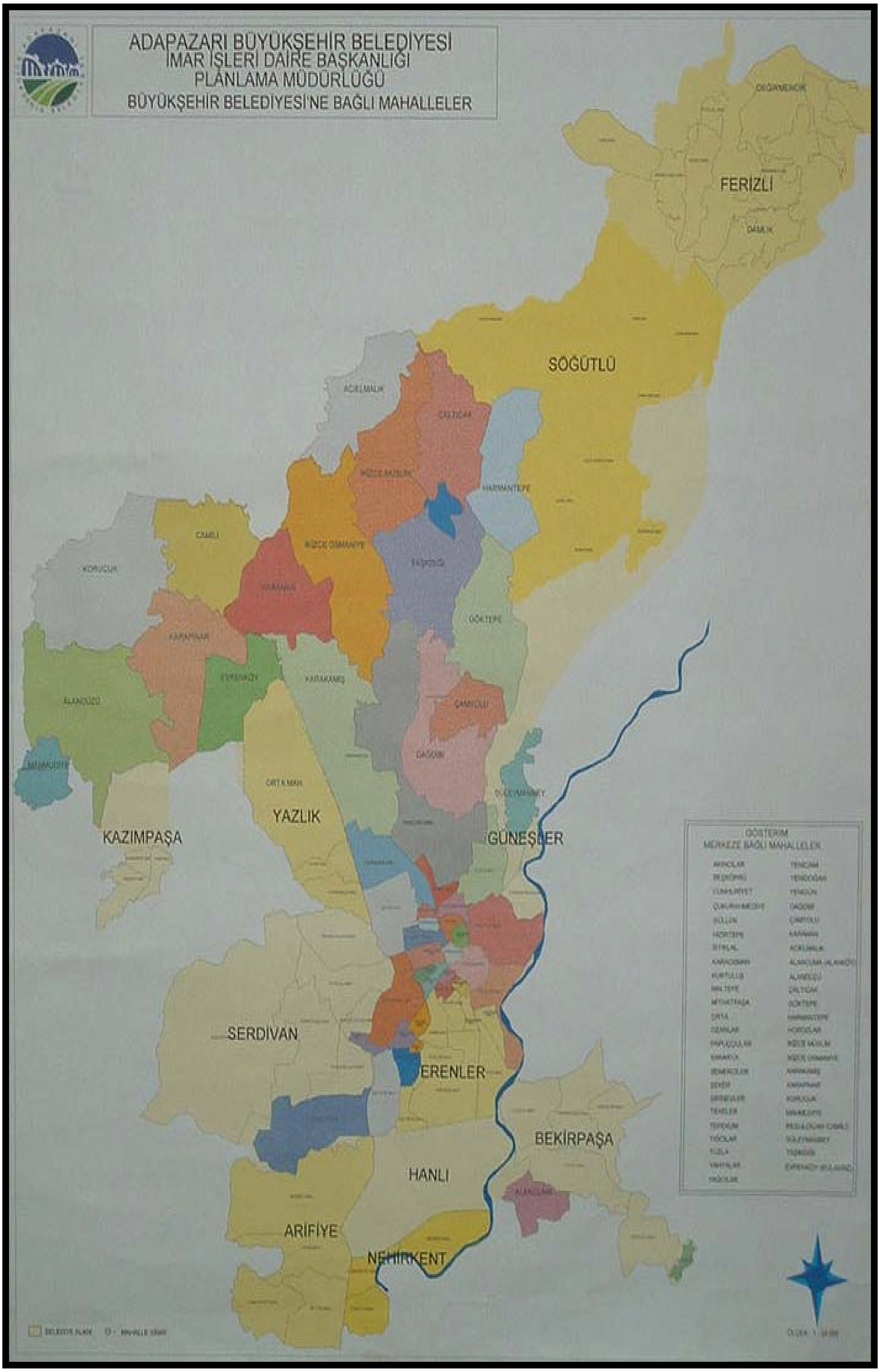
Table 5.2: Sectors and Factories in Sakarya

Sectors	The number of firms	Working labor	Firms have official industrial registration	Firms have encouragement document
Food	91	4815	57	13
Machine product and metallic industries	54	1137	29	11
Textiles	44	1506	15	5
Automotive and side industries	38	7722	21	8
Forestry products	38	752	17	1
Chemical and plastic industries	23	1903	14	5
Construction and building	22	557	11	3
Electricity	7	187	1	1

Source: Governor of Sakarya, 2003

Before earthquake in 1999, seven organized industrial area (see table 5.3) and free city project which has 8000 ha area, were planned in order to attract foreign investments. Also, the first OID in Adapazari began to operate in 1993 and the second OID began to operate in 1997 in Hendek. The third OID was planned in Sogutlu, the forth one in Ferizli, and the fifth one in Pamukova. Other five OID have not yet begun to operate and their official procedure was not completed (Governor of Sakarya, 2003).

Figure 5.1: Border and District of the greater municipality of Adapazari



Source: the greater municipality of Adapazari, directorate of Planning, 2002

Predictions show that population of Sakarya will have exceeded 2 millions people; population of Adapazari will have exceeded 1 million people in 2020, together with seven organized industrial area and free city project investments. Moreover, the population of Ferizli which accommodates 7500 people will have reached to four hundred thousands and the population of Akyazi of 25000 people will have reached to two hundred and fifty thousands people (Sengezer, 2002, p: 92).

Table 5.3: Organized Industrial Disrticts(OID) in Sakarya

Year of establishment	1993
Area(ha)	150
Number of lot	64
Number of automotive and Metallic goods firm	35
Number of plastic firm	10
Number of textile firm	8
Number of forestry production firm	2
Number of Electricity and Electronic firm	2
Number of food firm	2
Number of building material firm	2
Number of chemistry firm	3
Number of total workmen	3000
Second OID	
Year of establishment	1997
Area(ha)	320
Number of lot	106
Location	Hendek
Third OID	
Location	Sögütlü
Area(ha)	240
Number of lot	66
Fourth OID	
Location	Ferizli
Area(ha)	600
Fifth OID	
Location	Pamukova
Area(ha)	

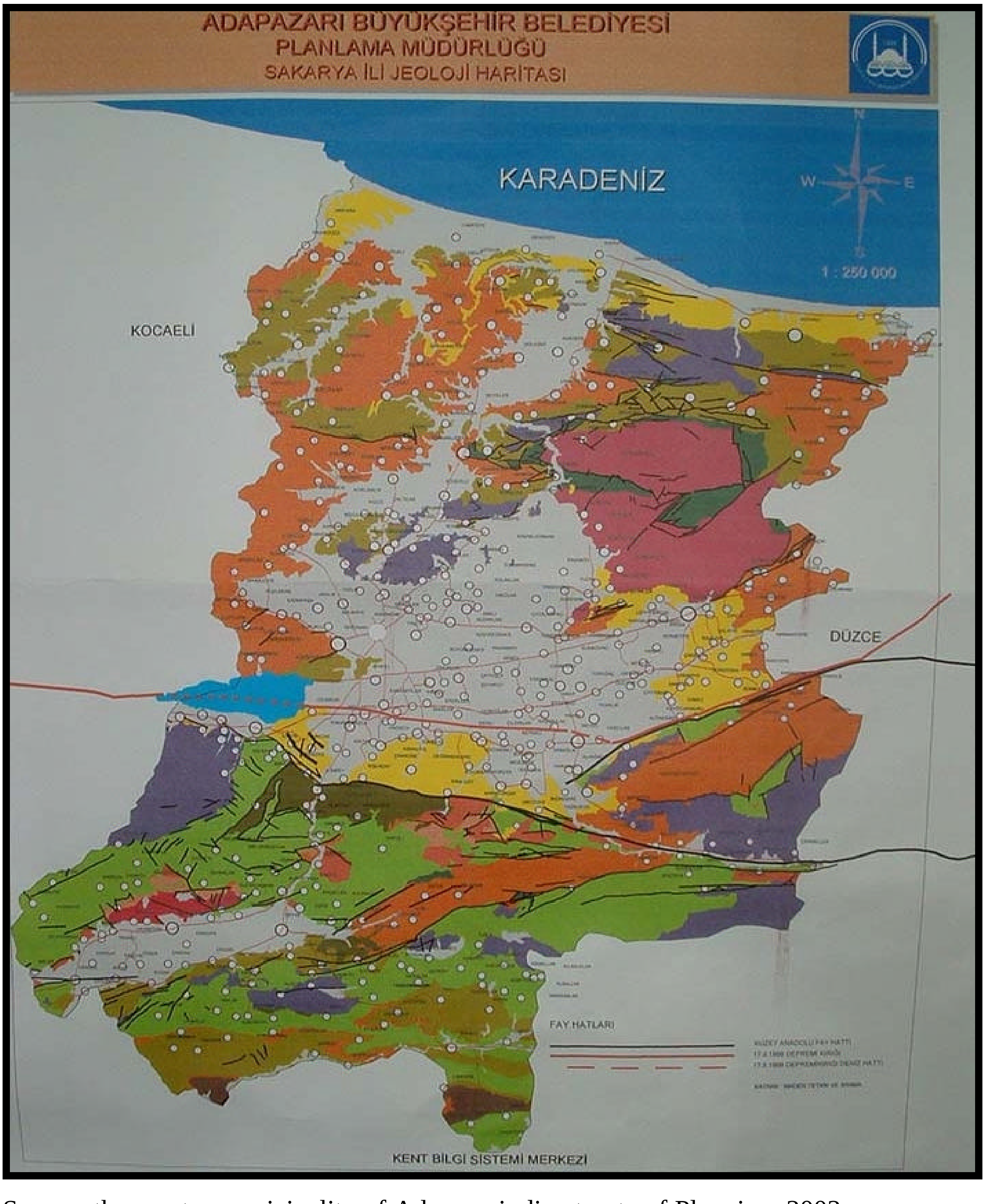
Source: Sakarya Valiligi, 2003

5.3. Geological Analysis (dated 1956, 1982 and 2000) and Distribution of Damage in Adapazari

Adapazari city center is mostly, 90%, located on alluvial ground which has thickness with 200 meters and also the river Sakarya, the stream of Mudurnu and Çark (deresi) pass through this alluvial ground. Thus, the level of underground water is quite high. The North Anatolian Fault Zone (see figure 47) is located near the South of the city center, approximately 8-10 km. therefore, the city settles on the first earthquake zone and liquefaction cause damage to increase in buildings(University of Sakarya, 1999, p:

2). Destructive and damage earthquakes which have historically taken place in Adapazari are those: 03 May 1035, 18 July 1668, 24 November 1863, 18 April 1878, 10 July 1894, 1897, 17 October 1902, 1935, 20 June 1943 (Hendek), 21 November 1952, 22 June 1967 (Mudurnu) and 17 August 1999 (Marmara) (University of Sakarya, 1999, p: 6).

Figure 5.2: Earthquake Zone Map and Faults in Sakarya



Source: the greater municipality of Adapazari, directorate of Planning, 2002

In 1943, half of building stock damaged extensively and 322 people died. In 1967, 6000 buildings damaged heavily due to uncontrolled and un-engineering construction and 89 people died (F. Turkoglu, 2001, p: 11). Also, chamber of Architects was prepared a report related to earthquake damage in 1967. The report suggested that demolished buildings did not meet require technical code and the municipality of Adapazari did not inspect all buildings and had not enough staff. Also, some high-rise and demolished buildings were illegally built and more than three story (D. Hasol and others, 1967). Geological report prepared by Bank of Provinces suggests that the north of Dagdibi such as Tepemuslim, in south of Adapazari less slope places surroundings of Erenler and Serdivan, Hanlikoy and Hizirtepe are convenient to new settlements from ground condition and underground water point of view. The report also determines underground water levels. In the city center levels of underground water is 0.45 meters, in Dagdibi 2.59 meters, in Hanlikoy and Karakamis 9.80 meters. In surroundings of Adapazari average levels of underground water is between 1 and 2 meters. The report pays attention to earthquake zone and underground water (Iller Bankasi, 1982).

In Sakarya, the last Kocaeli earthquake in 1999 caused the most extensive damage, especially at Adapazari, the city center. In Sakarya, the total housing number of damaged building (light, moderate, and heavy) is 70222 and the number of office is 11480. 86% of demolished or heavy damaged housing is in Adapazari, 4.1% in Akyazi, and 2.6% in Sapanca. Also, 92% of demolished or heavy damaged office is in Adapazari, 4% in Akyazi. Proportion of heavy and demolished houses is 35%; proportion of heavy and demolished shops is 44% (B. Sengezer, 2000, p: 41). Table 5.4 provides damage degree of houses, shops and building units. In Kocaeli earthquake the number of causality was 3891 people and the number of injury was 5180.

Table 5.4: Damage of eastern Marmara Earthquake in Sakarya

Degree of Damage	The number of houses	office	Building
Heavy and extensive	24.662	5.090	9.475
Middle	18.911	3.665	7.756
Light	27.692	2.828	15.114

Source: Sakarya Valiligi, 2003

Especially, buildings with 1-3 story damaged less than buildings with 4-6 story. Major problem in demolished buildings is the following reasons: ground condition, design faults, material, architectural and the floor number of buildings. In high-rise buildings damage arises due to using buildings for different aims, especially shops. Also the number of story causes damage to increase (S. Akbulut and others, 2000, p: 378-384).

After Kocaeli earthquake in 1999, geological and geotechnical report are prepared by municipality of Adapazari. The report emphasizes that adjacent order especially is prevalent in the central business district (CBD). In dwelling area surroundings of CBD, block order and detached building order are prevalent. Less dense districts are Tekeler and Dagdibi in the north of Adapazari. Other districts are densely built. The report suggests that in built environment main rock under ground deeply locates and depth of main rock is 75 meters under ground in Erenler. Between Tepekum district and Kavak Street deepness is 188 meters. Main rock is the shallowest place in Izmir tepe. In Sugar Factory deepness is 212 meters, surroundings of Kizilbeyli are 153 and in Serdivan is 112 meters. In west of Beskopru, in Maltepe and Hizirtepe districts main rock is near the surface of land these districts are in built-up and planning area. In 1999 earthquake these districts lightly damaged. Moreover, Adapazari locates on plain and alluvial ground. The slope of land is between 0.05 and 0.2. However, Erenler and Serdivan relatively locate on high land. All area on alluvial ground has potential to liquefaction risk according to liquefaction and Standard Penetration tests. The report emphasizes that reasons of damage are material quality and faulty project but demolished buildings are dependent on intensity of earthquake and ground condition (the greater municipality of Adapazari, directorate of Planning, 2000).

5.4. Planning periods and Decisions in Adapazari

First development plan was in 1960. The second development plan was made in 1974. Before earthquake in 1999, the final development plan was made in 1985. Development plans of Municipalities of Serdivan within borders of Adapazari were made in 1964, 1969 and 1976. A development plan of Municipalities of Erenler within borders of Adapazari was made in 1971.

Before the first development plan in Adapazari, the report of development council was prepared in 1956. The report paid attention to earthquake risk in Adapazari. Moreover, the report suggested that the south of Adapazari (Erenler Hills) and the south-west (near the railway car factory) slope of hillside and hills were less hazardous. First, the report suggested even that the city should have been developed towards deeper places in underwater level and second, sewer system should been built in order to lessen underwater level and the last recommendation was that the number of building -story should have been lessened (B. Gedikli, 2002, p: 58). In the first development plan in Adapazari, height of buildings had been limited to three-story and three-story buildings were only allowed first degree arterial roads of which the widths were 9.50 meters. Two and three story buildings were going to take place by the second degree roads. In the report, order of buildings was offered as adjacent order. But experiences show that adjacent buildings cause to heavy damage such as hammer and domino effect.

After 1980, in the city center, height of buildings reached to five-story and conventional building stock replaced by reinforced concrete framework apartment buildings and then in 1985, new development plan was made. The plan which included municipalities of Adapazari, Serdivan and Erenler was prepared on scale of 1/25.000. The plan was approved including Adapazari city and the Sapanca lake surroundings. Also, according to the plan, master plan on scale of 1/5000 and implementation plan were prepared.

Before master plan, the geological report was prepared by Iller Bankasi in 1982, including Adapazari, Serdivan, Erenler and Hanlikoy. The report emphasized that Adapazari located in the first degree earthquake zone and near the North Anatolian Fault, and that also Adapazari suffered heavy losses in 1967 earthquake. Most of the heavy damage was observed on alluvial ground because depth of underground water level causes the increase of earthquake damage. Therefore, the report paid attention to construction on alluvial ground and suggested that new settlement areas should take place in the slopes of Erenler and Serdivan Hills. Also the report especially suggested that Hanliköy was appropriate to new settlement areas because underwater level was less than other alluvial ground areas (Iller Bankasi, 1982). When the geological report was prepared in 1982, apartment buildings were not yet prevalent in Adapazari except the city center but in the city center, especially at Çark Avenue and Ataturk Boulevard, apartment buildings were starting to be dominant in early 1980.

Before earthquake in 1999, except some conventional districts in Adapazari, almost all the city consisted of apartment buildings. During the earthquake in 1999, the high-rise apartment building demolished but buildings with one or two story did not have heavily damage. The report of master plan in 1985 showed that the city was shaped with links of transportation along railway of Istanbul and Eskisehir, big industrial factories located along transportation axes such as TZDK (Association of Turkish Agricultural hardware), Sugar Factory, Uniroyal, Factory of Tank and Track and Çark industrial Site. The area near those industrial factories has became business area, therefore, districts which in Serdivan and west and south of Adapazari have inevitably developed. Industrial factories located on surrounding of Çark stream. After highway of Ankara and Istanbul was built, railway route lost its importance and small and middle industries, public buildings move to surrounding of highway. Therefore, at the city center and south of the city, buildings became denser and settlement of Erenler developed. Highway was built after master plan in 1985 (B. Gedikli, 2002, p: 60). Before master plan in 1985, research report of city development plan emphasized that Sakarya was appropriate for industry due to transportation advantages and energy of view but it was located in the first degree earthquake zone and underwater was high in some regions. As a result of these conditions, geological structure was not appropriate for industry. Highway started to serve after 1990 and it caused to increase industrial investments on surrounding of highway, especially big domestic industrial and foreign multi-national firms. Related to the highway, two organized industrial districts (OID) was founded and the third one is will be located between Adapazari and Karasu. Moreover, even though in master plan the first OID was predicted to be founded in north of the city, first OID located in south of the city, nearer both the North Anatolian Fault and productive agricultural areas. While first OID was at stage of establishment, the court order prevented establishment of OID due to locating in the first degree earthquake zone and first degree agricultural soil. Although the court took that decision, first OID construction was completed. During earthquake in 1999, factories locating in OID heavily damaged. The second OID was not yet completed (Sakarya Valiligi, 2003).

Table 5.5: Damage in OID

Operating factory	24
not operating factory	6
Demolished factory(during construction)	14
Undamaged factory (during construction)	22
Undamaged (level of basement)	7
Do not begin to operate	11
Production value of factories in 2000	37 trillion T.L

Source: Sakarya Valiligi, 2003

Before earthquake in Çark Street, apartment buildings using ground floor as shop were the common practice dominant. All those buildings with four or five story buildings almost collapsed. When there was enough distance between roads and buildings, emergency rescue was not timely done.

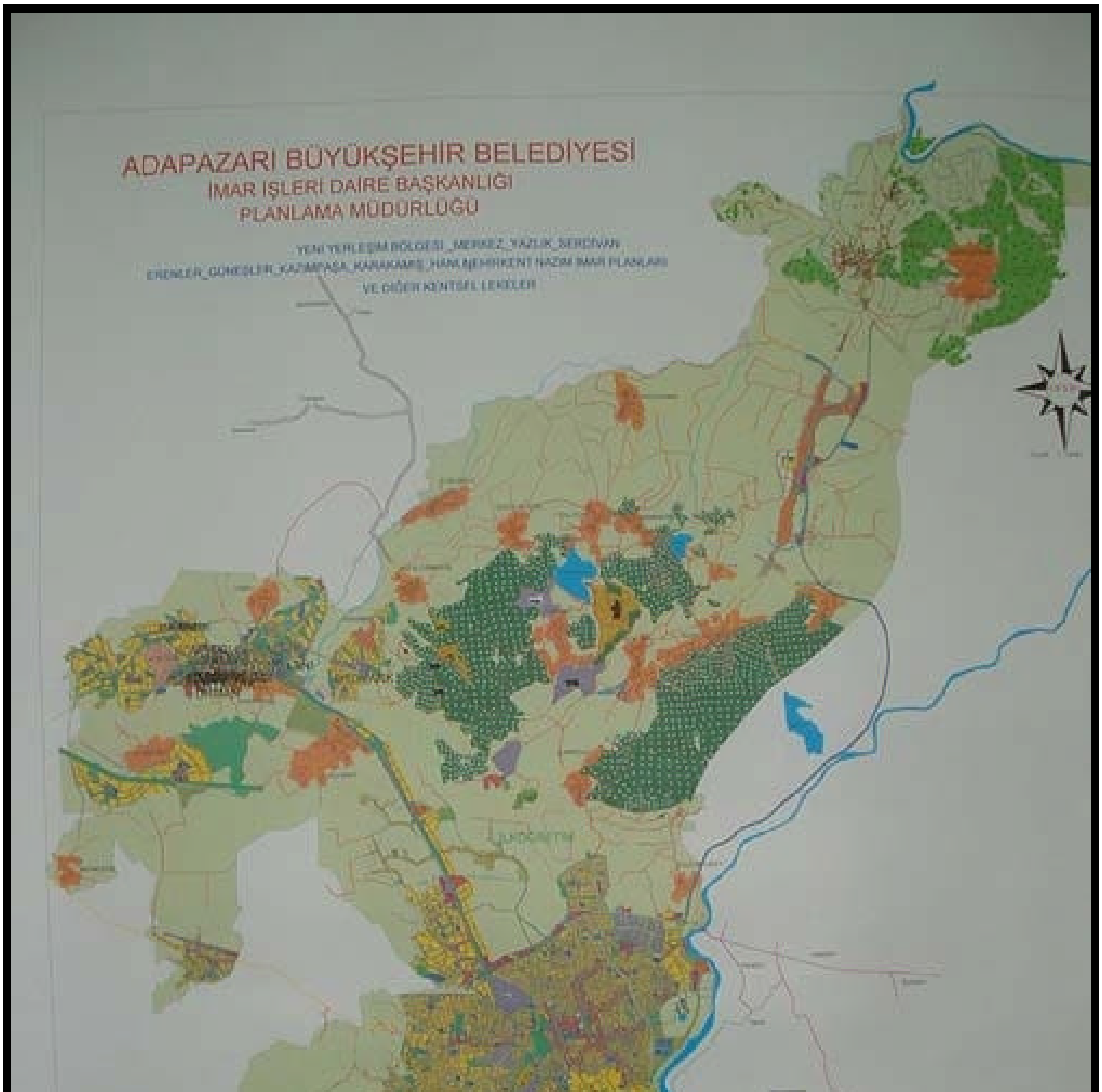
Master plan in 1985 increased population density which was determined as 300 people/ha and 350 people/ha in the city center and its environment. According to master plan, the highest density is observed to be as 350 people/ha, higher density as 300 people/ha, middle density as 250 people/ha and the least density as 200 people/ha. Also, prediction of population was 456.976 people for 2005 including Adapazari, Erenler, Serdivan, Hanlikoy, Gunesler, and Dagdibi (B. Gedikli, 2002, p: 62).

After earthquake in 1999, the greater municipality of Adapazari took new planning decisions and reviewed master plan. According to geological and geotechnical report, in master plan convenient areas for settlements was determined. Main planning decisions are following those:

In risky and alluvial ground, even if required measures are taken, permission for construction of buildings is given. In damaged buildings and no damaged buildings from earthquake on alluvial ground, the number of building story was restricted to two-story. If buildings more than two-story were built before, they have to be built as two-story after they were demolished. Also according to Revision Master Plan (see figure 5.3) Adjacent order is not given permission for construction of buildings because adjacent buildings cause to heavy damage such as hammer and domino effect. Moreover, if special measures are not taken in buildings with basement, permission for construction of buildings must not be given. Master plan suggested that in the north of the Adapazari, new settlements must develop vicinity of Karaman, Camili, Alandüzü, Korucu villages due to safe area from earthquake point of view. Also master plan suggested rail way system between new settlements and the city center.

After three planning experiences, it has been emphasized that Adapazari has earthquake risk and is prone to vulnerability, new buildings and land uses decisions must be located less risky areas, buildings must constructed according to earthquake and ground conditions but results show that buildings have not safe and planning decisions has not lead to mitigate for earthquake risk. Planning process has been static although risks have been known and the existing reality has not changed by planning institution and planning has focused post earthquake interventions.

Figure 5.3: Master Plan for the Greater Municipality of Adapazari, 2001

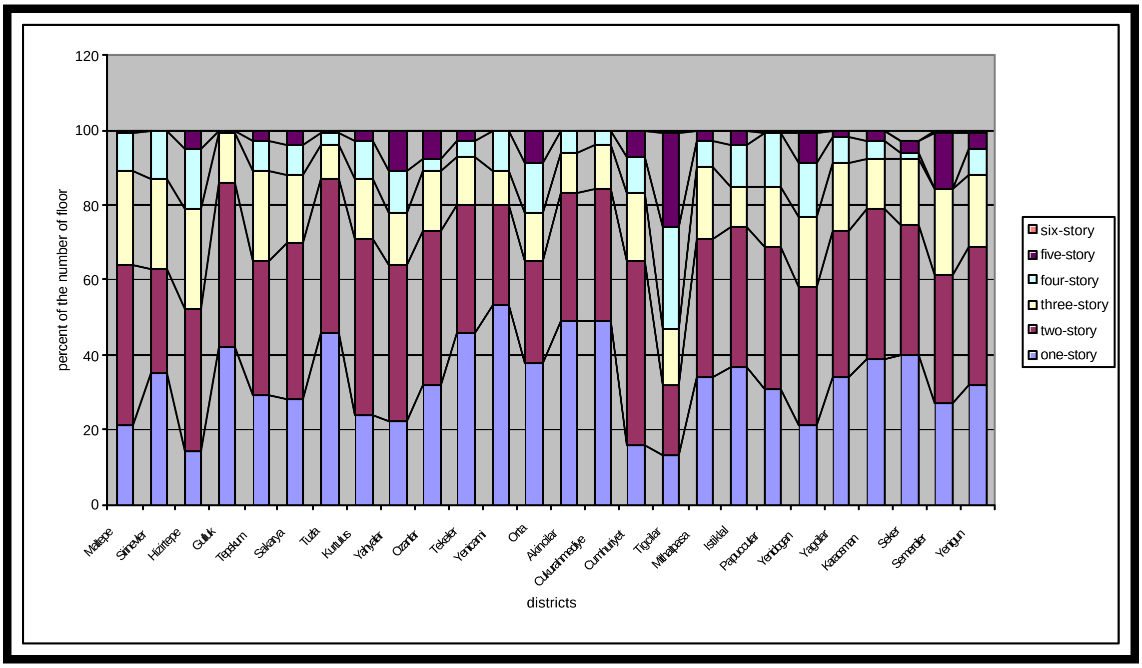


Source: The greater municipality of Adapazari, directorate of Planning, 2001

5.5. Outcomes of Analysis and Findings

In this study, unit of data analysis is defined as scale of district or “mahalle” in Adapazari. Before analysis is started, classification of land value, distribution of damage, the number of story is essential to ensure a uniform interpretation of data and results. The case study includes 26 “mahalle” that locate in the city centre. Data such as population density (see figure 5.9), proportion of earthquake damage, land value or urban rent (see figure 5.10), the number of demolished building (see figure 5.11, the physical building density (see figure 5.12), ground area ratio (see figure 5.13), and proportion of buildings with 4-6 story, in each district in Adapazari is firstly made numerical and is assigned to unit of “mahalle” and those data is transformed into images..

Figure 5.4: Proportion of the Number of Story in Each District



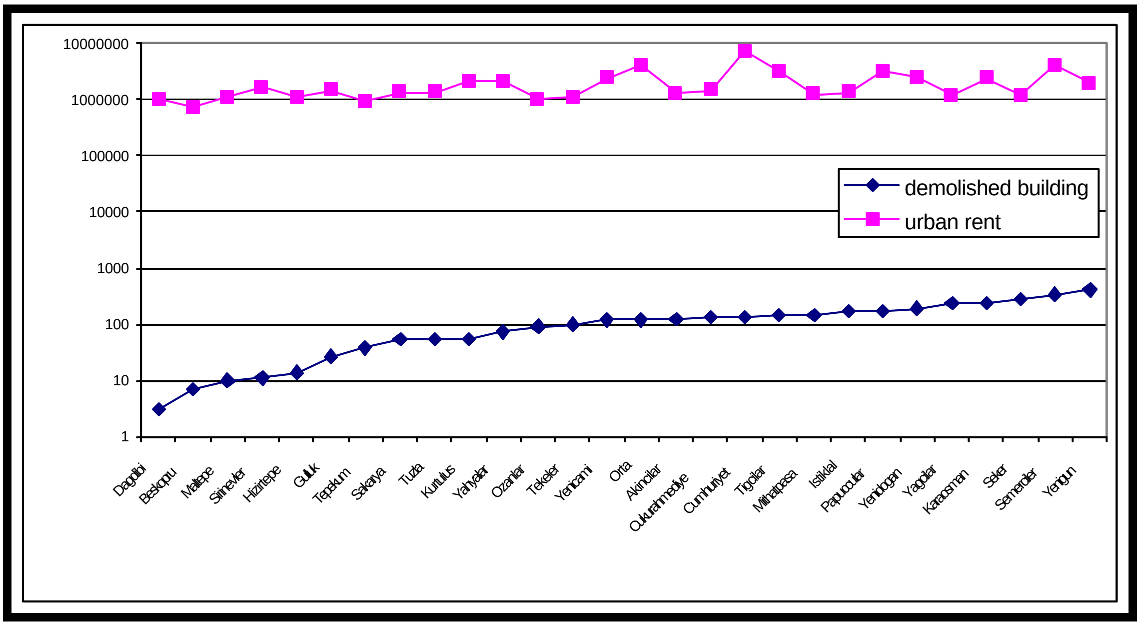
Source: The Greater Municipality of Adapazari

When the number of buildings story is assessed, buildings with 1-3 story are prevalent in urban area. In only one district, Tigcilar, proportion of buildings with 4-6 story is higher than 1-3 story and the proportion is 53 %. In districts located on the city center, proportion of buildings with 4-6 story is between 15% and 23%, except Tigcilar. These are Papuccular, Semerciler, Cukurahmediye, Cumhuriyet, Akincilar, Istiklal, Yenidogan, Orta, Yahyalar. In other districts, proportion of buildings with 4-6 story is less than 15%. In fringe of the city center, buildings with 1-3 story are prevalent (see figure 5.10). Buildings with 4-6 story are concentrated near the main road arteries.

During earthquake in 1999, the biggest damage and human losses took place between the city center and street of Adnan Menderes, railway car factory, sugar factory and street of Ankara. Although ground condition was not appropriate in those areas, land price had at the highest rate. Also, those areas were the most areas densely populated areas.

Majority of apartment buildings with four or five story demolishes in the earthquake had open space at the ground floors and had shop usage at the ground floors. 80% of apartment buildings with four or five story locating in those areas heavily damaged and buildings with two and three story damaged due to ground liquefaction. At the fringe of the city center, Hizirtepe, Maltepe, Majority of buildings had light damage or no damage (B. Gedikli, 2002, p: 60). These districts are relatively safe from geological condition point of view. For example, underground water and depth of main rock is near the surface.

Figure 5.5: Relationship between Urban Rent and Demolished Buildings



Source: The Greater Municipality of Adapazari

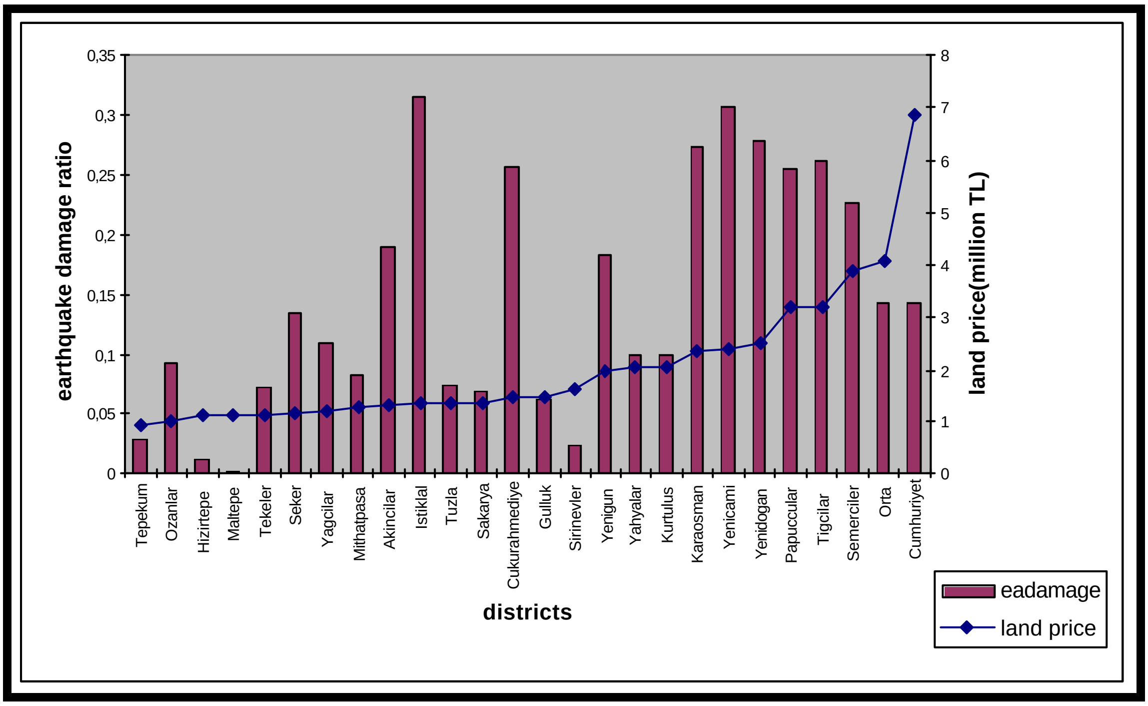
When the number of demolished buildings assessed in each districts, usually districts that have the highest land value damaged in 1999 earthquake. However, some districts that relatively have less land value extensively damaged from demolished buildings point of view. These districts are Seker, Yagcilar, Istiklal, Mithatpasa, Çukurahmediye, Akincilar. Moreover, from demolished buildings point of view, some districts lightly damaged in 1999 although they locate on the city center and that relatively have high land value. These are Kurtulus and Yahyalar.

Table 5.6: Variables of Analysis

Districts	Earthquake damage	land price(million)	Popdensity (people/ ha)	Distance(km)	Physical density	Ground area ratio	Building ratio with4-6 story
Tepekum	0,028	0,91	275	2,310	1,25	0,2	0,11
Ozanlar	0,093	0,98	250	1,357	1,2	0,24	0,11
Hizirtepe	0,011	1,092	250	3,209	1,2	0,24	0,21
Maltepe	0,002	1,09	250	4,627	1,2	0,24	0,11
Tekeler	0,071	1,1	225	1,799	1,05	0,21	0,07
Seker	0,135	1,149	250	1,338	1,2	0,24	0,08
Yagcilar	0,11	1,166	275	1,490	1,3	0,26	0,09
Mithatpasa	0,083	1,241	275	1,725	1,3	0,26	0,1
Akincilar	0,19	1,31	350	1,125	1,6	0,26	0,17
Istiklal	0,315	1,342	300	0 ,789	1,4	0,28	0,15
Tuzla	0,074	1,352	200	1,680	0,9	0,18	0,04
Sakarya	0,068	1,352	250	1,192	1,2	0,24	0,12
Cukurahmediye	0,257	1,45	350	0,881	1,6	0,32	0,04
Gulluk	0,062	1,463	300	2,522	1,4	0,28	0,01
Sirinevler	0,024	1,589	300	2,653	1,4	0,28	0,13
Yenigun	0,184	2	350	1,115	1,6	0,32	0,12
Yahyalar	0,1	2,067	350	0,660	1,6	0,32	0,22
Kurtulus	0,1	2,072	250	0,567	1,2	0,24	0,13
Karaosman	0,274	2,35	350	0,930	1,6	0,32	0,08
Yenicami	0,306	2,4	350	0,938	1,6	0,32	0,11
Yenidogan	0,279	2,516	325	0,915	1,5	0,3	0,23
Papuccular	0,255	3,19	325	0 ,971	1,5	0,3	0,15
Tigcilar	0,261	3,2	350	0,511	1,6	0,32	0,53
Semerciler	0,227	3,88	300	0,713	1,4	0,28	0,16
Orta	0,143	4,06	350	0 ,645	1,6	0,32	0,22
Cumhuriyet	0,143	6,87	300	0,525	1,4	0,28	0,17

However, when proportion of earthquake damage in each district is examined, it is seen that Yenidogan, Yenicami, Istiklal, Papuçcular, Karaosman, Tigcilar, Çukurahmediye have damage more than 20%. Cumhuriyet, Kurtulus, Yahyalar, Orta, Seker, Akincilar, Yenigün, Yagcilar, Semerciler have damage between 10% and 20%.

Figure 5.6: Relationship between earthquake damage ratio and land price



In Maltepe, Besköprü, Hizirtepe, Dagdibi, Tepekum, Sakarya, Güllük, Mithatpasa, and Sirinevler, damage proportion is under 10% and also these districts locate on the fringe of the city center. Districts locating in the fringe of the city usually damaged less than others. But although some districts relatively have lower land price, they extensively damaged such as istiklal, Seker, Yenigün, Çukurahmediye, Akincilar and Yagcilar.

Also, although some districts relatively have high land price, they damaged less such as Cumhuriyet, Orta. These findings weaken relationship between land price or urban rent and earthquake damage. However, if table is assessed, it can be seen that there is relationship between the high-rise building story and earthquake damage but not a strong.

Figure 5.7: Proportion of Earthquake Damage in Each District in Adapazari

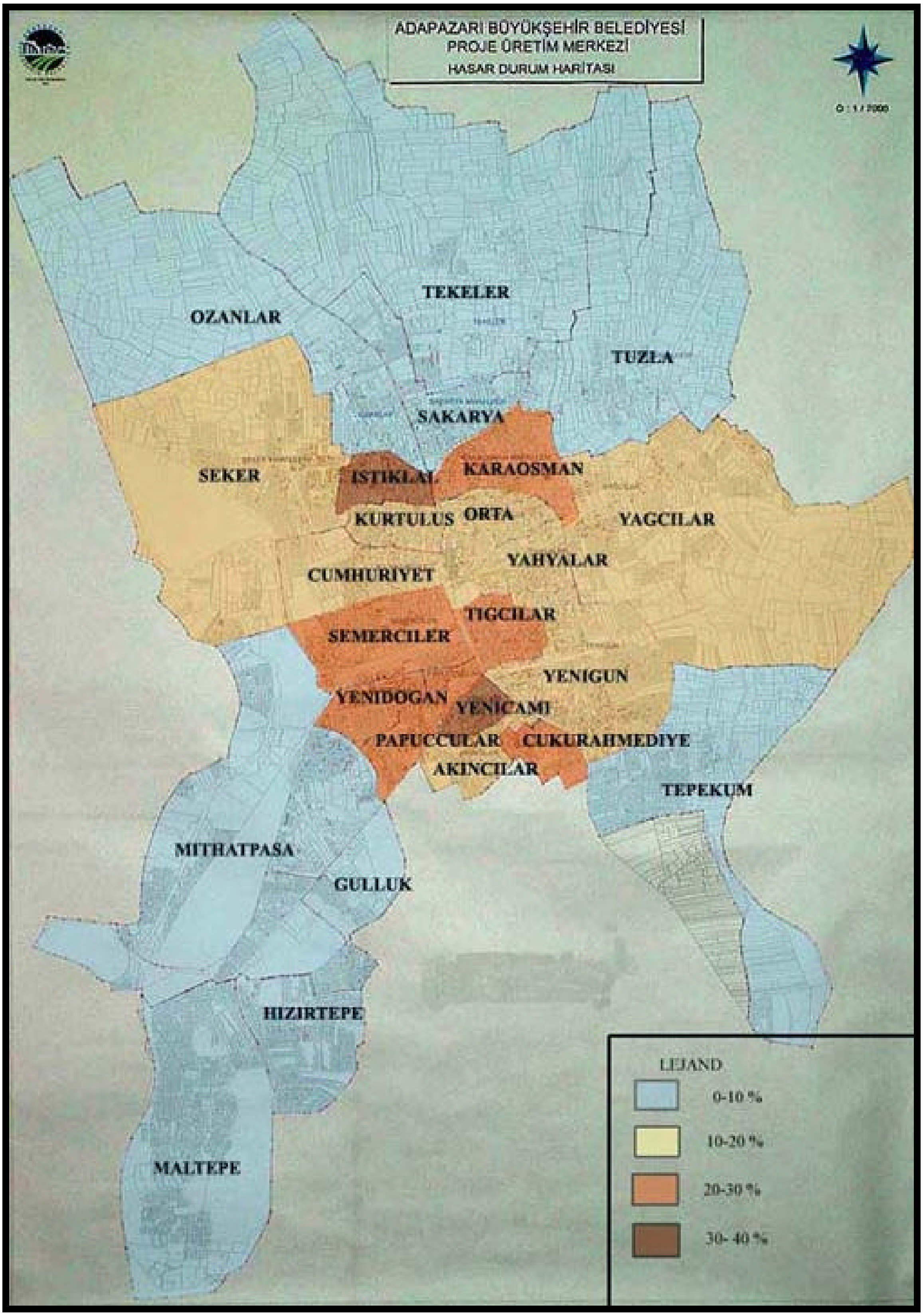


Figure 5.8: The Proportion of Building with 4-6 story in Adapazari

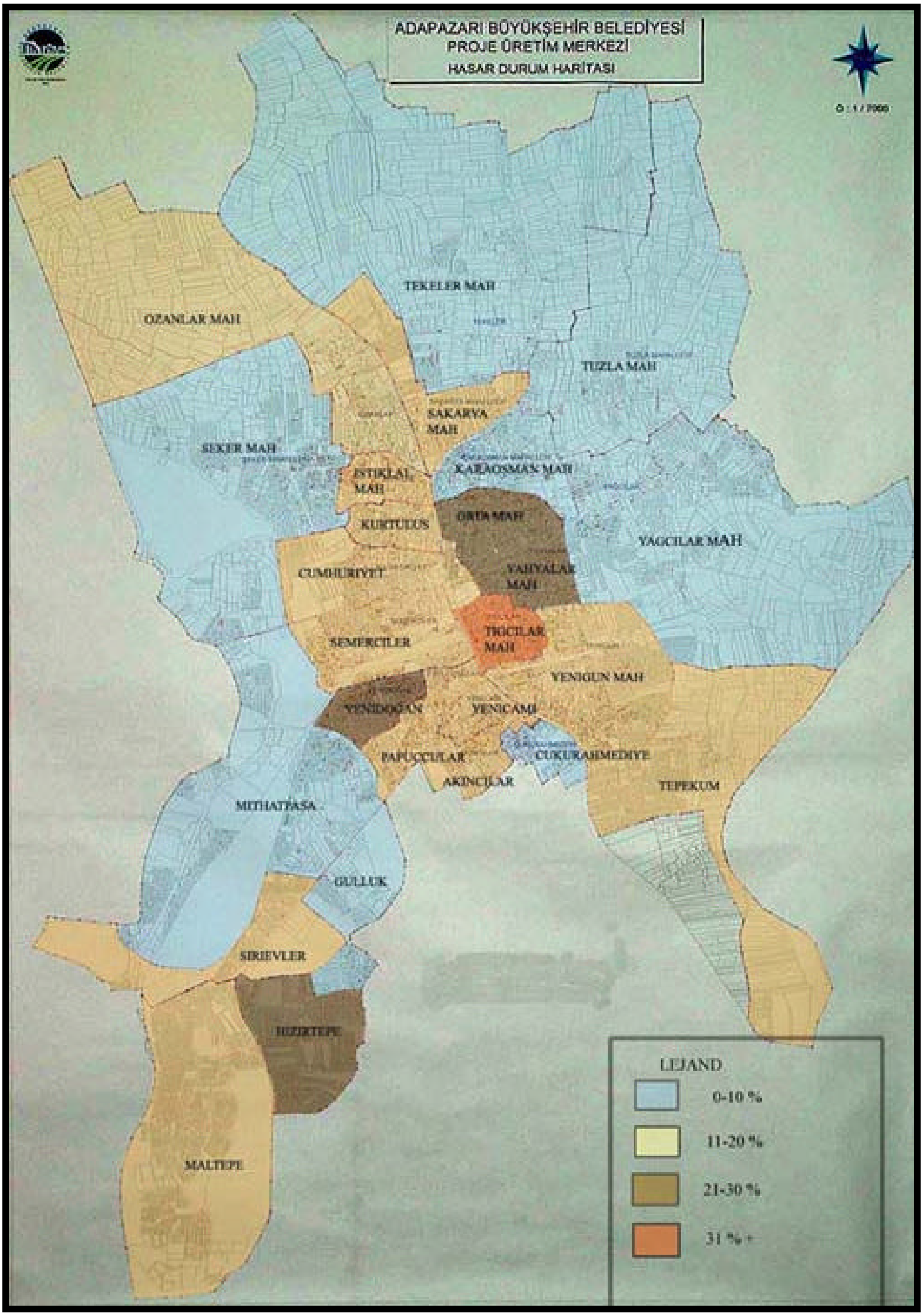


Figure 5.9: Population Density in Each District in Adapazari

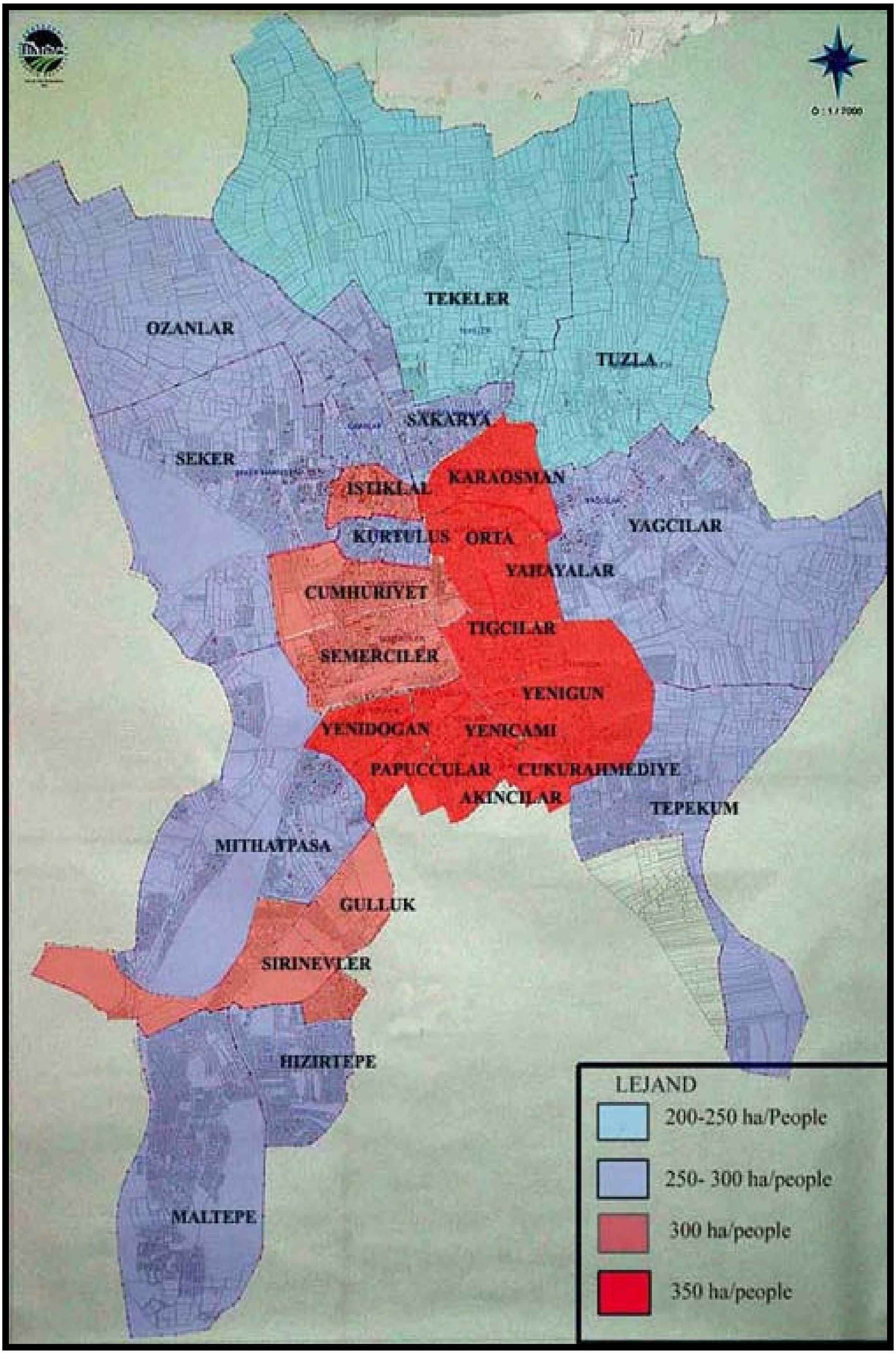


Figure 5.10: Land Price in Each District in Adapazari

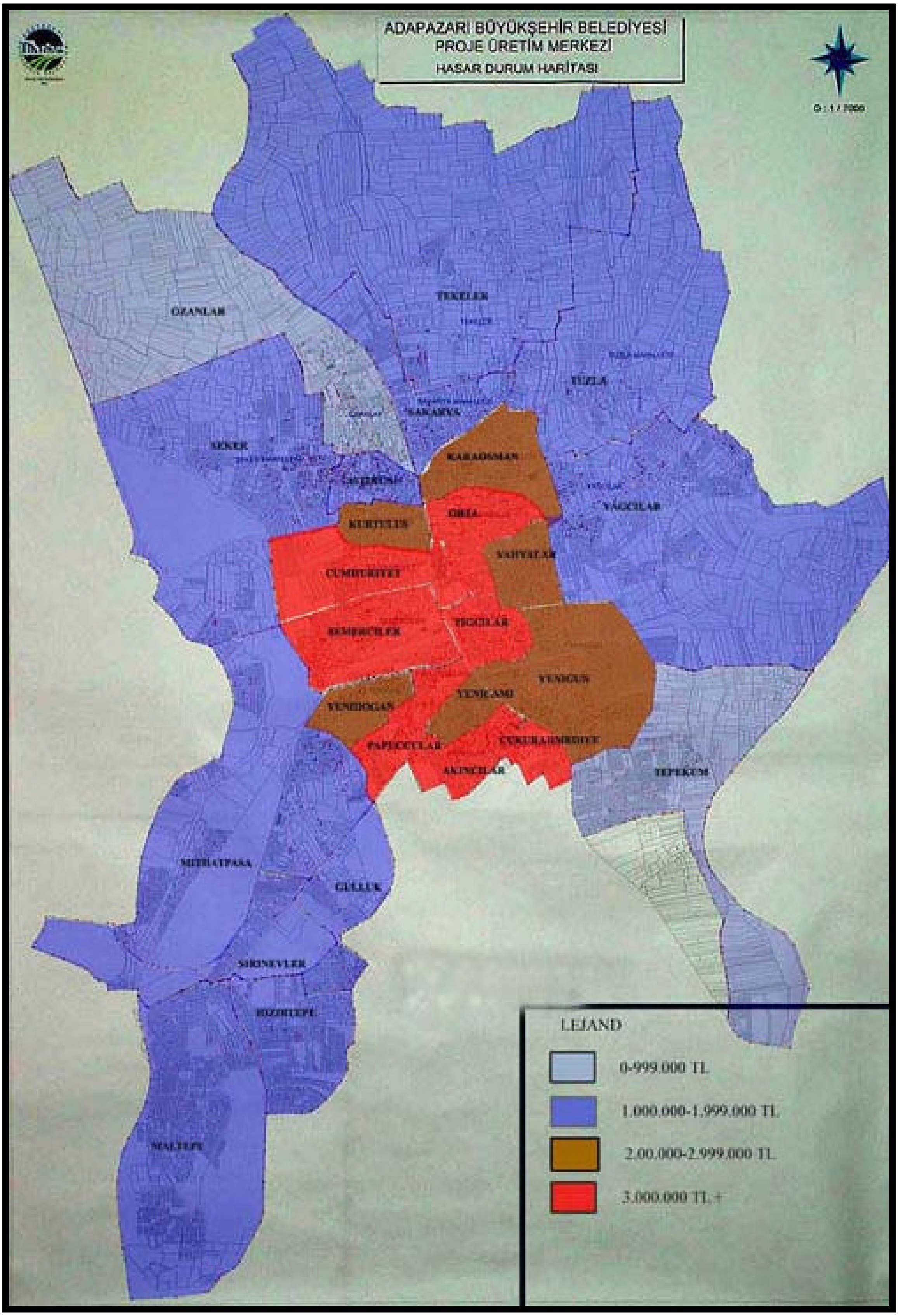


Figure 5.11: The Number of Demolished Buildings in Each District in Adapazari

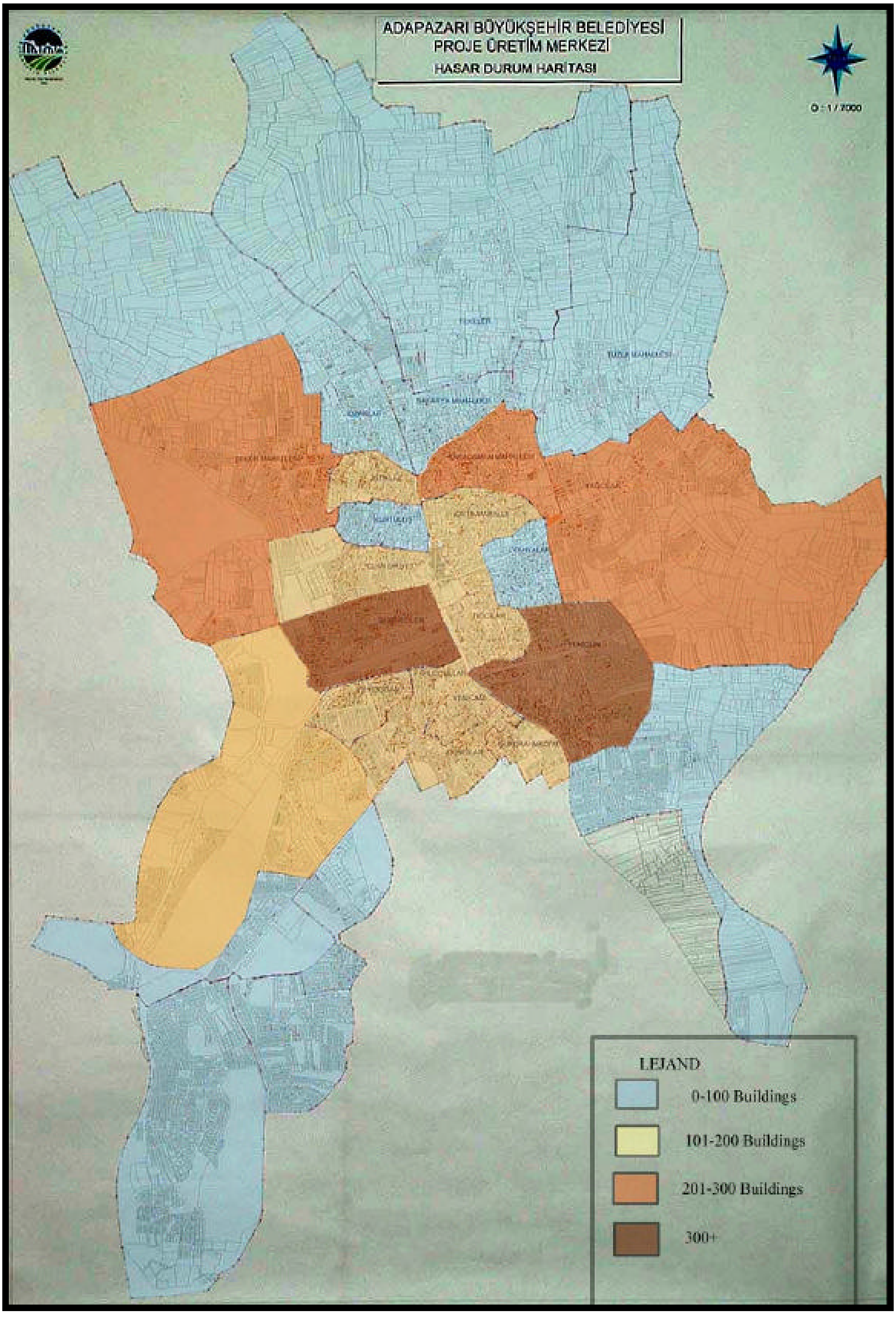
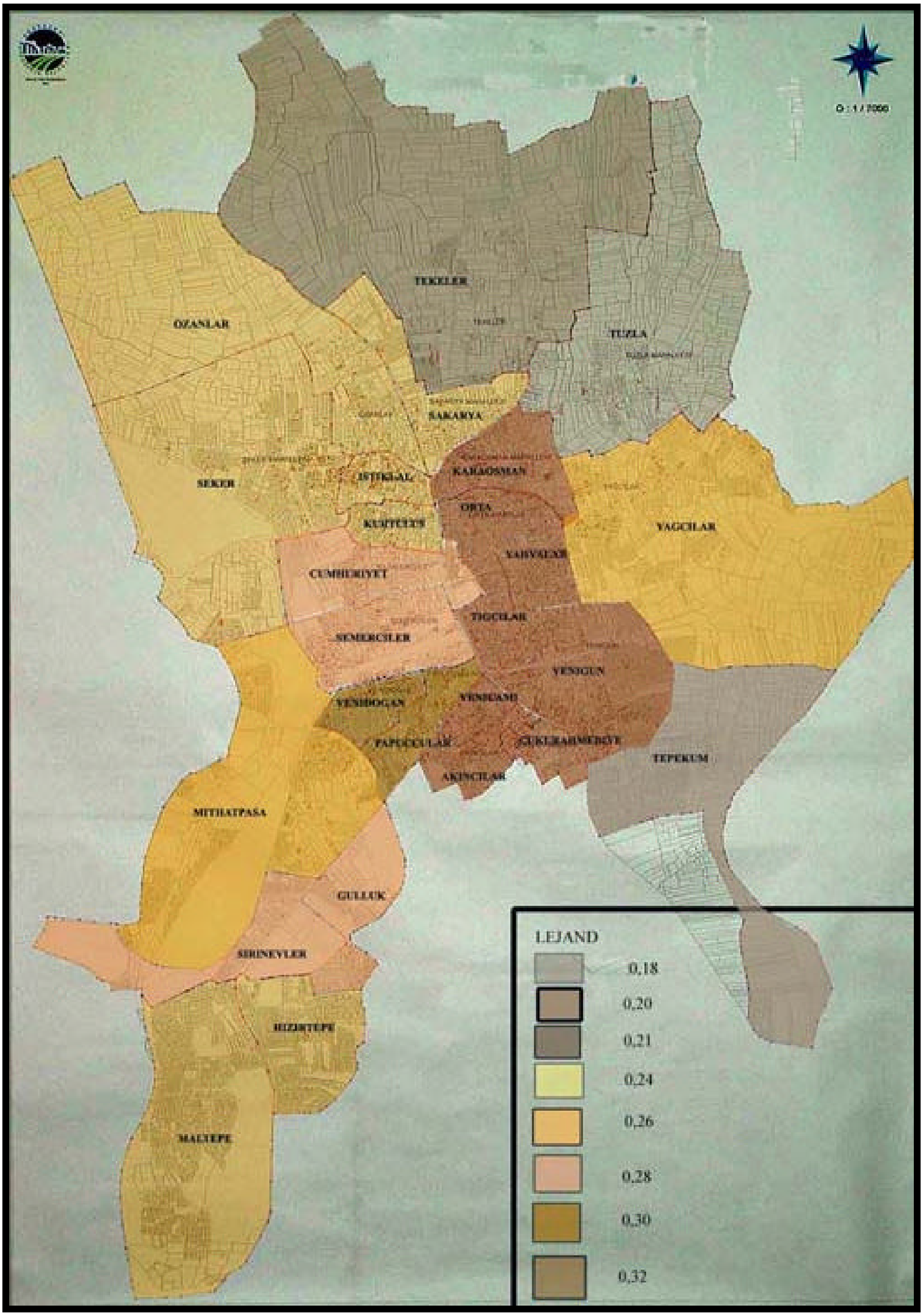


Figure 5.12: Physical Building Density (Floor Area Ratio) in Adapazari

Figure 5.13: Ground Area Ratio in Each District in Adapazari



Chapter 6
CONCLUSION

Previous chapters suggested that the event of earthquake resulted from natural factors but human beings actually determined vulnerability of settlements. Also, countries that have the scarce capital have come to face more risk than developed countries in terms of earthquake because developing countries have allocated large sources to industrialization. Thus, all developing countries have almost experienced housing problem. For this reason, the squatter settlement and illegal housings have met demand for housing stock but this housing stock is prone to vulnerability in urban areas and is not physically safe and durable against earthquake and other disasters in both Turkey and developing countries. Moreover, builder-seller (Yap-Satçi) form of construction has produced uncontrolled housings and other building types. Actually these groups are not specialized building producer. However, governments have been neglected demand for housing for the poor. Thus, they are dominant in housing sector. They have scarce sources but produce housing to minimum cost.

Also, while the increase of land price causes to allocate more capital to land for construction of housing, less capital is allocated for other materials in construction of housing. Use of inadequate concrete and iron caused buildings to collapse within legal and planning areas. Rents are obtained for speculative and injustice profits in urban area through transition to new use type or the increase of story. Therefore, this minimum cost results from poor material and inconvenient form of construction. Also construction of individual buildings is not exactly inspected and the technical requirements seldom follow. This process has caused to have unsafe and vulnerable building stock. Furthermore, changes of building codes, regulations and the amnesty laws increase vulnerability of majority of the existence building stock.

The thesis emphasizes social factors on earthquake damage such as urban rent and planning decisions. The thesis also aims to look closely to planning decisions and their causality on the increase of earthquake risk in terms of urban rent.

Outcomes of analysis suggest that in districts located on the city center, proportion of buildings with 4-6 stories is between 15% and 23%, except Tigcilar. These are Papuccular, Semerciler, Cukurahmediye, Cumhuriyet, Akincilar, Istiklal, Yenidogan, Orta, Yahyalar. In other districts, proportion of buildings with 4-6 story is less than 15%. In fringe of the city center, buildings with 1-3 stories are prevalent. However, when proportion of earthquake damage in each district is examined, it is seen that Yenidogan, Yenicami, Istiklal, Papuçcular, Karaosman, Tigcilar, Çukurahmediye have damage more than 20%. Cumhuriyet, Kurtulus, Yahyalar, Orta, Seker, Akincilar, Yenigün, Yagcilar, Semerciler have damage between 10% and 20%. When in each district proportion of earthquake damage and buildings with 4-6 story compare, exactly high relationship is not found.

If land price (urban rent) is examined, districts locating in the fringe of the city usually were damaged less than others. But although some districts relatively have lower land price, they extensively damaged such as istiklal, Seker, Yenigün, Çukurahmediye, Akincilar and Yagcilar. Besides, some districts relatively have high land price, they damaged less such as Cumhuriyet, Orta. These findings weaken relationship between land price or urban rent and earthquake damage. For this reason it can be seen that there is a relationship among the high-rise building, land price and earthquake damage but not strong.

However, it does not mean that there is not any relationship between earthquake damage and land price (urban rent). This study only includes socio-economic and technical risk factors.

Moreover, when correlation analysis is assessed, relationship between dependent and independent variables is not very strong in firs step analysis. The strongest relationship is between urban rent and distance to the city center. The weakest relationship is between urban rent and ground area ratio. Except distance variable, other two independent variables do not provide more contribution in order to explain relationship. Distance only explains land price as approximately 50% but ground area ratio and population density have not more importance on urban rent (land price). When correlation analysis is assessed, relationship between dependent and independent variables is not very strong in second step analysis. The strongest relationship is between earthquake damage and distance (69%). The weakest relationship is between earthquake damage and urban rent (35%).

Finally, my assumption related to urban rent and earthquake damage was falsified by correlation and regression analysis. However, it does not mean that there is not any relationship between earthquake damage and land price (urban rent). This study only includes socio-economic and technical risk factors. The goal of this study is to understand the impact of the mentioned factors on earthquake damage. Also, even if natural risk factors want to be added to analysis, it is not possible because geological factors are not convenient with unit of analysis. For example, there is not data of level of underground water and depth of main rock for every district. Thus these data is not includes in analysis. The study is based on experimental approach and the weak relationship between earthquake damage ratio and urban rent is expected result. Also regression and correlation analysis reveal the weak relationship. Natural risk factors and building technology of construction are important in earthquake damage. Thus, the study especially suggests that future research should be directly focused on risk and planning process.

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APPENDICIES

APPENDIX A

The result of Regression and correlation analysis:

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	GROAR, DISTANCE, POPDENS[a]	,	Enter

a. All requested variables entered.

b. Dependent Variable: LANDPRIC

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,718[a]	,516	,450	,9847

a. Predictors: (Constant), GROAR, DISTANCE, POPDENS

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22,717	3	7,572	7,809	,001[a]
	Residual	21,334	22	,970		
	Total	44,050	25			

a. Predictors: (Constant), GROAR, DISTANCE, POPDENS

b. Dependent Variable: LANDPRIC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,351	1,743		1,349	,191
	POPDENS	-,399	1,058	-,139	-,377	,710
	DISTANCE	-1,133	,303	-,633	-3,735	,001
	GROAR	8,914	12,207	,275	,730	,473

a. Dependent Variable: LANDPRIC

Correlations

		LANDPRIC	POPDENS	DISTANCE	GROAR
LANDPRIC	Pearson Correlation	1,000	,392*	-,704**	,453*
	Sig. (2-tailed)	,	,047	,000	,020
	N	26	26	26	26
POPDENS	Pearson Correlation	,392*	1,000	-,441*	,915*
	Sig. (2-tailed)	,047	,	,024	,000
	N	26	26	26	26
DISTANCE	Pearson Correlation	-,704**	-,441*	1,000	-,482*
	Sig. (2-tailed)	,000	,024	,	,013
	N	26	26	26	26
GROAR	Pearson Correlation	,453*	,915**	-,482*	1,000
	Sig. (2-tailed)	,020	,000	,013	,
	N	26	26	26	26

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The result of stepwise:

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	DISTANCE	,	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).

a. Dependent Variable: LANDPRIC

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,704[a]	,496	,475	,9621

a. Predictors: (Constant), DISTANCE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21,835	1	21,835	23,588	,000[a]
	Residual	22,216	24	,926		
	Total	44,050	25			

a. Predictors: (Constant), DISTANCE

b. Dependent Variable: LANDPRIC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,761	,400		9,394	,000
	DISTANCE	-1,261	,260	-,704	-4,857	,000

a. Dependent Variable: LANDPRIC

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	POPDENS	,101[a]	,620	,542	,128	,805
	GROAR	,148[a]	,893	,381	,183	,768

a. Predictors in the Model: (Constant), DISTANCE

b. Dependent Variable: LANDPRIC

The result of backward:

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	GROAR, DISTANCE, POPDENS[a]	,	Enter
2	,	POPDENS	Backward (criterion: Probability of F-to-remove >= ,100).
3	,	GROAR	Backward (criterion: Probability of F-to-remove >= ,100).

a. All requested variables entered.

b. Dependent Variable: LANDPRIC

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,718[a]	,516	,450	,9847
2	,716[b]	,513	,470	,9662
3	,704[c]	,496	,475	,9621

a. Predictors: (Constant), GROAR, DISTANCE, POPDENS

b. Predictors: (Constant), GROAR, DISTANCE

c. Predictors: (Constant), DISTANCE

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22,717	3	7,572	7,809	,001[a]
	Residual	21,334	22	,970		
	Total	44,050	25			
2	Regression	22,579	2	11,289	12,093	,000[b]
	Residual	21,472	23	,934		
	Total	44,050	25			
3	Regression	21,835	1	21,835	23,588	,000[c]
	Residual	22,216	24	,926		
	Total	44,050	25			

a. Predictors: (Constant), GROAR, DISTANCE, POPDENS

b. Predictors: (Constant), GROAR, DISTANCE

c. Predictors: (Constant), DISTANCE

d. Dependent Variable: LANDPRIC

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2,351	1,743		1,349	,191
	POPDENS	-,399	1,058	-,139	-,377	,710
	DISTANCE	-1,133	,303	-,633	-3,735	,001
	GROAR	8,914	12,207	,275	,730	,473
2	(Constant)	2,285	1,701		1,343	,192
	DISTANCE	-1,133	,298	-,633	-3,807	,001
	GROAR	4,800	5,377	,148	,893	,381
3	(Constant)	3,761	,400		9,394	,000
	DISTANCE	-1,261	,260	-,704	-4,857	,000

a. Dependent Variable: LANDPRIC

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
2	POPDENS	-,139[a]	-,377	,710	-,080	,162
3	POPDENS	,101[b]	,620	,542	,128	,805
	GROAR	,148[b]	,893	,381	,183	,768

a. Predictors in the Model: (Constant), GROAR, DISTANCE

b. Predictors in the Model: (Constant), DISTANCE

c. Dependent Variable: LANDPRIC

The Second Step Analysis:

Y= 0, 0670 + 0, 00602(X_1) +0, 0536(X_2) + 0,219(X_3)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	FLOORAR, URBRENT, DISTANCE[a]	,	Enter

a. All requested variables entered.

b. Dependent Variable: EARTDAMA

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,790[a]	,625	,573	6,397E-02

a. Predictors: (Constant), FLOORAR, URBRENT, DISTANCE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,150	3	4,992E-02	12,199	,000[a]
	Residual	9,002E-02	22	4,092E-03		
	Total	,240	25			

a. Predictors: (Constant), FLOORAR, URBRENT, DISTANCE

b. Dependent Variable: EARTDAMA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-6,70E-02	,113		-,595	,558
	URBRENT	-6,02E-03	,011	-,082	-,529	,602
	DISTANCE	-5,36E-02	,016	-,527	-3,306	,003
	FLOORAR	,219	,074	,444	2,948	,007

a. Dependent Variable: EARTDAMA

Correlations

		EARTDAMA	URBRENT	DISTANCE	FLOORAR
EARTDAMA	Pearson Correlation	1,000	,354	-,690**	,653**
	Sig. (2-tailed)	,	,076	,000	,000
	N	26	26	26	26
URBRENT	Pearson Correlation	,354	1,000	-,496**	,392*
	Sig. (2-tailed)	,076	,	,010	,047
	N	26	26	26	26
DISTANCE	Pearson Correlation	-,690**	-,496**	1,000	-,458*
	Sig. (2-tailed)	,000	,010	,	,018
	N	26	26	26	26
FLOORAR	Pearson Correlation	,653**	,392*	-,458*	1,000
	Sig. (2-tailed)	,000	,047	,018	,
	N	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The result of stepwise:

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	DISTANCE	,	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
2	FLOORAR	,	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).

a. Dependent Variable: EARTDAMA

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,690[a]	,476	,454	7,235E-02
2	,787[b]	,620	,587	6,296E-02

a. Predictors: (Constant), DISTANCE

b. Predictors: (Constant), DISTANCE, FLOORAR

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,114	1	,114	21,809	,000[a]
	Residual	,126	24	5,234E-03		
	Total	,240	25			
2	Regression	,149	2	7,430E-02	18,746	,000[b]
	Residual	9,116E-02	23	3,964E-03		
	Total	,240	25			

a. Predictors: (Constant), DISTANCE

b. Predictors: (Constant), DISTANCE, FLOORAR

c. Dependent Variable: EARTDAMA

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	,246	,026		9,567	,000
	DISTANCE	-7,01E-02	,015	-,690	-4,670	,000
2	(Constant)	-7,25E-02	,110		-,657	,518
	DISTANCE	-5,03E-02	,015	-,494	-3,418	,002
	FLOORAR	,211	,072	,427	2,948	,007

a. Dependent Variable: EARTDAMA

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	URBRENT	,016[a]	,089	,930	,019	,754
	FLOORAR	,427[a]	2,948	,007	,524	,790
2	URBRENT	-,082[b]	-,529	,602	-,112	,719

a. Predictors in the Model: (Constant), DISTANCE

b. Predictors in the Model: (Constant), DISTANCE, FLOORAR

c. Dependent Variable: EARTDAMA

The result of backward:

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	FLOORAR, URBRENT, DISTANCE[a]	,	Enter
2	,	URBRENT	Backward (criterion: Probability of F-to-remove >= ,100).

a. All requested variables entered.

b. Dependent Variable: EARTDAMA

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,790[a]	,625	,573	6,397E-02
2	,787[b]	,620	,587	6,296E-02

a. Predictors: (Constant), FLOORAR, URBRENT, DISTANCE

b. Predictors: (Constant), FLOORAR, DISTANCE

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,150	3	4,992E-02	12,199	,000[a]
	Residual	9,002E-02	22	4,092E-03		
	Total	,240	25			
2	Regression	,149	2	7,430E-02	18,746	,000[b]
	Residual	9,116E-02	23	3,964E-03		
	Total	,240	25			

a. Predictors: (Constant), FLOORAR, URBRENT, DISTANCE

b. Predictors: (Constant), FLOORAR, DISTANCE

c. Dependent Variable: EARTDAMA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-6,70E-02	,113		-,595	,558
	URBRENT	-6,02E-03	,011	-,082	-,529	,602
	DISTANCE	-5,36E-02	,016	-,527	-3,306	,003
	FLOORAR	,219	,074	,444	2,948	,007
2	(Constant)	-7,25E-02	,110		-,657	,518
	DISTANCE	-5,03E-02	,015	-,494	-3,418	,002
	FLOORAR	,211	,072	,427	2,948	,007

a. Dependent Variable: EARTDAMA

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
2	URBRENT	-,082[a]	-,529	,602	-,112	,719

a. Predictors in the Model: (Constant), FLOORAR, DISTANCE

b. Dependent Variable: EARTDAMA

APPENDIX B

Destructive earthquakes in Turkey									
DD/MM/YYYY	Magnitude (Ms)	Region	Number of deaths	Number of injured	Number of heavily damaged houses	Latitude (N)	Longitude (E)	Depth (km)	Intensity (MSK)
09.03.1902	5.6	Çankiri	4	-	3000	40.65	33.60	-	-
28.04.1903	6.7	Malazgirt	2626	-	4500	39.10	42.50	-	IX
10.02.1903	5.8	Zara	-	-	1500	39.90	37.80	-	-
04.12.1905	6.8	Çemisgezek	-	-	15	39.00	39.00	30	-
09.08.1912	7.3	Mürefte	216	466	5540	40.60	27.20	16	-
04.10.1914	5.1	Afyon-Bolvadin	400	-	1700	38.00	30.00	15	-
13.05.1924	5.3	Çaykara	50	-	700	40.00	42.00	30	-
13.09.1924	6.9	Pasinler	310	-	4300	39.96	41.94	10	-
07.08.1925	5.9	Afyon-Dinar	3	-	2043	38.10	29.80	20	IX
08.02.1926	4.7	Milas	2	-	598	36.80	27.10	30	-
18.03.1926	6.9	Finike	27	-	190	35.84	29.50	10	-
22.10.1926	5.7	Kars	355	-	1100	40.94	43.88	10	VIII
31.03.1928	7	Izmir-Torbali	50	-	2100	38.18	27.80	10	IX
18.05.1929	6.1	Sivas-Susehri	64	-	1357	40.20	37.90	10	VIII
06.05.1930	7.2	Hakkari Siniri	2514	-	3000	37.98	44.48	70	X
19.07.1933	5.7	Denizli-Çivril	20	-	200	38.19	29.79	40	VIII
15.12.1934	4.9	Bingöl	12	-	200	38.85	40.55	-	-
04.01.1935	6.7	Erdek	5	30	600	40.40	27.49	30	IX
01.05.1935	6.2	Digor	200	-	1300	40.09	43.22	60	-
23.03.1936	4.5	Kars-Kötek	-	-	100	39.00	42.00	30	-
19.04.1938	6.6	Kirsehir	149	-	3860	39.44	33.79	10	IX
16.12.1938	4.8	Kirsehir	-	-	300	39.52	33.91	10	-
22.09.1939	7.1	Izmir-Dikili	60	-	1235	39.07	26.94	10	IX
21.11.1939	5.9	Tercan	43	-	500	39.82	39.71	80	-
26.12.1939	7.9	Erzincan	32962	-	116720	39.80	39.51	20	X-XI
20.02.1940	6.7	Kayseri-Develi	37	20	530	38.40	35.30	30	VIII
13.04.1940	5.6	Yozgat	20	-	1250	40.04	35.20	30	-
10.01.1940	5	Nigde	58	-	586	38.00	34.70	-	-
10.09.1941	5.9	Van-Ercis	194	-	600	39.45	43.32	20	VIII
12.11.1941	5.9	Erzincan	15	-	500	39.74	39.43	70	-
13.12.1941	5.7	Mugla	-	-	400	37.13	28.06	30	-
23.05.1941	6	Mugla	2	-	500	37.07	38.21	40	-
15.11.1942	6.1	Bigadiç-Sindirgi	7	-	1262	39.55	28.55	10	VIII
21.11.1942	5.5	Osmancik	7	-	448	40.82	34.44	80	-
20.12.1942	7	Niksar-Erbaa	3000	6300	32000	40.87	36.47	10	IX
11.12.1942	5.9	Çorum	25	-	816	40.76	34.83	40	-
20.06.1943	6.6	Adapazari-Hendek	336	-	2240	40.85	30.51	10	IX
26.11.1943	7.2	Tosya-Ladik	2824	-	25000	41.05	33.72	10	IX-X
01.02.1944	7.2	Bolu-Gerede	3959	-	20865	41.41	32.69	10	IX-X
06.10.1944	7	Ayvalik-Edremit	27	-	1158	39.48	26.56	40	IX

10.02.1944	5.4	Düzce	-	-	900	41.00	32.30	10	-
05.04.1944	5.6	Mudurnu	30	-	900	40.84	31.12	10	-
25.06.1944	6.2	Gediz-Usak	21	-	3476	38.79	29.31	40	VIII
20.03.1945	6	Adana-Ceyhan	10	-	650	37.11	35.70	60	VIII
20.11.1945	5.8	Van	-	-	1000	36.63	43.33	10	-
21.02.1946	5.6	Kadinhan-Ilgin	2	-	509	38.24	31.79	60	VIII
31.05.1946	5.7	Varto-Hinis	839	349	1986	39.29	41.21	60	VIII
23.07.1949	7	Izmir-Karaburun	1	7	824	38.57	26.29	10	IX
17.08.1949	7	Karliova	450	-	3000	39.60	40.60	40	IX
05.02.1949	5.2	Harmancik	-	-	150	39.89	29.35	40	-
04.02.1950	4.6	Kigi	20	-	100	39.50	40.60	30	-
08.04.1951	5.7	Iskenderun	6	10	13	36.58	35.85	50	-
13.08.1951	6.9	Kursunlu	52	208	3354	40.88	32.87	10	IX
03.01.1952	5.8	Hasankale	133	-	701	39.95	41.67	40	VIII
22.10.1952	5.5	Misis	10	-	511	37.25	35.15	70	-
18.03.1953	7.4	Yenice-Gönen	265	336	9670	39.99	27.36	10	IX
02.05.1953	5.1	Karaburun	-	-	73	38.51	26.55	60	-
07.09.1953	6.4	Kursunlu	2	-	230	41.09	33.01	40	VIII
18.06.1953	5.1	Edirne	-	-	323	41.55	26.55	30	-
16.07.1955	7	Aydin-Söke	23	-	470	37.65	27.26	40	IX
20.02.1956	6.4	Eskisehir	2	-	1219	39.89	30.49	40	VIII
25.04.1957	7.1	Fethiye	67	-	3100	36.42	28.68	80	IX
26.05.1957	7.1	Bolu-Abant	52	100	4201	40.67	31.00	10	IX
07.07.1957	5.1	Basköy	-	-	300	39.37	40.46	60	-
25.04.1959	5.7	Köycegiz	-	-	59	36.94	28.58	30	VIII
25.10.1959	5	Hinis	18	-	300	39.25	41.63	50	-
26.02.1960	4	Bitlis	-	-	80	38.49	41.52	40	-
10.04.1960	4.4	Germencik	-	-	100	37.73	27.80	40	-
26.07.1960	4.6	Tokat	-	-	22	40.56	37.25	40	-
23.05.1961	6.5	Marmaris	-	9	61	36.80	28.70	70	-
10.02.1962	4	Mus	-	-	97	38.70	41.45	-	-
04.09.1962	5.3	Igdir	1	22	-	39.96	44.13	40	-
11.03.1963	5.5	Denizli	-	-	54	37.96	29.14	40	-
18.09.1963	6.3	Çinarcik-Yalova	1	26	230	40.77	29.12	40	VII
22.11.1963	5.1	Denizli	-	-	298	37.07	29.68	60	-
24.03.1964	4	Siirt	1	-	100	37.95	42.00	-	-
14.06.1964	6	Malatya	8	36	678	38.13	38.51	3	VIII
06.10.1964	7	Manyas	23	130	5398	40.30	28.23	24	IX
13.06.1965	5.7	Denizli-Honaz	14	217	488	37.85	29.32	33	VIII
31.08.1965	5.6	Karliova	-	-	1500	39.30	40.79	33	-
07.03.1966	5.6	Varto	14	75	1100	39.20	41.60	26	VIII
12.07.1966	4	Varto	12	-	90	39.17	41.56	-	-
19.08.1966	6.9	Varto	2394	1489	20007	39.17	41.56	26	IX
07.04.1966	4.8	Adana-Bahçe	-	-	100	37.00	35.30	-	-
22.07.1967	7.2	Adapazari	89	235	5569	40.67	30.69	33	IX
26.07.1967	6.2	Pülümür	97	268	1282	39.54	40.38	30	VIII
30.07.1967	6	Akyazi	2	40	-	40.70	30.40	18	-
07.04.1967	5.3	Adana-Bahçe	-	-	91	37.40	36.20	32	-

24.09.1968	5.1	Bingöl-Elazig	2	40	-	39.20	40.20	8	-
03.09.1968	6.5	Amasya-Bartin	29	231	2073	41.81	32.39	5	VIII
14.01.1969	6.2	Fethiye	-	-	42	36.11	29.19	22	-
03.03.1969	5.7	Gönen	1	-	20	40.08	27.50	6	-
23.03.1969	6.1	Demirci	-	-	1100	39.10	28.40	9	VII
25.03.1969	6	Demirci	-	-	1826	39.25	28.44	37	-
28.03.1969	6.6	Alasehir	41	186	4372	38.55	28.46	4	VIII
06.04.1969	5.6	Karaburun	-	3	443	38.50	26.40	16	-
28.03.1970	7.2	Gediz	1086	1260	9452	39.21	29.51	18	IX
19.04.1970	5.9	Çavdarhisar-Kütahya	-	2	41	39.10	29.70	18	-
23.04.1970	5.7	Demirci	-	43	150	39.10	28.70	28	-
02.07.1970	4.8	Gürün	1	-	150	38.80	36.70	19	VIII
12.05.1971	6.2	Burdur	57	150	1389	37.64	29.72	30	VIII
22.05.1971	6.7	Bingöl	878	700	5617	38.85	40.52	3	VIII
26.04.1972	5	Ezine	-	-	400	39.50	26.30	25	-
22.03.1972	4.7	Sarikamis	-	4	100	40.40	42.20	2	-
16.07.1972	5.2	Van	1	-	400	38.30	43.30	46	-
01.02.1974	5.2	Izmir	2	20	47	38.55	27.22	31	VI
06.09.1975	6.9	Lice	2385	3339	8149	38.47	40.72	32	VIII
25.03.1975	5.1	Kars-Susuz	2	26	762	40.95	42.96	25	VI
19.08.1976	4.9	Denizli	4	28	887	37.67	29.17	-	VII
24.11.1976	7.2	Çaldiran-Muradiye	3840	497	9552	39.12	44.16	10	IX
02.04.1976	4.8	Dogu Beyazit	5	13	236	39.91	43.76	14	VI
30.04.1976	5	Ardahan	4	-	300	41.20	42.60	-	-
25.03.1977	4.8	Lice	8	17	210	38.58	40.03	29	-
26.03.1977	5.2	Palu	8	26	842	39.34	43.50	25	-
09.12.1977	4.8	Izmir	-	-	11	38.56	27.47	-	-
16.12.1977	5.3	Izmir	-	-	40	38.40	27.19	24	-
14.06.1979	5.9	Foça	-	-	22	38.92	26.89	-	-
30.06.1981	4.4	Antakya	-	-	2	36.17	35.89	63	-
27.03.1982	5.2	Mus-Bulanik	-	-	424	39.23	41.90	38	-
05.07.1983	4.9	Biga	3	-	85	40.33	27.21	7	-
30.10.1983	6.8	Erzurum-Kars	1155	1142	3241	40.20	42.10	16	VIII
18.09.1984	5.9	Erzurum-Balkaya	3	35	187	40.90	42.24	10	-
05.05.1986	5.8	Malatya-Sürgü	8	24	824	37.95	37.80	10	VII
06.06.1986	5.6	Sürgü-Malatya	1	20	1174	38.01	37.91	11	-
07.12.1988	6.9	Kars-Akyaka	4	11	546	40.96	44.16	5	-
13.03.1992	6.8	Erzincan-Tunceli	653	3850	6702	39.68	39.56	27	VIII
01.10.1995	5.9	Dinar	94	240	4909	38.18	30.02	24	VIII
14.08.1996	5.4	Çorum-Amasya	-	6	707	40.73	35.28	12	VI
27.06.1998	5.9	Adana-Ceyhan	146	94-0	4000	36.85	35.55	23	-
17.08.1999	7.4	17 Agustos Kocaeli	15000	32000	50000	40.70	29.91	20	IX

Source : Bagci, G., Yatman, A., Özdemir, S., Altin ,N., Türkiye'de Hasar Yapan Depremler Deprem Arastirma Bülteni, Sayi 69,113-126