IDENTIFICATION OF GAPS IN THE INTERFACE BETWEEN SPATIAL PLANNING DECISIONS AND CONSTRUCTION PRACTICE OF BUILT-UP AREAS IN THE SCOPE OF SEISMIC RESILIENT CITIES: CASE OF KAHRAMANMARAŞ

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ELİF ZEYNEP ÇEPNİ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
EARTHQUAKE STUDIES

JANUARY 2023

Approval of the thesis:

IDENTIFICATION OF GAPS IN THE INTERFACE BETWEEN SPATIAL PLANNING DECISIONS AND CONSTRUCTION PRACTICE OF BUILT-UP AREAS IN THE SCOPE OF SEISMIC RESILIENT CITIES: CASE OF KAHRAMANMARAŞ

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ABSTRACT

IDENTIFICATION OF GAPS IN THE INTERFACE BETWEEN SPATIAL PLANNING DECISIONS AND CONSTRUCTION PRACTICE OF BUILT-UP AREAS IN THE SCOPE OF SEISMIC RESILIENT CITIES: CASE OF KAHRAMANMARAŞ

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January 2023, 267 pages

During the urbanization and construction processes in Türkiye, earthquakes caused by tectonic reasons have resulted in great damage. Damage to life and properties as a result of earthquakes lead to great material and moral losses. Particularly in our country where earthquakes are frequently experienced, development decisions on unsuitable grounds together with construction processes without engineering standards and designs had led today's most populous cities to be vulnerable to earthquakes which is the core topic of this study. From the analysis stage of a regional and urban planning process development decisions and construction processes are examined in the case of Türkiye's legislative scheme in order to find out the major gaps between planning decisions and construction practices in order for having seismic resilient cities.

In this context, as a first step in the study, the relationship between geological studies and planning, which will be the basis for development plans and then the building design principles in earthquake-prone areas and the problems encountered in this process in the case of Türkiye's cities is evaluated together. Furthermore, it is explained in detail how studies that require expertise in a wide range of fields such as planning and engineering can be implemented with the contribution of different disciplines within the seismically resilient urbanization and construction processes. In the last chapter, the urban seismic resilience criteria obtained are evaluated in particular for the city of Kahramanmaraş and spatial suggestions developed for the city of Kahramanmaraş based on the urban seismic resilience are presented.

Keywords: Earthquake, Seismic Resilience, Kahramanmaraş, Planning Decisions, Code of Construction Practice

ÖZ

SİSMİK DİRENÇLİ KENTLERDE MEKANSAL PLAN KARARLARI VE YAPILI ÇEVRENİN YAPILAŞMA SÜREÇLERİ ARAYÜZÜNDEKİ BOŞLUKLARIN BELİRLENMESİ: KAHRAMANMARAŞ ÖRNEĞİ

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Ocak 2023, 267 sayfa

Türkiye'de kent planlama ve yapılaşma süreçlerinde tektonik nedenlerle meydana gelen depremler büyük hasarlarla sonuçlanmıştır. Depremler sonucu gerçekleşen can kayıpları ve mal hasarları büyük maddi ve manevi kayıplara yol açmıştır ve açmaya devam etmektedir. Özellikle depremlerin sıklıkla yaşandığı ülkemizde, sismik açıdan uygun olmayan zeminler için alınan imar kararları, mühendislik standartlarından ve tasarımlarından yoksun olarak devam eden inşaat süreçleri, günümüzün en kalabalık şehirlerini, bu çalışmanın ana konusunu oluşturan depremlere karşı savunmasız hale getirmiştir. Bu nedenle bu çalışmada, şehir ve bölge planlama sürecinin analiz aşamasından itibaren, sismik açıdan dirençli şehirlere sahip olmak için planlama kararları ile inşaat uygulamaları arasındaki temel boşlukları bulmak için Türkiye'nin mevzuat şeması altında alınan gelişme kararları ve uygulanan inşaat süreçleri incelenmiştir.

Bu bağlamda çalışmada ilk aşama olarak, imar planlarına altlık oluşturacak jeolojik etütlerin planlama ile ilişkisi ve daha sonra sismik açıdan riskli alanlarda yapı tasarım ilkeleri ve bu süreçte karşılaşılan sorunlar, ülke genelinde değerlendirilmiştir. Sismik açıdan dirençli kentleşme ve yapılaşma süreçleri içinde planlama ve mühendislik gibi geniş alanda uzmanlık gerektiren çalışmaların farklı disiplinlerin katkısı ile hayata nasıl geçirilebileceği detaylı olarak açıklanmıştır. Son bölümde ise elde edilen kentsel sismik dirençlilik kriterleri Kahramanmaraş İli özelinde değerlendirilmiş ve buna bağlı olarak geliştirilen mekansal öneriler sunulmuştur.

Anahtar Kelimeler: Deprem, Sismik Dayanıklılık, Kahramanmaraş, Kent Planlama, Yapı Yönetmelikleri

To Those Who Lost Their Lives in the Kahramanmaraş Earthquakes,

ACKNOWLEDGMENTS

First of all, I would like to express my sincere gratitude to my supervisor Assoc. Prof. Dr. Meltem Şenol Balaban, who accepted me to my master's degree and started this adventure. My faith in my thesis increased even more because she did not hesitate to give all kinds of support during this process and always answered my questions with the best guidance. Secondly, I am very grateful to my co-advisor Prof. Dr. Ayşegül Askan Gündoğan who does not spare her support and her smiling face by encouraging me to start working.

Also, I would like to express my deep appreciation to METU, City and Regional Planning and METU, Civil Engineering professors who have contributed to me throughout my university and graduate life to write this thesis. Also, I would like to deeply thank Mr. Necati Uyar for everything, for his support in answering some of the questions that came to my mind during the writing of the thesis.

I would like to express my sincere gratitude to my mother Emine Jale Çepni, my father Kubilay Çepni and my brother Münif Sertaç Çepni for always being there for me, who encouraged me whenever I gave up during this process. I really appreciate their endless support, love, patience and motivating speeches. I could never have done without them. I would also like to express my deep thanks to my dear friend Görkem Yalın, who was always there for me, for always listening to me with tolerance and helping and cheering me.

I couldn't have done this thesis without you...

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LIST OF ABBREVIATIONS

ABBREVIATIONS

AD: Anno Domini – Milattan Sonra

AFAD: Disaster and Emergency Management Presidency - Afet ve Acil Durum Yönetimi Başkanlığı

BC: Before Christ - Milattan Önce

EAFZ: East Anatolian Fault Zone - Doğu Anadolu Fay Zonu

EM-DAT: Emergency Events Data Base/The International Disaster Data Base - Uluslararası Afet Veritabanı

FEMA: Federal Emergency Management Agency - Federal Acil Durum Yönetimi Ajansı

GNP: Gross National Product - Gayri Safi Milli Hasıla

HFA: Hyogo Framework for Action - Hyogo Eylem Çerçevesi

IRAP: Provincial Disaster Risk Reduction Plan - İl Afet Risk Azaltma Planı

M_w: Moment Magnitude - Moment Büyüklüğü

OECD: Organisation for Economic Co-operation and Development - Ekonomik İş Birliği ve Kalkınma Örgütü

OSB: Organized Industrial Zone - Organize Sanayi Bölgesi

UNDP: United Nations Development Programme - Birleşmiş Milletler Geliştirme Programı

UNISDR: United Nations International Strategy for Disaster Reduction - Birleşmiş Milletler Uluslararası Afet Azaltma Stratejisi

USA: United States of America - Amerika Birleşik Devletleri

USGS: United States Geological Survey - Amerika Birleşik Devletleri Jeoloji Araştırmaları Kurumu

TBEC: Turkish Building Earthquake Code - Türkiye Bina Deprem Yönermeliği

CHAPTER 1

INTRODUCTION

1.1 Context of the Research

Disasters are phenomena that cannot be known from the beginning in terms of their occurrence time, duration and severity with the technological possibilities of this century. It is clearly known that the consequences might possibly leave deep soul-shattering and sorrow in the light of lived experiences.

As an undeniable fact, due to its geographical location and geological structure, as well as climatic conditions, Türkiye is exposed to many nature-induced disasters, like earthquakes, floods, landslides and rock falls. Such disasters have been causing great damage in many countries like Türkiye. In addition to natural disasters, human-induced (technological) disasters are also experienced in our country. In this context, in Figure 1.1 and Figure 1.2, the percentages of both nature and human-induced disasters are given depending on the frequency of occurrence. The damage and loss of life caused by all these disasters corresponds to approximately 3% of Türkiye's Gross National Product (GNP). Environmental destructions, labor losses and social psychological effects indirectly led this value to increase the percentage value of the damage.

A large percentage of this damage in Türkiye is caused by earthquakes because most of its territory is located in earthquake risky regions (Karaesmen, Boyacı Korkut, & Güngör, 2004). Therefore, it can be said that a very large part of the population in our country lives in problematic areas in terms of earthquake risk. When the regions with high risk of damage are examined under the guidance of the Türkiye Earthquake Hazard Map as of 2019, it should not be overlooked that the majority of the country's population and economic assets are under the risk of earthquakes.

Considering the geographical location of Türkiye, the fact that it is located in the Alpine-Himalayan belt increases its seismic activity since approximately 20% of all earthquakes in the world take place in this region. Regarding earthquakes that were experienced in Türkiye, they could be described as destructive as they have been occurring approximately every five years (AFAD, 2022).

In this context, according to the International Emergency Database (EM-DAT), it has been stated that approximately 94.000 people died and more than 100.000 were injured in earthquakes with a magnitude greater than Mw=5 between 1900 and 2022 in Türkiye. The total number of people affected by these disasters is more than 7 million (EM-DAT, 2022). The following table summarizes the major earthquakes that occurred between 1900 and 2022 (Table 1.1).

Table 1.1: *Experienced Nature Induced Disasters between 1900 and 2022*

	Year	Type of Disaster	Location	Number of Casualties	Number of Affected People	Economic Loss (USD)
1	1999	Earthquake	Gulf of İzmit	17.127	1.358.953	20.000.000
2	2011	Earthquake	Van	604	32.938	1.500.000
3	1939	Earthquake	Erzincan	32.962	466.880	-
4	1999	Earthquake	Düzce	845	224.948	1.000.000
5	1992	Earthquake	Erzincan	653	348.850	750.000
6	1970	Earthquake	Kütahya (Gediz)	1.086	80.000	1.000.000
7	1998	Earthquake	Adana,Hatay	145	1.589.600	550.000
8	2020	Earthquake	İzmir	115	6.034	450.000
9	2002	Earthquake	Afyon (Sultandağı)	42	13.200	100.000
10	2003	Earthquake	Bingöl	176	9.078	500.000

Source: *(EM-DAT, 2022)*

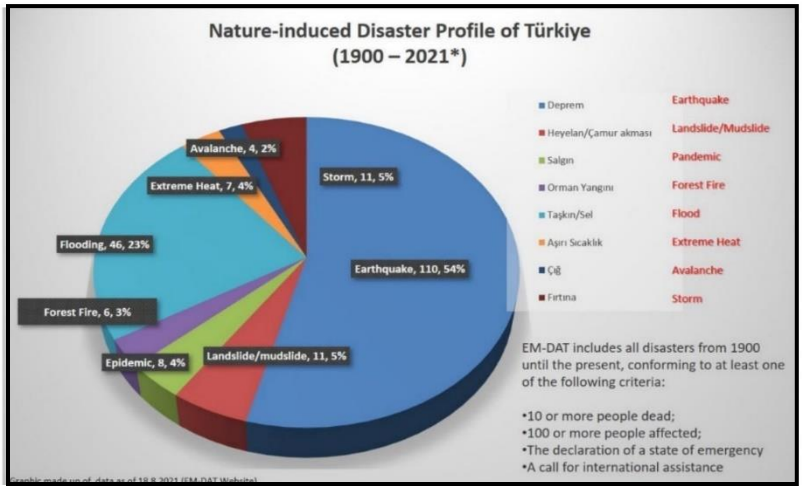


Figure 1.1: *Types of Nature Induced Disasters that Occurred in Türkiye between 1900-2021*

Source: *(AFAD, 2022)*

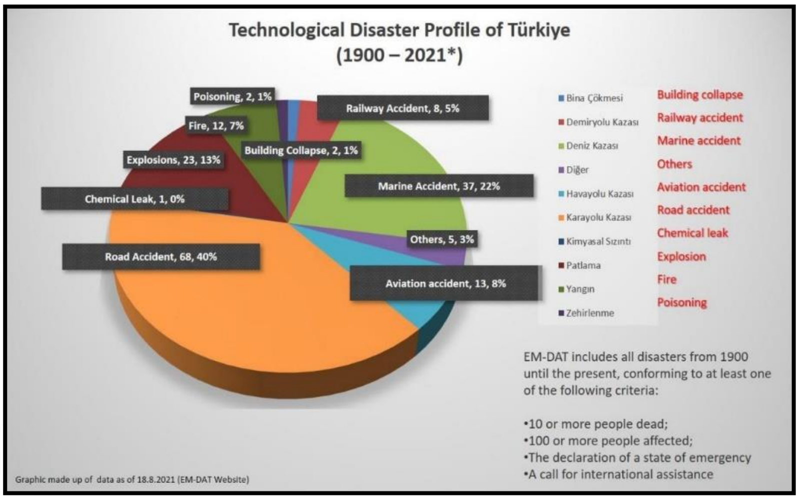


Figure 1.2: *Types of Human Induced (Technological) Disasters that Occurred in Türkiye between 1900-2021*
Source: *(AFAD, 2022)*

According to the Active Fault Map of Türkiye prepared based on the data of the General Directorate of Mineral Research and Exploration in Türkiye, it is known that there are more than 300 active faults (Mineral Research Exploration, 2020). One of the active faults is the North Anatolian Fault Line, which is 1100 km long, while the other is the Eastern Anatolian Fault Line, which is 600 km long (Şaroğlu, Emre, & Kuşçu, 1992). Figure 1.3 shows the location of 1796 earthquakes with a magnitude of Mw=5 between January 1, 1900 and April 14, 2022, which is shown as the instrumental period in Türkiye (AFAD, 2020). When these data are examined, it is understood that they are compatible with the data of the Türkiye Earthquake Hazard Map renewed by AFAD. In this context, Türkiye Earthquake Hazard Map, which was renewed in 2019, is given in Figure 1.4 (AFAD, 2022). Since 2019 the current building code has been used as a basis for construction processes based on the Earthquake Hazard Map of Türkiye, which is accessible on the web (1).

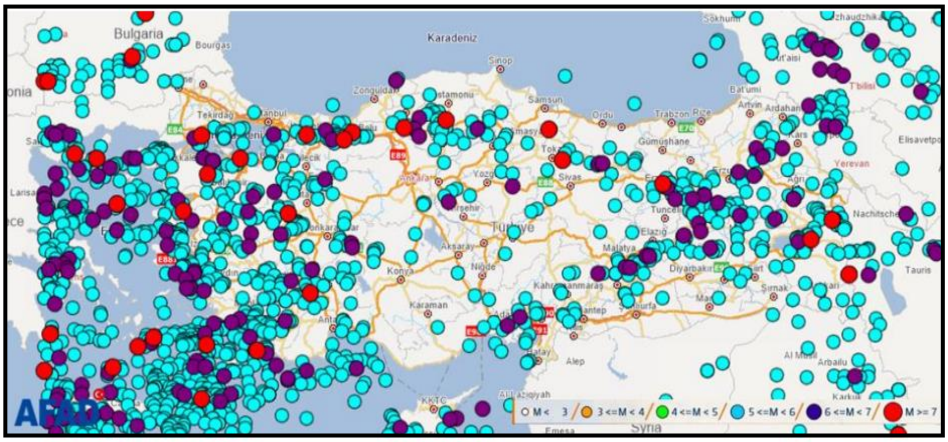


Figure 1.3: *Spatial Distribution of Earthquakes of Mw≥ 5 between January 1st, 1900 and April 14th, 2022*
Source*: (AFAD, 2022)*

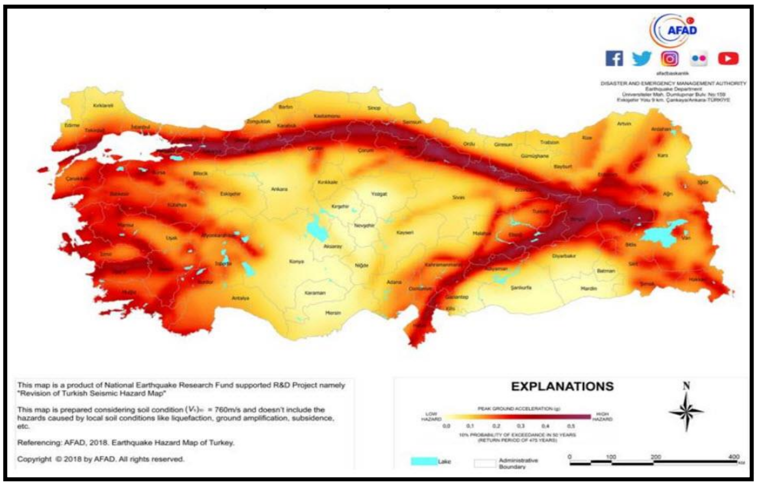


Figure 1.4: *Türkiye Earthquake Hazard Map*
Source*: (AFAD, 2022)*

(1) https://tdth.afad.gov.tr/TDTH/main.xhtml

1.2 Aim and Objective of the Research

Loss of life and property due to earthquakes cause great financial and moral losses. Because of such great losses, it is extremely necessary to carry out some preparatory work especially before events turn into disasters. These preparatory works would probably minimize the loss of life and property as much as possible that may occur as a result of disasters, especially earthquakes. However, many examples of settlement and built-up areas in our country do not take these decisions seriously and do not put them into practice as regulations indicate. Therefore, the planning and construction system in our country could be found as not effectively directing urban development for the benefit of the society. One of the negative consequences of this situation is the failure to develop methods and tools that take into account disaster hazards and risks in the planning. This will result in the formation of residential environments and building stock that are highly vulnerable to earthquakes. Planning decisions at each scale and the construction decisions taken accordingly are critical tools in reducing disaster risks and should be the main objective of disaster risk management and planning. When we think in terms of earthquake hazard, there are several problems in urban planning and many construction projects in Türkiye. One of the reasons for these problems is that the limiting effects of geological and geomorphological conditions are not taken into account sufficiently and necessary precautions are not taken in a timely manner.

Different strategies have been developed to solve the housing problem that has arisen with the increasing population in our country. Among these strategies, the expansion of the existing risky settlement area or the redevelopment of existing areas that were previously excluded from planning due to their geological structure and physical characteristics were on the agenda. Such applications are observed more frequently before 1999. Today, it can be said that the geological geotechnical studies required by the laws after 1999 are made in a more controlled manner. However, it is difficult to say that these studies, which are obligatory in the urban planning and construction process, are carried out appropriately. Areas developed in many provinces of Turkey without appropriate geological and geotechnical studies and adequate engineering standards leave cities vulnerable to earthquakes. For this reason, the places where the losses are the highest in our country are the areas where such urban settlements and constructions occur. Therefore, it is imperative to act within the scope of proactive measures, more important than reactive disaster measures and regulations in these places. In other words, the measures to be taken before the disaster within the scope of the package of pre-disaster, during and post-disaster measures have more crucial importance in reducing the damages of disasters. Therefore, urbanization and construction decisions have to be preventive and ready for dealing with disaster risks from the very beginning until a disastrous event hits. For this reason, in our country where strong earthquakes are frequent and disastrous, improper planning and building construction problems and designs which are made by ignoring or paying less attention due to geological factors form the basis of this study. In fact, this process requires a wide range of expertise and applications such as planning, design and engineering. As a subject that has a great deficiency in our country, both the urban planners and the civil engineers should follow a joint work in terms of settlement decisions and construction decisions to be taken on areas where earthquake hazard and risk are higher. As an initial step, geological survey studies and planning relationships that are the basis for development and implementation plans are investigated; then, accordingly, building design principles in hazard prone areas are examined in detail. In particular, understanding how the earthquake hazard based urbanization and seismic resilient construction are possible in a settlement, and finding out what kind of problematic areas through the processes in Türkiye's practice in accordance with regulations would be helpful for proposing solutions to be more resilient communities. The precautions to be taken and the principles to be followed under the main headings of site selection, settlement and construction, which are within the scope of various fields of expertise such as city planning and engineering, will be discussed. Then, in the light of the findings gaps among those relations, the city of Kahramanmaraş, which was determined as the study area, will be examined as the application area of findings as well as possible proposals in order to overcome the negative results of those gaps.

In this context, this study would consider the responsiveness of urbanization and construction to hazards and disaster risks under three headings..

1. Location Selection and Settlement Decisions; include analysis stage, planning decisions and actual developments,
2. Construction Decisions; include pre-design, design, and actual structures,
3. The relationships between 1 and 2.

These decisions should be guides to be organized under certain headings and they have to draw guiding frameworks for most of the settlement and construction decisions. In this way, disaster risks could be minimized as much as possible before an event turns into disaster since damages could be minimized to level of acceptance. In the contexts mentioned above, it is common idea that disaster resilient urbanization and construction decisions include necessary proactive measures. These proactive measures should require process planning. The major steps in this process are collecting data, analyzing it, and then filtering it to reach an interpreted bundle of information as a base. Then risk avoidance and reduction measures could be formulated and should be followed by necessary steps to be implemented as planned.

These three criteria which should be applied basically, guide the decisions about the location of the urban settlement and construction in the urban area, what kind of urban pattern could possibly be settled in proper way on the selected place with which density distribution and how the buildings could be built on the land for resilient physical structure. The values that these decisions will add to the subject related to their expertise might be various and abundant for all areas of expertise involved in the process of implementing. In this context, these criteria also point out the need for engineers and planners to collaborate from the beginning. It is imperative for disaster resilient urbanization and construction to carry out the same teamwork at the level of sub-topics.

In the light of the above-mentioned description, the first issue is stages of the urban planning process starting from the analysis and survey. Accordingly, the location selection and settlement decisions would be the next step that is the key for avoiding specific hazard zones if possible in this context. Especially in our country, the key points that cause current vulnerability issues in this process will be emphasized and relevant solutions will be tried to be presented. Then, the city of Kahramanmaraş will be investigated, evaluated and how alternative proposals should be applied to this case will be discussed.

1.3 Problem Definition and Expected Results of the Thesis Study

1.3.1 Basis of the Problem Definition and Reasons of the Case Study Selection

According to the known historical and instrumental earthquake records, Türkiye has been exposed to many damaging earthquakes. Türkiye and its surroundings are located on the Alpine-Himalayan belt, which is one of the most active earthquake zones in the world. With the North-Northeast movement of the African-Arabian plates, the Arabian plate is pushed to the north and remains under the Eurasian plate (Figure 1.5). Thus, the Eastern Anatolia region is also compressed due to this movement (Karaağaç, Karaman, & Aktuğ, 2019). Due to this tectonic location, almost all of Türkiye's landmass is under the risk of earthquakes. In the study carried out by the American Geological Survey, it was stated that approximately 6% of the number of earthquakes worldwide occurred in Türkiye (United States Geological Survey, 2015).

When the active fault map of Türkiye prepared by Mineral Research and Exploration Agency is examined, it is stated that the number of active faults or fault segments that can produce earthquakes of M_w =5.5 and above is approximately 485, and the number of single or multi-segment fault zones is approximately 326 (Duman & Emre, 2015). Among these active faults, the North Anatolian Fault, the East

Anatolian Fault have large fault systems consisting of sub-parts that can produce destructive earthquakes alone. Considering before mentioned historical earthquakes, it is seen that numerous important earthquakes with loss of life and property are repeated in the Northeast Anatolia and East Anatolian Fault Line regions (Bikçe, 2017). In today's conditions, it is not possible to know exactly where and when an earthquake will occur. Because the probability of such earthquakes to recur at certain periods is a strong possibility.

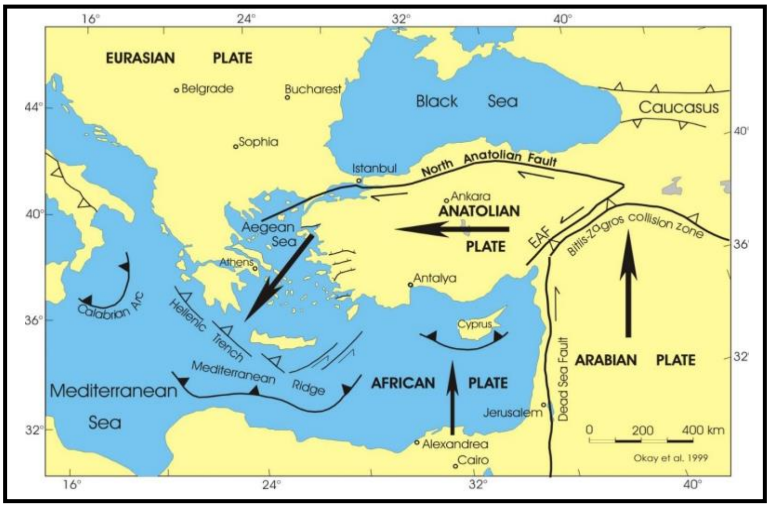


Figure 1.5: *Tectonic Map of the Eastern Mediterranean Region*

Source: *(Yalçın, Gülen, & Utkucu , 2013)*

In this context, it is observed that especially the western part of the East Anatolian Fault did not produce a significant earthquake activity in the instrumental period and remained silent (Coşkun, 2022). Although the East Anatolian Fault has been silent for a long time in terms of seismic activity, it is understood from the earthquake records that the seismic activity of this fault was quite high in the historical period (2100 BC - 1900 AD) in Kahramanmaraş and its surroundings.

In the historical period, there have been many earthquakes affecting Kahramanmaraş and varying intensity (according to Mercalli-Sieberg scale) between VI and IX. Later, the East Anatolian Fault entered a quiet period after the earthquakes in the Türkoğlu region in 1513 and 1874 (VIII intensity) (Biricik & Korkmaz, 2001).

Figure 1.6 shows the historical earthquakes that occurred in Kahramanmaraş and its surrounds.

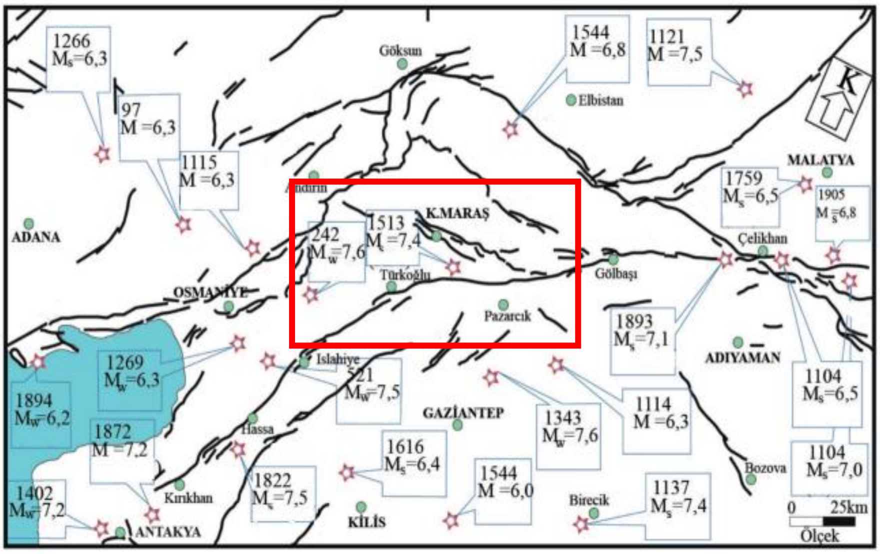


Figure 1.6: *Several Historical Earthquakes that Occurred in Kahramanmaraş and Its Surrounds*

Source: *(İRAP, 2020)*

In fact, this inactivity in seismic activity continues in the instrumental period. However, this phase can be interpreted as representing the "earthquake preparation phase" of an earthquake series likely to occur within the next century, probably at the western ends of the East Anatolian Fault and the northern ends of the Dead Sea Fault. Because, the areas along the active major fault lines that have not experienced earthquakes for a long time are defined as places with a high potential to create earthquakes in the future and these are interpreted as “seismic gaps” (Biricik & Korkmaz, 2001). However, in the seismic belt, it is not correct to use a definite statement that there will be earthquakes in the future in all of the spaces in between, as a result of marking the regions where aftershocks of large earthquakes spread on the map. Because in some parts of these belts, there may be continuous deformation discharge as a result of seismic shear, and while micro earthquakes occur very frequently, they do not form large magnitude earthquakes. However, in some cases, intense micro-earthquake activity is observed in regions far from the focal region of the big earthquake before the big earthquake occurs. This indicates a kind of precursor events in the focal region before a major earthquake, which are interpreted as "temporal gaps" (Biricik & Korkmaz, 2001).

In the light of this information, when Kahramanmaraş seismicity is examined, the biggest earthquake that has occurred within the borders of Kahramanmaraş since 1900 to the present occurred on 10.01.1901 in Ekinözü district of Kahramanmaraş province and its magnitude is M_w = 5.5. This was followed by earthquakes with magnitude M_w = 5.3 in Nurhak district in 1908, Mw 5.0 in Kahramanmaraş center in 1961, M_w = 5.0 in Andırın district in 1996, M_w = 5.0 in Andırın district in 2012, and M_w = 5.1 magnitude in Pazarcık district in 2012 (Figure 1.7).

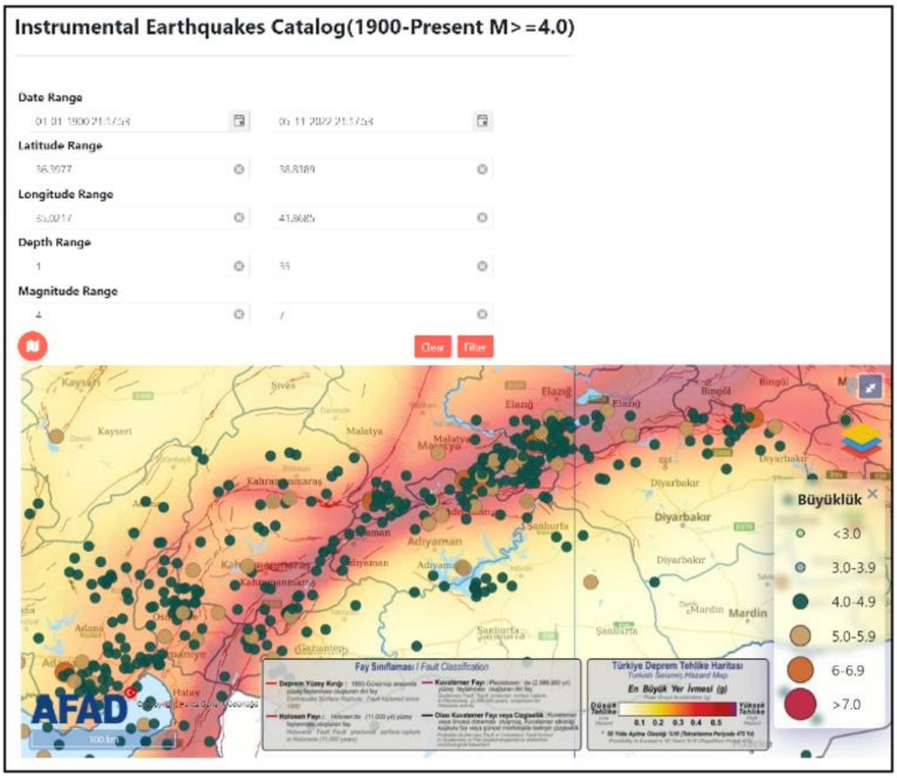


Figure 1.7: *Spatial Distribution Maps of Disasters in Kahramanmaraş and Its Surroundings*

Source: *(AFAD, Deprem Kataloğu, 2022)*

According to the Türkiye Earthquake Hazard Map published by the Disaster and Emergency Management Presidency in 2019, Kahramanmaraş Province is located in a very risky region. The Gölbaşı-Türkoğlu segment of the eastern Anatolian fault zone passes through Kahramanmaraş which is shown in Figure 1.8. The length of this segment is around 90 km and it is approximately 15 km away from Kahramanmaraş city center. It is known that this fault produced earthquakes over M_w =7.0 in 1113-1513 and its recurrence period is estimated to be approximately 400 years (Palutoğlu & Şaşmaz, 2017).

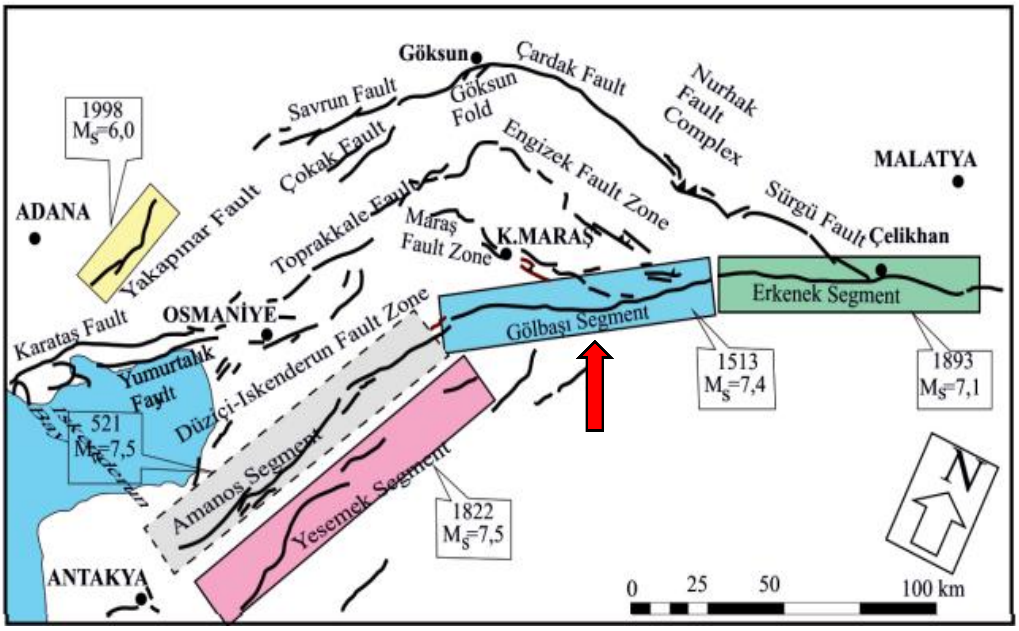


Figure 1.8: *Surface Ruptures Caused by Major Earthquakes in the 19th and 20th Centuries throughout Eastern Anatolia*

Source: *(Palutoğlu & Şaşmaz, 2017)*

No major earthquake has occurred in the Gölbaşı-Türkoğlu segment of the fault for 509 years. This situation raises the concern that the seismic activity that has increased in Kahramanmaraş and its surroundings in recent years will end with a severe earthquake (Biricik & Korkmaz, 2001). For this reason, it is of great importance that Kahramanmaraş province, which has a high risk in terms of earthquake hazard, takes precautions and be prepared against this danger socially (İRAP, 2020). In other words, this long-standing silence on the segment of the East Anatolian Fault passing through Kahramanmaraş and its vicinity has a high potential for a possible earthquake risk. For this reason, Kahramanmaraş province was considered as the study area.

1.3.2 Expected Outcomes of the Research

When the expected results from the study are considered within the framework of the problems determined to start the research;

- ✓ Identification of earthquake resilient components based on the concept of urban seismic resilience,
- ✓ Elaborating common international policies and practices in urban seismic resilience concept,
- ✓ Identification of gaps in urban planning and construction processes in Turkey by considering the urban seismic resilience,
- ✓ Developing strategies for seismically resilient urban planning and construction processes,
- ✓ Revealing the spatial reflections of planning and construction processes problems determined by the Kahramanmaraş Case and developing proposals.

1.4 Methodology of the Thesis Study

Within the scope of the thesis research, firstly, the general literature review was made for the research methods to be used in this thesis. The basis of the literature review was firstly to examine what kind of studies have been done on seismic resilient cities in world cities. In this context, world-wide theoretical and technical research, world-wide practices and studies have given the author a perspective on the problems experienced in Türkiye. Afterwards, a theoretical in-depth literature research was conducted on the formation process of seismically resilient cities in

Türkiye. Previous studies on this subject, articles and reports, legislative publications, conferences and collective events have been examined in order to reveal the functioning in Türkiye.

People who are experienced and involved in the subject were interviewed and their opinions were taken about the operation in Türkiye. Experienced and relevant people on the subject were interviewed and their opinions were received about the operation in Turkey. In this context, the manager of Ege Plan (a private planning office) was interviewed. In particular, information was obtained about the difficulties they faced in the urban planning process in Turkey. In the process of making geological surveys, taking appropriate land use decisions and the changes that the plans experienced negatively over time were determined as the main problems during planning process. Accordingly, in Chapter 3, a synthesis was made by including this information into the subjects defined as gaps in the urban planning process. In Chapter 3, the data obtained from an experienced planner has been very instructive in terms of presenting current practices.

Later, in the process of examining the selected application area, the seismic evaluation data for the city of Kahramanmaraş were investigated both qualitatively and quantitatively. The results from these research studies were subjected to spatial evaluation to answer the research questions presented in the introduction. Accordingly, it has been evaluated whether the theoretical and technical problems in the functioning of the urbanization and construction process in Türkiye overlap with the reflection of the space. In addition, Kahramanmaraş data was analyzed and spatially evaluated in terms of seismic resilient city principles. In addition to the literature review, the analysis and evaluations were tried to be presented by interpreting the author's experiences from dual disciplines (civil engineering and urban and regional planning).

1.4.1 Data Collection and Analysis

The study was prepared to be a guide based on the earthquake events that took place in Türkiye. In order to show an exemplary application to this process, Kahramanmaraş Province has been determined as the study area. In the first part of the research, the literature review was conducted as a method for the development of disaster risk reduction solutions in the process of urbanization and construction decisions, and the importance of risk reduction and urban resilience was examined through disaster reports containing the past years. In this regard, the international framework and legal justifications of disaster risk reduction plans have been researched and the units responsible for preparing the relevant plan have been examined in detail.

For the second part of the study, the provincial disaster risk reduction plan for the province of Kahramanmaraş was examined and the disaster hazards and risks of the province were investigated. Literature review was conducted using a content analysis method to evaluate the seismic characteristics of the province and its immediate surroundings and the spatial and structural development of the city. In addition, the data obtained as a result of the literature studies were made in the form of documents and case studies within the qualitative research methods. While carrying out this study, a detailed investigation of the Turkish Disaster Risk Reduction Plan at the national level and the provincial disaster risk reduction plans at the local level were made. The development of this application at the local level in the province of Kahramanmaraş as a pilot province made an extra contribution to the study. These studies were included in the disaster risk reduction strategies developed as suggestions after they were thoroughly examined. In this context, the urban development of Kahramanmaraş was revealed by literature studies and the effects of seismicity in the city were evaluated on the basis of settlement and building purchase.

In addition, the earthquake data that occurred in and around the city were obtained through the active fault map prepared for the region by the Mineral Research and Exploration Agency, the Prime Ministry Disaster and Emergency Management

Presidency and the Kandilli Observatory Earthquake Research Institute. Disaster reports and city plans of earthquakes that have occurred in the city with the data of the Provincial Directorate of Disaster and Emergency, urban strategy plans using the data of Kahramanmaraş Metropolitan Municipality, data on the building and neighborhood population, territorial plans using the data of the Ministry of Environment, Urbanization and Climate Change, TR63 Region Plans using data of Eastern Anatolia Development Agency, urban population data using Turkish Statistical Institute were accessed. The existing plans were examined considering the links between earthquake sensitivity and urban development decisions. Inferences developed as recommendations have been presented considering urban risk areas and damage vulnerability limits. In particular, all key data of urban planning and development, including ground condition, geological structure, topography and land use maps, plan decisions and reports, existing urban building stock, aerial photographs obtained at this stage, were examined on the basis of historical change.

1.5 Structure of the Thesis

The thesis consists of five chapters in total, based on the literature on how the decision-making and implementation process of urbanization and construction decisions should be carried out in order to reduce the risk of earthquakes. The conceptual diagram of the structure of the thesis is given in Figure 1.9.

Chapter-1 is defined as the introduction part and it is the part where the aim of the study is explained. In addition, the research methodology associated with the data collection and data analysis process is explained.

Chapter-2 has been developed on the explanation of the terms disaster resilience and urban resilience, which are tried to be explained on the basis of the concept of urban resilience. In this context, the terms that need to be understood correctly in the context of urban resilience are given in Sections 2.1, 2.2, and 2.3. As the last part of this section, the title 2.4 and its sub-titles have been developed with the focus of the concept of urban resilience and the world-accepted theoretical urban resilience criteria have been explained.

Chapter-3 consists of five subsections and consists of the section in which the decision making and implementation process of urbanization and construction in Türkiye is evaluated in detail. In other words, the main purpose of the third chapter is to present the current situation in the city planning and construction process in earthquake risk areas in Türkiye. In this context, Sections 3.1 and 3.2 have been developed to reveal the relationship between spatial planning and disaster in Türkiye. Afterwards, the problems experienced in this process in Türkiye were evaluated separately under the titles of urbanization and structuring.

Chapter-4 includes the analysis of the case study evaluated within the scope of the resilient city. The deficiencies and mistakes of the urbanization policies implemented within the scope of earthquake risk were emphasized and spatial analyzes were made.

Chapter-5, the last part of the thesis, has presented the conclusion of the research based on the research findings. In this context, suggestions have been made in order to make the city chosen as a case earthquake resistant.

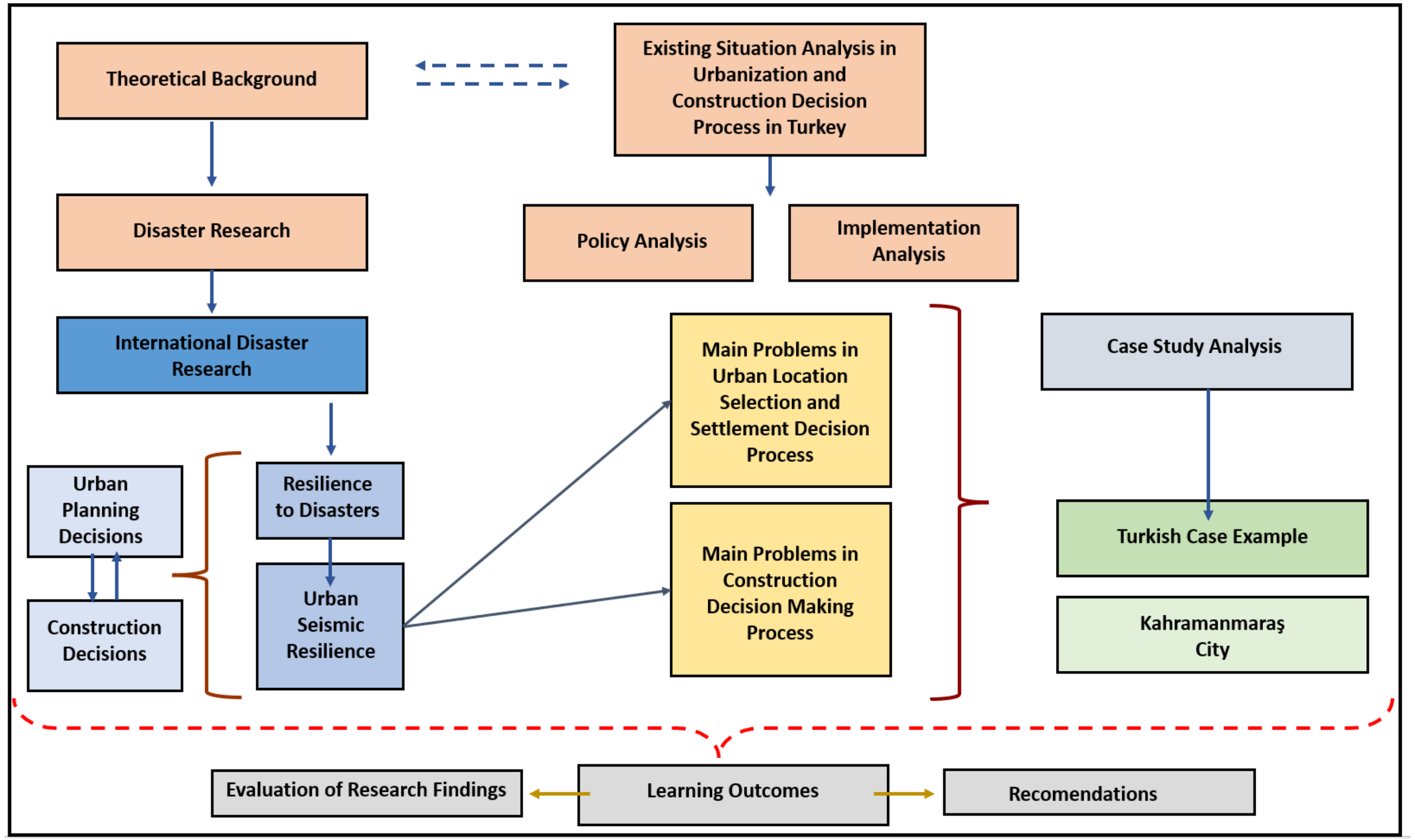


Figure 1.9: *Conceptual Diagram of the Thesis*

CHAPTER 2

AN INTERNATIONAL VIEW OF URBAN RESILIENCE

Since the day they came into existence, people have been dealing with many threats that they have either become aware of or have not realized, which may adversely affect the safety of life and property. The biggest of these threats can be described as disasters. In addition to the physical damage it causes to the environment, the concept of disaster, which stands out as a situation that adversely affects the connection of people with the destruction and their psychology as well as the economic and social loss, turns into a more important part of planning in the process of urban and increasing densities.

In this context, this section first includes the explanation of the main terms that should be known for the classification of disaster types and accordingly the definition of seismic disasters. The basic concepts that need to be known in order to understand the concept of disaster resistant city will be explained. Basic concepts such as a definition of disaster, disaster management, vulnerability and risk, will be defined and the relationship between them will be tried to be established. Later, the main concepts that should be taken as a basis in the formation process of seismically resistant cities will be explained in detail. In this context, the principles of urban risk analysis, urban risk reduction and risk planning have been emphasized and a visionary perspective has been tried to be given to the subject.

Since the seismic resilience issue is not very developed in the current planning and construction process in Türkiye, this section will be explained in the context of urban resilience by giving theoretical information on how seismic resistant cities develop on an international scale. For this reason, mostly foreign practices and examples will be mentioned. Although the concept of urban resilience is a multidimensional concept, spatial seismic resilience principles will be emphasized in this section. A framework will be presented under the guidance of examples and studies developed in the world on this subject. This developed framework will also be used in the following stages of the selected field research. In other words, this section will provide a theoretical basis for how the urbanization and decision making process should be.

In this section, the studies carried out within the scope of urban resilience are summarized in Table 2.1. This table, which summarizes the emergence dates of the concepts used in the literature on the subject of resilience, their scope and by whom studies have been made, can be used to summarize the history of the concept of urban resilience.

Table 2.1: *Development of the Theoretical Framework about Urban Resilience Concept*

Concepts	Target Area/Social Groups	Year	Scope/ Reason	Researchers
Risk	Whole City + Building Stock	1920s economic risks 1970-1980s social risks	It is the sum of the amount of damage that will occur on objects that are under a certain danger at a certain time and place. With the increasing population growth, the risk ratios in cities also increase. Risk = Hazard x Vulnerability	(Sahlins, 1974), (Pelling, 2003), (Maskrey, 1989), (Lash, Szerszynski, & Wynne, 1996), (Adam, Beck, & Loon, 2000),

Table 2.1: (Continued)

Concepts	Target Area/Social Groups	Year	Scope/ Reason	Researchers
				(Burton, Kates, & White, 1993), (Castree & Braun, 2001), (Hewitt, The Idea of Calamity in a Technocratic Age, 1983), (Alexander & Smith, 1996)
Vulnerability	Whole City + Building Stock	At the beginning of the 1980s	Researchers working on this subject have associated resilience, adaptability and vulnerability with risk.	(Liverman, 1989), (Maskrey, 1989), (Hewitt, 1997), (Blaikie, Cannon, Davis, & Wisner, 1994), (Cannon, 2000), (IDNDR, 1990)
Disaster	Whole City	1970s	Disaster = Hazard + Vulnerable Society	(Baird, O'Keefe, Westgate, & Wisner, 1975),

Table 2.1: (Continued)

Concepts	Target Area/Social Groups	Year	Scope/ Reason	Researchers
			Disasters are closely related to the living conditions of the urban population. In other words, disasters are the main factors that reveal urban poverty.	Jeffrey (1980), (Hardoy & Satterthwaite, 1989), (Jeffery, 1980), (White, Salamanca, & Courtney, 2002)
Hazard	Whole City	1990s	It is the relationship between humans and ecology that creates disasters.	(Mitchell, 1990), (Lindell & Prater, 2003), (Kunreuther & Roth, 1998)
Hazard and Vulnerability	Socially Vulnerable Groups	1990s	Focusing on potential areas where disasters can occur and combining social resilience with potential risks.	(Kasperson, Kasperson, & Turner, 1995), (Cutter, Boruff, & Shirley, 2003)
Risk Mitigation	Whole City	1990s	Risk mitigation policies form the basis of development policy.	(Mitchell, 1990) (Sanderson, 2000), (Peacock, 1996), (Kobe Conference

Table 2.1: (Continued)

Concepts	Target Area/Social Groups	Year	Scope/ Reason	Researchers
				Declaration 2005), (El-Masri & Tıpple, 2002) (Balamir, 2007a)
Resilience	Whole City + Building Stock + Socially Vulnerable Groups	1980s	The characteristics of cities are defined systematically and resilience principles are put forward in order to cope with natural disasters.	(Wildavsky, 1988), (Pelling, 2003), (Blaikie, Cannon, Davis, & Wisner, 1994), (Hewitt, 1997), (Tierney, 2003)

Source: *(Balta, 2013)*

2.1 What is Disaster?

In the definition of disaster adopted by the Nations Humanitarian Aid Organization, “Any natural, technological or man-made event that causes physical, economic and social losses for people,affects societies by stopping or interrupting normal or disabling them, and cannot be met with local means.” (UNDP, 2004). Disasters can also be defined as the formation of unexpected and undesirable situations in which a society is under threat, intervention with local means is insufficient, national resources need to be mobilized, and great losses of life and property are created

(Drabek, 1996). According to Disaster and Emergency Management Presidency, disaster is defined as natural, technological or man-made events that cause physical, economic and social losses for the whole or certain segments of society, and that stop or interrupt normal life and human activities (AFAD, 2014). Lastly, EM-DAT explains the disasters as “Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance ; an unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins.” (EM-DAT, 2022)

Disasters occur as a combination of natural hazards and vulnerabilities that endanger vulnerable communities or groups that will be affected by the adversities that occur with disasters. Multiple factors can cause the concept of disaster. However, basically, disasters can be expressed as the risk of the physical infrastructure creating disasters by causing significant changes in the superstructure (Erdinç, 2018). The main point that needs to be emphasized here is that in order for a disaster to be considered as a disaster, it must have caused losses or interrupted an ongoing process. Therefore, "disaster" is not an event itself, but the result of the event.

The concept of disaster accepted in society is basically a set of events that interrupt normal life, adversely affect a part or all of the people, and create material and moral losses for people. In general, the origin of disasters can be grouped into two groups, natural or human caused.

2.1.1 Nature Induced Disasters

Nature induced disasters are events in which instant, sudden natural changes cause long-term problems and social devastation (Scheidegger, 1994). Nature induced disasters can also be defined as events that cause great destruction on human communities caused by meteorological and geological-geomorphological events (Erdinç, 2018). Nature induced disasters can be caused by geological, meteorological, hydrological, climatological and biological factors. These disasters are not the kind of disasters that people can resist, but may consist of events such as eprem, volcanic eruptions, floods, landslides, avalanches and rockfalls, droughts, storms, hail, tornadoes, droughts, falling in the sky,etc. In short, natural events that cause loss of life and property without the effect of people can be characterized as natural disasters. The main characteristics of nature induced disasters are unpredictability, availability of limited resources in the affected areas and dynamic changes in the environment (Çelik & Çorbacıoğlu, 2010). Unpredictability means that serious impacts on humans and people during nature induced disasters cannot be predicted with acceptable accuracy (Sutanta, Bishop, & Rajabifard, 2010).

2.1.2 Human Induced Disasters

Human induced disasters are man-made disasters that occur due to imprudent behavior of people. Forest fires, nuclear, chemical and biological disasters, epidemic diseases, aircraft accidents, environmental pollution, industrial accidents and wars can be counted among man-made disasters. In short, human induced disasters occur not due to the influence of nature, but due to the excesses and negative deterioration experienced during the interaction of man with nature.

Disasters are a phenomenon that can be predicted to be in the future, but the full day and time cannot be given. In this context, it is also possible to classify the disasters according to their speed of occurrence. According to the speed at which they occur, we can group disasters into two groups. The first is sudden disasters. Such disasters are called "sudden disasters" because their losses occur suddenly at the moment the disaster becomes real. Even if it is predicted that sudden disasters may occur, it is not known exactly on which day and time they may occur, and the losses of events occur suddenly (Uzunçıbuk, 2005). Examples of this type of disaster are earthquakes, volcanic eruptions, avalanches and rock storms, storms, typhoons, floods. In the case of slowly developing disasters, the disaster does not occur suddenly and the losses over time occur gradually (Özçalkalp, 2022). Accordingly, it is easier to take preventive measures before a disaster. We can give examples of such disasters as environmental pollution, drought, erosion, deforestation, garbage disasters, sea water rise (Uzunçıbuk, 2005).

There are two important concepts that the word disaster contains. The first of these is the concept of hazards, and the second is the concept of risk.

2.2 What is Hazard, Vulnerability and Risk?

2.2.1 Hazard

Hazard is a situation that may cause great harm or destruction, or a situation that is likely to be realized but is undesirable, in other words, a situation that poses a threat is a reservation, a reservation, which threatens the existence or situation of a person or raises anxiety (Özkılıç, 2008). According to the UNISDR definition, danger is defined as a potentially harmful physical event or human activity that can cause either loss of life or injury, property damage, interruption of social and economic conditions, or environmental degradation. According to Disaster and Emergency Management Presidency, physical events and phenomena arising from nature, technology or human beings that arise in a certain time or geography or threaten the society and have the potential to harm the socio-economic order and activities, the natural environment, natural, historical and cultural resources are considered as dangers (AFAD, 2014)

In general, the understanding of danger is based on events that people do not expect and cannot control in any way, because the people threaten the human being. In their daily lives, people live with many hazards such as traffic, home accidents, fires, diseases, sports activities, etc. caused by them. That is, people face different dangers, knowingly or unknowingly. Therefore, it is impossible to live in complete safety, completely away from danger. In this context, "danger" is defined as the most negative and rare events in the natural or man-made environment that can significantly affect people's lives, social and economic activities, goods and services (Uzunçıbuk, 2005).

The concept of hazard in engineering emerges as a phenomenon that increases as the concepts of time and space grow. For example, an earthquake large enough to cause damage in a settlement within a hundred years is more likely than the same events to occur within a decade or a year because time increases the danger percentage. In other words, the probability of an event of the same magnitude occurring in an area within the same time period is greater than the probability of occurring in a specific settlement.

2.2.2 Disaster Vulnerability

The concept of vulnerability refers to situations that affect the capacity of an individual or a particular community to cope with the effects of a disaster, to resist the disaster, and to return to normal after a disaster (Wisner, Blaikie, & Cannon, 2003). The foreseen hazard is defined as the measure of physical, social, economic or environmental damages and losses that people and the environment may suffer when they occur at the level foreseen. Tezgider (2008) explains vulnerability in the context of "the fact that individuals, communities, institutions or countries are exposed to danger and do not have the necessary characteristics and resources (capacity) to deal with danger and to reduce the effects of danger" (Tezgider, 2008).

2.2.3 Risk

According to Tezgider (2008), risk is "the probability that a hazard will return to a disaster in a locality unit, depending on physical, social, economic, cultural, political, etc. reasons; the negative consequences and losses that are expected to be caused by them". Disaster risk is given as the sum of the expected or predicted negative consequences that are expected or predicted to occur as a result of the impact of a hazard on a particular element at risk in a certain area over a certain period of time (Erdinç, 2018).

Especially in urban areas where the population is dense, disaster factors pose a significant risk. In a region where urban activities are intensive, risks may arise for individuals, groups, institutions or organizations. Therefore, the risk is universal.

As mentioned above, risk is the sum of the negative consequences that an event can have. The risk that gives the definition of the occurrence of a disaster mainly consists of the following factors. These factors are;

(a) The probability of the occurrence of a disaster hazard;

(b) The distribution of man-made elements exposed to the disaster;

(c) The level of vulnerability that determines the extent to which these elements are affected by the disaster. Ultimately, the risk is created by the combination of these (Uzunçıbuk, 2005).

When the residential areas in the cities are evaluated in terms of population density, economic, social activities and services, natural disasters are a great risk. Earthquakes, although ultimately a natural phenomenon, can turn into a real disaster when they occur in settlements with high population density and intense social and economic activities. At this point, all the preparations made before the earthquake have a direct relationship with the loss of life and property that may be experienced after the earthquake. In other words, pre-earthquake preparations and all the negativities that arise after the earthquake are inversely proportional to each other. In this context, disasters pose a significant risk in cities in terms of both population density and the intensity of social and economic activities (Uzunçıbuk, 2005).

Earthquake risk can be determined according to probabilistic calculation methods. This approximate calculation reveals the magnitude, location of the expected earthquake and the probability that it will occur in 10, 20, 30 or 50 years. At this stage, different "earthquake damage scenarios" are produced and the earthquake risk is revealed. With the calculations made according to different earthquake probabilities, the loss of life and property caused by the possible earthquake can be determined. For example, it is tried to predict in advance which floors in which parts of the city an earthquake will be more effective, which buildings and infrastructure may be more damaged, where fires may occur after the earthquake, how to create an alternative transportation and communication system, accommodation and health facilities and where the possibility of chemical contamination may be (Uzunçıbuk, 2005). It is possible to reduce the earthquake risk by using this information. In this case, the stage of determining earthquake scenarios is important.

The concept of earthquake risk is the sum of living and inanimate elements in the region that will be exposed to the earthquake and a function of the state of this sum being affected by the earthquake. In other words, earthquake risk is a breakdown of the loss of property and life that will occur when an earthquake occurs. These castings may occur as building damage, loss of life, financial loss. The most important factor affecting the earthquake risk is the rate at which life, property, social structure, infrastructure and economic structure can be damaged by the earthquake (Uzunçıbuk, 2005). For example, if we think that there are no buildings and people in a city, we cannot talk about the earthquake risk, but we cannot change the risk of an earthquake. If we consider that the structures and infrastructure in the city are very robust, the earthquake risk will still continue, but the risk will be much less. In addition to the high probability of an earthquake as another situation, if the low earthquake resistance of the infrastructure and building stock is added, the earthquake risk increases too much. As a result, if we can reduce the rate of damage due to earthquakes, we will also reduce the risk of earthquakes but we cannot change the likelihood of an earthquake.

2.3 The Relation between Urbanization and Risk

With the increasing urbanization rates in the world, disasters are usually experienced in urban areas. This process actually takes place in mutual interaction. In other words, just as disasters can affect urbanization, urbanization also affects disasters

(Pelling, 2003). However, at this stage, the main problem that increases urban risk should not be shown only as population growth. Due to the limited number of areas that can be settled, the increase in illegal settlements has created settlement units where infrastructure services cannot be adequately met. Later, the inability to adapt to the changing urban form has led to an increase in the areas that can be defined as risky within the cities. Therefore, it can be said that the risk trend is increasing in urban areas.

Urban development, whether planned or unplanned, must rarely include a perspective that takes disaster risk reduction into account (Balta, 2013). There is a large gap between planning and risk reduction, and this gap has been proven by the history of planning and the literature [Wamsler, 2006]. Risk reduction and planning issues should not be seen as two separate issues because the close relationship between "urbanization" and "disaster" issues should be established. In Figure 2.1, the relationship between planning and disasters is given as an integrated risk reduction scheme. The conclusion obtained from this scheme is that risk reduction policies should be considered as a whole with planning policies.

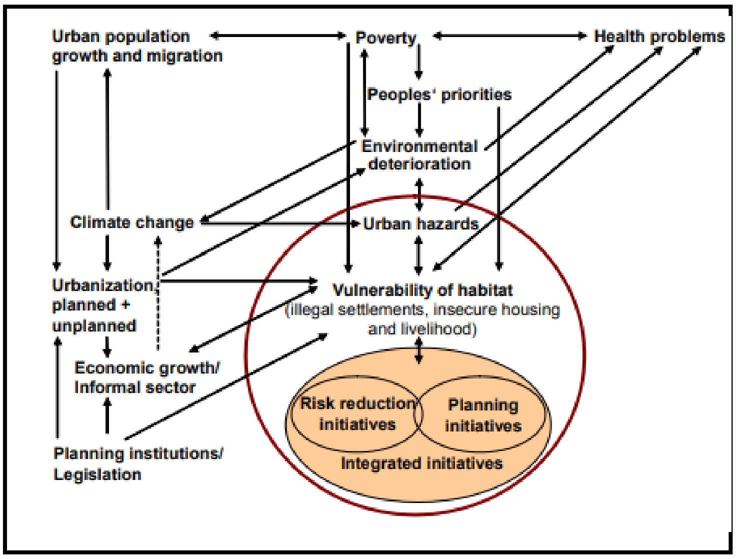


Figure 2.1: *The Complex Relationship between Planning and the Occurrence of Disasters Showing the Potential of Integrated Risk Reduction and Planning Initiatives*

Source*: (Wamsler, 2004)*

2.3.1 Urban Risk Analysis

The vulnerability of the urban population to disasters is structured by economic, social and political systems. The city center is an area where very complex relationships are gathered together and multiple risks can occur together, which makes it difficult to define these relationships. For this reason, multidimensional risk analyzes to be carried out in the city are needed. An understanding of the complex mix of disaster risks and urban poverty, which includes many relational components, not only unequal income, but also low-quality housing, lack of basic infrastructure, and deprivation of political rights (Pelling, 2003).

Urban risk analysis is historically sensitive and conceptually based. The starting point is nature, society and the stock of building (Balta, 2013). There are multiple types of risks that have a cogwheel effect in cities. Environmental risks as well as crime and violence, epidemics, unemployment, pollution, technological hazards should be taken into account (Pelling, 2003)

Pelling (2003), summarized what needs to be done for risk analyses as follows:

- In order to understand urban risk processes, it is necessary to avoid focusing only on disaster events.
- It is necessary to understand how the social, economic and political structure constitutes risk.
- It is necessary to focus on multiple risk analyses rather than single disasters.

Most of the literature on urban problems and urban disasters focuses on large cities, including megacities. But with everyday dangers on the agenda, cities with fewer populations are also at risk. The increasing number of disaster studies in small-scale cities confirms this (Pelling, 2003).

2.3.2 Urban Risk Mitigation

When natural disasters occur in urban areas, industry, agriculture and areas with touristic value, their effects are further examined and solution-oriented processes are supported. The extent of the material and moral losses caused by disasters depends on the type of disaster and the severity of the disaster as well as the level of resilience of the physical environment in which it occurs. In this context, it is observed that physical planning, which is or is expected to be the main determinant in the formation of the physical environment in the settlements, in other words, urban-regional planning, is of critical importance (Balamir, 2011).

Before risk mitigation planning is carried out, it is necessary to examine each city and region separately in depth and at the same time to allow detailed examination of the risk with the knowledge accumulated at the city-region level. In other words, work on determining the risk should be carried out at different levels. The most complex risk assessment of these is the one at the urban level. Determining the multifaceted risks in the urban environment requires the solution of the physical, economic and social characteristics of the city by considering systemic unity (Karahan, 2018). At this stage, it is also necessary to foresee the possible dangers and to focus on the physical danger. Therefore, with the help of the policies to be developed, it is necessary to establish a connection between disasters and plans. The main purpose of the plan here should be to prevent the loss of life and property and to protect resources. For this reason, in order for disaster events not to cause loss of life and property in the current disaster management model or to reduce this loss, the measures to be taken before and after the disaster should be considered both separately and as a whole (Tercan, 2018). Today, many measures can be taken to reduce the effects of earthquakes. With the measures taken, such as security level levels, policy and planning decisions, technological damages or other man-made risks can be reduced (Karahan, 2018). But the main thing here is not to focus only on damage reduction work.

2.3.3 Urban Risk Planning

Since it contains the most powerful and employment opportunities in the urban environment with the dense population, it is necessary to determine the multifaceted risks that will affect the cities and the individuals living in them. In order to reduce the risks in the physical, social, economic and political context, the ideal for cities is to develop a defense mechanism against disasters and to make plans accordingly. These plans should be made before disasters come true,but in most cases in our country, these plans are formulated only after a disaster has occurred. In order to minimize the risks before the disaster and the negative situations that may occur afterwards, the 'Urban Risk Planning' approach has emerged to draw attention to the difference of the new planning area and to ensure the understanding of the decision environment brought about by physical, economic and social integrity. The purpose of planning here is to avoid resources and life-property from dangers (Balamir, 2007).

In summary, contingency planning is defined as the process of finding out how to reduce or eliminate the loss of life and property caused by natural hazards (Kreimer, et al., 1999). It is a type of plan that should be made to prevent or minimize possible disasters. In this way, the identification, analysis and management of urban risks are provided.

According to Kadığlu, 2008, “Urban risk planning is guided by three main approaches. The first is “**Risk Avoidance**”, the scope of which is expressed as "Damage reduction" and "Prior preparation", and the second is “**Risk Mitigation**” whose scope is listed as "Recovery and first aid", and "Reconstruction". Another element is the “**Risk Financing**”, which is called " Risk transfer and Risk coverage"” (Gözlükaya & Türk, 2016).

The realization of this kind of urban and regional risk planning study necessitates interdisciplinary work. For the preparation of plans, there is a need for an engineering part related to disasters such as geodesy, seismology, geology, geophysics, earthquake engineering, and a planning and design part related to city and regional planning and architecture. The part of interpreting the produced data together on the basis of disaster planning objectives should be done together with all kinds of disciplines. In this way, the generated data can be used directly in sub-scale planning studies ranging from national to local scale.

According to Cutter (1996), risk is the probability of the occurrence of the hazard itself. Risk basically consists of two main factors, which are potential sources of risk (industrial, spatial, transportation) and the contextual nature of the risk itself. If the risk is not considered together with good mitigation policies (such as planning), the probability of creating a hazard increases. It is filtered geographically (territorially, spatially) and socially by the potential of the hazard that occurs. Potential hazards are used to identify the vulnerability of a geographical and social. Determining the vulnerability of a geographic location to hazard is achieved by determining its biophysical/technological vulnerability. The same can be applied to the social fabric to determine the social vulnerability.

As a result, the vulnerability of a place to hazard emerges as a result of evaluating the two main factors, biophysical/technological and social vulnerability. In this sense, it is necessary to examine the biophysical and social interaction to determine the place vulnerability in the place hazard model. At the end the resulting vulnerability can be reduced by risk mitigation methods.

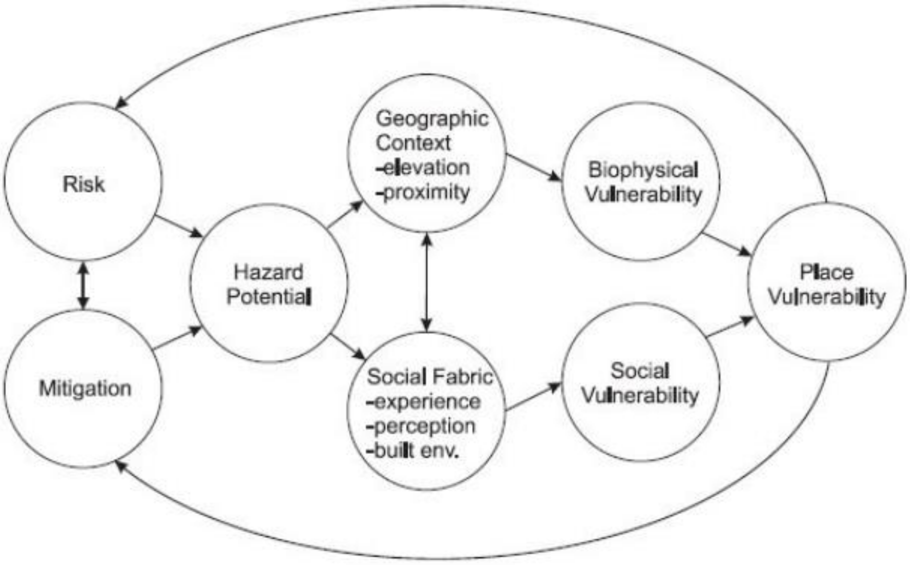


Figure 2.2: *The Hazards of Place Model of Vulnerability*

Source: *(Cutter S. , 1996)*

2.3.4 Urban Vulnerability Analysis Approach in Urban Areas

The determination of risks in the human and physical geographical context before the disaster and the development of risk reduction methods should be considered as the priority field of activity of the planning profession. The type of plan that targets pre-disaster risk reduction practices is contingency planning. The stages of preparing the conservation plan presented by (Balamir, 2007) are given in Figure 2.3.

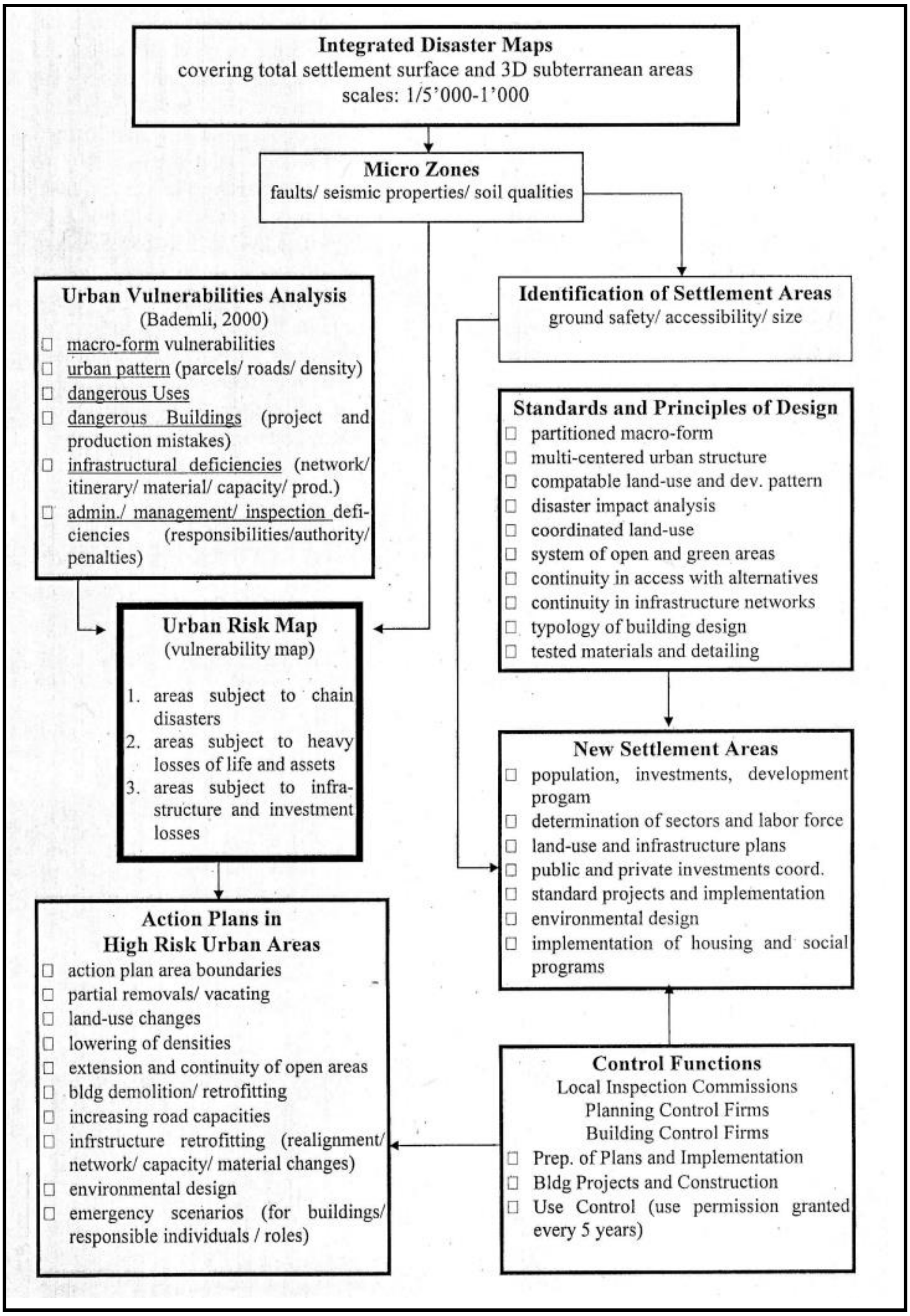


Figure 2.3: *Land-Use Planning in Settlements of High Risk*

Source: *(Balamir, 2007)*

Planning studies to be prepared for disaster risk reduction require the determination of hazard data and possible losses first. For example, the contribution of the knowledge accumulated in the structural scale engineering accumulation against seismic hazards in urban, regional and national risk management issues is limited. Therefore, at each level, the risks specific to that level will need to be defined separately. However, the most complex risk is the urban level, where causality links are located.

Cities have a very large number of risk factors. The existing building stock is only one of these risks, but urban risk planning is not just a development or land-use planning. Urban risk reduction studies determine a special planning approach and content. It should be considered appropriate to give a separate definition to emphasize the difference of this activity from ordinary development planning in its spatial, social, administrative and physical aspects (Balamir, 2007).

The work to be done before the disaster during the conservation phase is called "proactive" approaches. The intervention and recovery phases are post-disaster studies and are called "reactive" approaches (Figure 2.4). Urban risk planning is based on the preparation of existing maps detailed in 1/5.000 or 1/1.000 scale. Prevention of natural disasters should not be based only on technological solutions, but should include engineering methods, land management, social regulations, economic developments and far-reaching qualifications. The decisions that are so important are taken and implemented not only in writing. It can function as it should with the integration of risk reduction processes and programmes into policies, practices and regulations that control urban development.

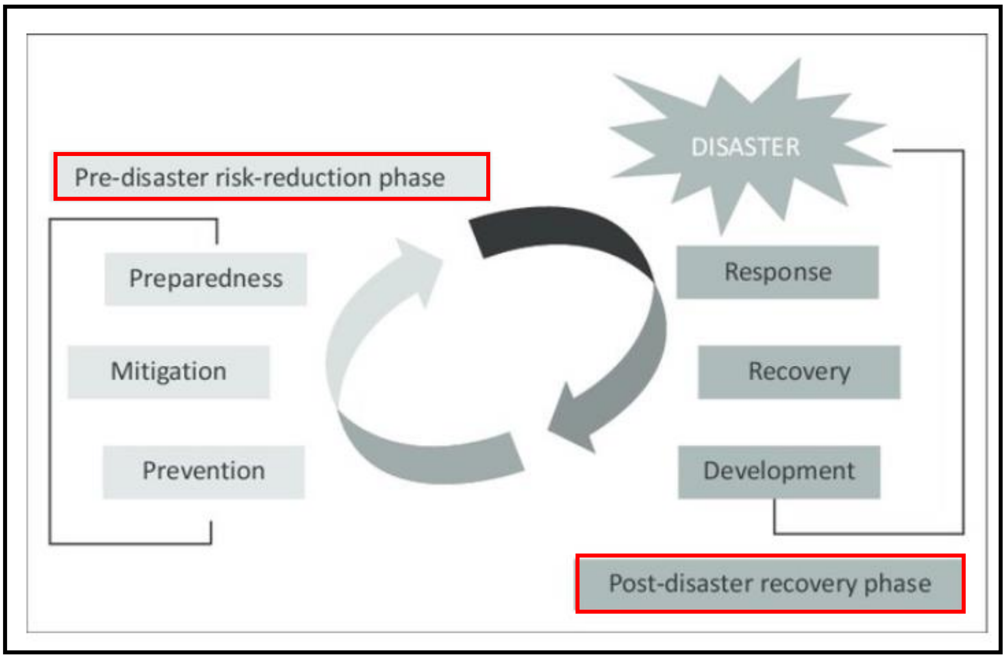


Figure 2.4: *Disaster Management Cycle*

Source: *(Sawalha, 2020)*

2.3.4.1 Principles in Urban Risk Planning

In areas where urban risks are concentrated, the purpose of contingency planning is to identify policies and actions that can be implemented in the long term to reduce risk and future losses. The flow plans created in this context form the basis of a community's long-term strategy to reduce disaster-related adversity and break the cycle of reconstruction and repeated damage (FEMA, 2012).

The risk planning process involves the need for risk-based thinking and decision-making to mitigate damage to lives, property and the economy from potential future disasters. With this plan, focusing on hazards is fundamental. By addressing areas that can be considered vulnerable to disaster, appropriate risk mitigation actions are identified. This helps communities become more sustainable and resilient.

Urban risk planning defines denominator and cost-effective actions for risk reduction that are accepted by the public. It focuses resources on the biggest risks and weaknesses. It establishes partnerships by including the advanced and established sectors. It increases education and awareness of hazards and risks and aligns risk reduction with others (Saner, 2015).

Risk planning can basically be defined as a negative impact mitigation plan. It refers to a phase that leads the planning team within the framework of the steps taken towards this goal. The primary purpose of the planning process is to facilitate the development of strategies that will reduce damage, protect people and property, and increase resistance to natural hazards (Saner, 2015). According to FEMA (2012), this process details four basic steps and the important sub-criteria within these steps, as can be seen in Table 2.2. The sub-criteria determined by FEMA can be explained as follows within the framework of four principles;

1. Resource Organizing: Communities should focus on the resources needed for a well-rounded contingency planning process. The basic steps include the necessary technical expertise in the planning process, as well as the identification and organization of relevant members of the community.

2. Analysis of Hazards and Assessment of Risks: Authorities need to determine the characteristics and possible consequences of hazards. It is important to understand how much of the community may be affected by certain hazards and what their impact will be on important community assets.

3. Developing a Conservation Plan: Communities that understand the risks posed by hazards need to determine what their priorities should be, and then look for possible ways to avoid or minimize undesirable impacts. As a result, a conservation plan is made.

4. Plan Implementation and Feedback: Authorities can implement the plan in a variety of ways, from the implementation of specific avoidance projects to changes in day-to-day organizational operations. It is very important to

constantly check the plan to ensure that an ongoing program is in order. That's why it's important to conduct periodic assessments and make revisions as needed (FEMA, 2012).

Table 2.2: *Requirements for local mitigation plans according to FEMA's Local Mitigation Plan Review Guide*

Elements	**Sub Criterion**
Planning Process	Does the plan document the planning process, including how it was prepared and who was involved for each jurisdiction?
	Does the plan document an opportunity for neighboring communities, local and regional agencies involved in hazard reduction activities, agencies with development regulating authority, and other interests to be included in the planning process?
	Does the plan document how the public is involved in the planning process during drafting?
	Does the plan describe the review and incorporation of existing plans, studies, reports and technical information?
	Is there a discussion about how communities will maintain public participation in the implementation of the plan?
	Is there a description of the method and schedule to keep the plan up to date? (monitoring, evaluating and updating the mitigation plan in a 5 year cycle)
Hazard Identification and Risk Assessment	Does the plan include a description of the type, location and extent of all natural hazards that may affect each jurisdiction?
	Does the plan contain information on prior hazard events and the probability of future hazard events for each jurisdiction?

Table 2.2: (Continued)

Elements	Sub Criterion
	Is there a description of the impact on the community of each identified hazard, as well as an overview of community vulnerability for each jurisdiction?
Risk Strategy	Does the plan document each jurisdiction's current mandate, policies, programs and resources, and its ability to expand and improve those existing policies and programs?
	Does the plan include targets to mitigate/prevent long-term vulnerabilities to identified threats?
	Does the plan identify and analyze a comprehensive set of specific mitigation actions and projects for each jurisdiction considered to mitigate the impacts of hazards, with an emphasis on new and existing buildings and infrastructure?
	Does the plan contain an action plan that explains how the identified actions will be prioritized (including cost-benefit review), implemented and managed by each jurisdiction?
	Does the plan comprehensively define the requirements of local governments' risk reduction plan, where appropriate?
Plan Review, Evaluation and Implementation	Has the plan been revised to reflect changes in development?
	Has the plan been revised to reflect progress in local mitigation efforts?
Plan Acceptance	Does the plan contain documentation of formal acceptance of the plan by the governing body of the jurisdiction requesting approval?
	For multi-stakeholder schemes, has each jurisdiction seeking approval of the plan documented the adoption of the official plan?

Source: (*FEMA*, *2012)*

In this context, the dimensions of the material and moral losses caused by disasters are closely related to the type of disaster and the level of resilience of the physical environment in which it occurs, as well as the severity of the disaster. The concept of resilience, which increases the resilience of the areas of the crop, is also gaining importance in terms of disasters. In the plans made to make urban or rural areas resilient to disasters that may occur, some targets are adopted in order to ensure resilience. These are;

- Prevention or reduction of potential disaster hazard,
- Reducing the effects of disasters,
- Prevention of secondary disasters such as fire, explosion, landslide due to the main disaster,
- Fast and effective rescue after disaster, easy recovery of improvement work,
- It is profitable as an easy reconstruction of reconstruction and reconstruction activities after a disaster (Gözlükaya & Türk, 2016).

The concept of conservation, which is also included in the first phase of the traditional disaster management model and has gained importance especially in recent years, can be determined as the main stage of disaster resistant planning. With this approach, efficient use of resources will be ensured by improving and maintaining social, economic and physical standards.

2.4 Concept of Resilience

The word resilience is a concept that has very different definitions when different disciplines are considered. Many people from different disciplines actually use this concept to explain the same thing. Basically, what is wanted to be emphasized is shown as the response to distortion. If something can heal and recover after it is broken, if it can continue in the future in a more durable and sustainable way compared to its previous state, it can be defined as resilient. In other words, resistance, in its most basic sense, can be explained as the word that describes the ability of an object to return to its original position after receiving an impact. In other words, the deterioration of a system after the effect it receives and the ability to return to equilibrium after that. From a different point of view, it can be defined as the ability of the current system to adapt, adapt to and cope with changes in processes (Figure 2.5). For example, economists try to explain the degree of ability to recover after industrial losses with the concept of resistance. Psychologists use it to describe the capacity of individuals to respond to traumatic events and to maintain their functions effectively (Vale, 2014). Therefore, there can be no clear definition of the concept of resilience.

Figure 2.5: *Model of Resilient Nation*

Source: *(Stevenson, Bowie, Kay, & Vargo, 2018)*

As a result of the social, economic, political and environmental effects that occur, it is possible that societies and cities will be adversely affected by these changes. Because a disaster can have the kind of impact that affects the city at the most negative level. At this stage, the issue of urban resilience gains importance. Disaster risk reduction, adaptation to climate change, humanitarian aid, spatial planning, and security issues are the areas where the concept of resilience is frequently used. Especially in the case of disasters, the concept of resistance comes to the fore as a measure of how quickly the system recovers without deterioration, minimizing possible losses and damage when a disaster occurs (Ersavaş Kavanoz, 2020).

2.4.1 Urban Resilience

In the past to the present day, people have developed different solutions and established different settlement areas in order to continue their lives. Settlement areas, which initially developed on a smaller scale, continued to grow and develop over time. Growing settlements have formed cities. Another mention of the features that cities have with the formation of cities is that the systems that cities have are beginning to gain importance (Özçalkalp, 2022). Cities that developed over time continued to develop in some ways as strong and in some respects as weak. To this end, the concept of urban resilience has gained importance all over the world in order to strengthen the weaknesses of cities. In this way, it is aimed to increase the resistance of cities against risks. This is a process that must be carried out in a multidisciplinary manner due to the complexity of urban functions. In the literature, the need for a multidisciplinary approach to a resilient urban structure, the fact that urban resilience is not just physical robustness, has often been emphasized by different studies (Figure 2.6). Because urban settlements, and especially urban centers, are in a constant state of imbalance and are the focus of internal and external pressures coming from various directions (Ersavaş Kavanoz, 2020).

The city is not only a system of ecological and physical structures, but also a system where social and political processes come together. When resilience is defined as the adaptation to be achieved in the long term and the coping ability to be provided in the short term, urban resilience can be explained as the ability of the society to absorb the effects in the short term, to organize itself and to increase the learning capacity in the long term (Sharifi & Yamagata, 2014). In other words, urban resilience refers to adapting to the conditions encountered and responding quickly to possible changes in the system. At the same time, the city can be described as a sustainable phenomenon formed by the combination of physical and social factors. It is seen that the studies on urban resilience focus not only on the capacity for "flexibility and adaptation", but also on the issue of "sustainability". Urban resilience is defined in terms of its potential for sustainability. In this process, when a sudden change and a negative effect is profited from, the resilient system provides the capacity for renewal and innovation (Ersavaş Kavanoz, 2020). Especially in the field of spatial planning, sustainability is one of the basic criteria used in the evaluation of resilience. Conceptually, there is an intertwined relationship between sustainability and urban resilience. Both concepts are used interchangeably, and the concept of resilience is also used as an important element for broader sustainability goals (Meerow & Newell, 2016). A resilient city needs to continue its life no matter what happens after a disaster. In particular, physical systems must be sustainable and able to perform their functions even under some influence. Otherwise,cities where the physical structure is not resilient will be vulnerable to disasters. Before the disaster, it should become more resilient with risk reduction measures and the adaptation capacity should be developed in such a way that the city and society can continue their important functions. As a result, when disasters occur, the city will begin the recovery process more quickly, improving its ability to adapt to the current conditions.

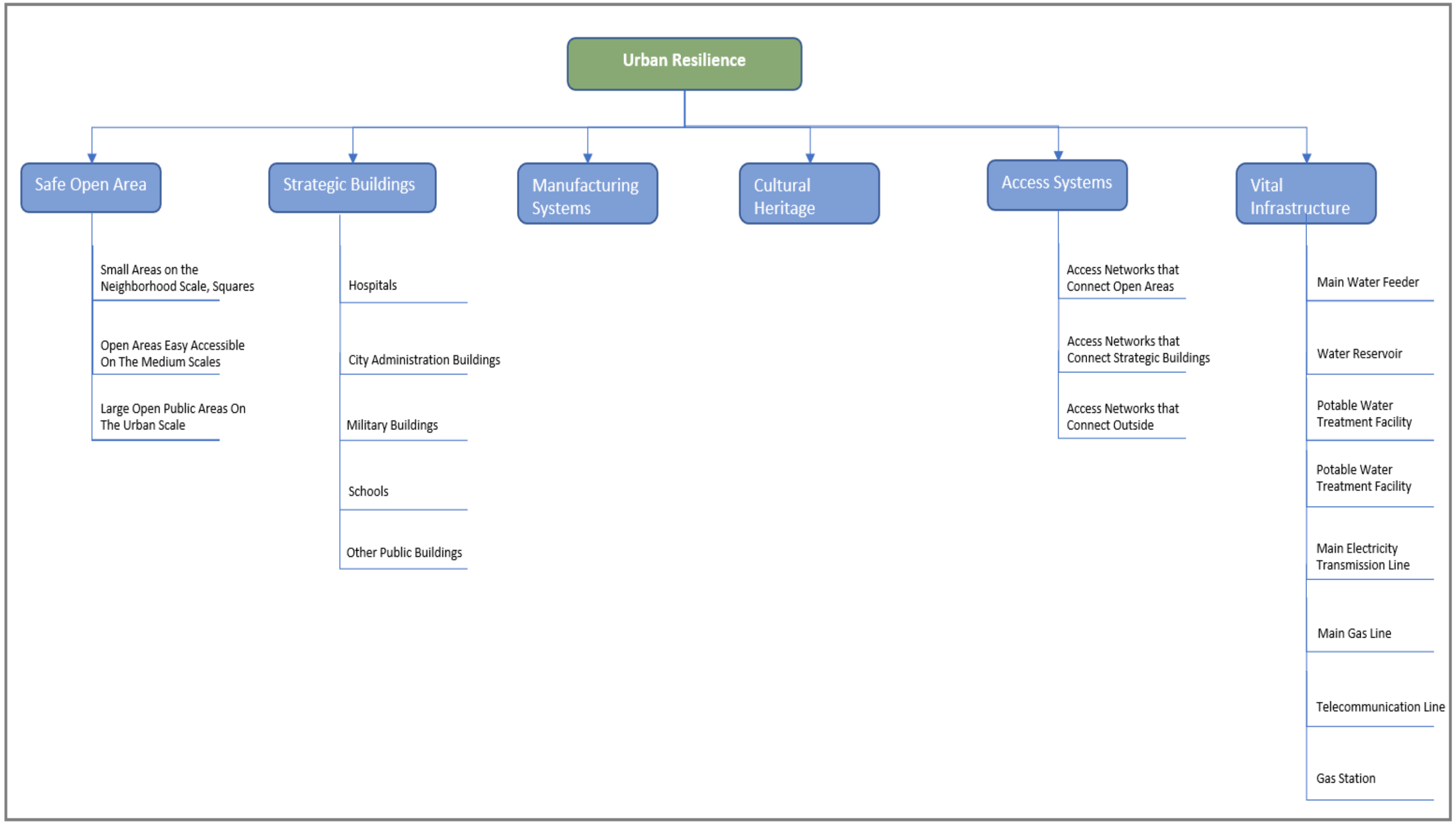


Figure 2.6: *Physical Components of the Resilient City*

Source: *(Gerçek & Güven, 2016)*

Urban resilience is the result of a combination of a local government that has assumed the necessary responsibilities for the right city planning and infrastructure, as well as for sustainable urban planning and the joint efforts of the community in general (AFAD, 2014). In this context, this form of understanding, which should be applied before the disaster, will be the main factor for making cities resilient. In this process, the possible disaster hazards of the cities are determined and harm reduction strategies are developed for urban uses such as residential areas, transportation infrastructure, urban technical infrastructure, industrial areas and dangerous uses, etc. In this way, the risks for the society living in such uses are minimized. Urban resilience practices progress to include political decision-making on public lands. As a result, it is aimed that the city is minimally affected by the disaster. The recovery process after the disaster accelerates in parallel with this situation. The steps to be taken to create a resilient city and the policies to be developed will ensure that urban resilience is achieved.

2.4.2 Studies Conducted in the Scope of the Resilient City in the International Agenda

In order to take into account the risks faced by cities, a campaign titled "Making Cities Resilient" was launched by the United Nations International Center for Disaster Reduction (UNISDR) in 2010. The aim of the campaign is to reduce the risks of possible disasters at the city scale and to ensure the safety of the community through sustainable development practices. With this study, it is aimed to increase the awareness of the society and to encourage its participation in the risk reduction process (UNISDR, 2010).

In addition to this study, the Hyogo Framework Action Plan (Increasing the Resilience of Nations and Communities to Disasters- 2005-2015) and the Sendai Conference on Disaster Risk Reduction organized in different time periods emphasized resilience (Erdinç, 2018). As a result of the Hyogo Action Plan, ten basic principles for resilient city formation were determined. This framework focuses on the "Impact of Resilience of Nations and Communities Against Disasters" adopted by 168 governments in 2005 (Özçalkalp, 2022). In the following years, many conferences and campaigns were organized to make cities resilient to disasters, such as the "Safe Cities Campaign" (2010-2011) and the 100 Resilient Cities campaign, which were launched under the Incheon resolutions (Figure 2.7).

Ultimately, as of today, the process of understanding the resilience of cities and how they should move to a more resilient state is the most complex part of the job. In this process, it is the main conclusion that social, economic, physical, environmental, spatial and cultural dimensions should be handled within an integrated framework with the contributions of different disciplines.

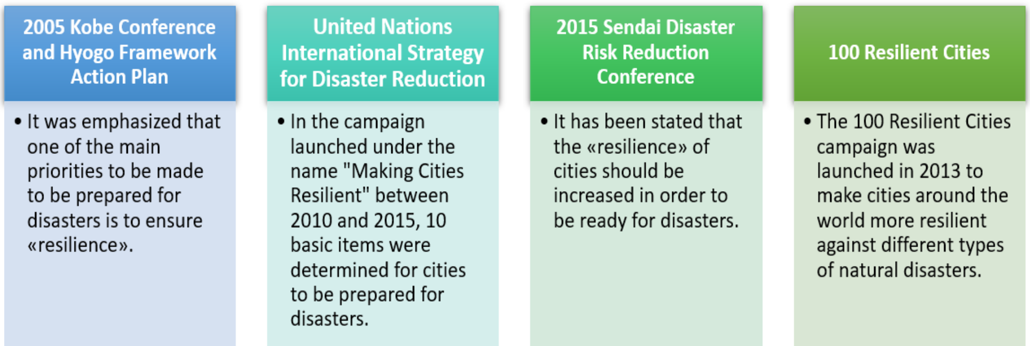


Figure 2.7: *Studies Organized in the Scope of Resilient Cities in the World*

Source*: (Özçalkalp, 2022)*

2.4.2.1 Incheon Conference "Resilient Cities" Campaign Activities

With the 2005 Kobe Conference and Hyogo Framework Action Plan, the United Nations Incheon Conferen, the United Nations International Center for Disaster Damage Reduction "100 Resilient Cities" (2013), the 2015 Sendai "Disaster Risk Reduction Conference", it was stated that the safe protection of cities against disaster risks would be ensured by fulfilling the requirements of resilient cities (Erdinç, 2018).

In this context, the 100 Resilient Cities campaign was launched in 2013, and between 2010 and 2015, another campaign called "Making Cities Resilient" was launched. With these campaigns, the issues that local administrations should pay attention to were emphasized and the interaction and solidarity between each other were supported.

Within the scope of the "Making Cities Resilient" campaign, 10 main issues have been identified to make cities resilient. 635 local governments from about 60 countries have participated in 48 campaigns. Some candidates evaluated by ISDR(International Strategy for Disaster Reduction) in 2011 were awarded. Accordingly, the cities of North Vancouver (Canada), San Francisco (Philippines) and Santa Fe (Argentina) were awarded monetary prizes, and the city of Bhubaneswar (India) was awarded a certificate of exclusivity (Erdinç, 2018).

When an evaluation is made as a result of these grabs and awards, it is seen that the formations that provide the highest level of urban resilience requirements are local administrations organized in this area and planned cities (Balamir, 2011). In particular, as a common feature of these plans, the risk reduction at the local level, that is, the diversity of disaster prevention studies, has enabled the resilient city plans to work much more effectively.

When we look at the countries that received awards as a result of the "Making Cities Resilient" campaign;

- Santa Fe is a city known for its floods with a population of 370,000. It has suffered many material and spiritual losses due to flood disasters. In 2003, 130.000 people were homeless and 24 lives were lost due to the scabbard, and in 2007, 28.000 of them were homeless (Erdinç, 2018). For this reason, it is aimed to meet the danger from all aspects, to deal with the entire watershed of the river system and with the relevant national institutions, to include many physical and social measures in coordination, to include legal, physical and financial measures for the relocation of the houses at risk, to prevent illegal construction and to replace it with safe housing. The municipality's cooperation with national governmental organizations, universities and related institutions, efforts to improve and expand the drainage system, early warning systems, comprehensive emergency plans, rescue teams, evacuation routes, arrangement of meeting points, training of municipality and public institutions personnel and raising awareness in the society. A multi-faceted plan has been developed, covering topics liked by the jury, such as providing trainings and transparent use of resources (Erdinç, 2018).

- North Vancouver is a city that has to live with the earthquakes, storms, flooding and landslides hazards. City has approximately 82.000 population. Against such hazards that the city faced, all members of the local government have carried out a joint work. Establishing a cooperation between municipalities, universities and non-governmental organizations on risk reduction, developing new methods based on technology and sharing these methods with the society, applying scientific criteria in determining disaster hazards and reducing the damage with the relevant institutions and institutions, universities and private sectors are within the scope of the studies carried out. Practices such as making special risk area definitions for slopes, stream beds, landslides and rubble slides, forest fire areas in spatial planning and handling of conservation plans separately from legislation, policy, prevention and emergency actions are the features that come to the fore in jury evaluations (Erdinç, 2018).

- San Francisco is known as a city with floods, storms, monsoon rainfall and related landslide threats. In the city, which has a population of around 40.000, the "Purok" system developed within the scope of cooperation and local support against possible disaster threats has been established. In this system, individuals have created a resource that provides support in emergencies by making the agreed regular payments to the 120 mutual aid funds that everyone participates in. In addition, the participation of all local communities on the island in collective avoidance work with a traditional social solidarity mechanism stands out as a good example of a community-based risk reduction effort despite the lack of material and monetary, education, technology and infrastructure. Practices such as the participation of teachers in risk reduction seminars and the organization of events and games related to disaster risks in schools, the development of the bicycle transportation system and the development of risk reduction culture in every field with the local community and daily life are other features that come to the fore in the evaluations of the jury (Erdinç, 2018).

- The city of Bhubaneswar, located in the northeast of India, is in danger of extreme heat, storms and flooding. In 1998, many people lost their lives due to temperature problems. In 1999, there was great damage to the city due to the storm that occurred. In 2003, with the aim of restoring industrial units that had become distant from the city and filling the settlement areas again, a series of risk reduction developments were achieved and the city gained the identity of one of India's most economically ambitious investment areas. truck. Regional growth potentials and urban level effects are examined, multiple hazard maps are prepared, planning and management is important. Physical plans, infrastructure projects, health, housing issues developed through region-wide evaluations are carried out in cooperation with local communities, and local community groups have established committees and associations to be effective in planning decisions. In addition, it has had a disaster management unit since 2005, as well as a building inspection system, early warning, planning supervision mechanism and building strengthening regulations are in force (Erdinç, 2018).

2.4.2.2 Actions Taken under the 100 Resilient Cities Campaign

The 100 Resilient Cities campaign was launched in 2013 in order to make cities more resilient against physical, social and economic problems in cities and natural disasters such as earthquakes, floods and fires. A total of 100 cities from 49 countries from Africa, Asia, Europe, Central America and the Caribbean, the Middle East and North Africa, North America, South America and Oceania participated in the campaign (Erdinç, 2018).

Among these cities, which are in danger of natural disasters and evaluated as having completed their resilience strategies in this context;

-SanFrancisco which is located in the San Francisco Bay Area in the north of the US state of California, has a population of approximately 826.000 and has been under the influence of disasters such as earthquake, fire, sea level rise,

-Mexico City, which is the capital and largest city of Mexico and has a population of approximately 9 million, is under the influence of natural disasters such as hurricanes, earthquakes and floods due to its geographical location,

-Semarang City which is established on the northern coast of Java Island in Indonesia, has a population of 1.5 million and is in danger of flooding, coastal flooding and landslides,

-The city of Greater Christchurc, located on the south island of New Zealand, with a population of approximately 430.000 on the east coast and facing disasters such as earthquakes, epidemics, floods, coastal erosion, sea storms, winds and tsunamis, have been studied (Erdinç, 2018).

In this context, the strategies developed for earthquake disaster can be counted as follows according to different urban usage areas:

-Suggestions developed for residential areas (Erdinç, 2018);

- ✓ Analysis of houses in areas with high risk potential and determination of actions according to the conditions of the houses.
- ✓ In the event of an earthquake, the type with the most damage or the structures that are thought to be able to collapse should be re-evaluated and renovated by considering modern regulations.
- ✓ Repair of dwellings in areas where those with low incomes.
- ✓ Conducting pilot studies by producing resilient urban development projects.
- ✓ Carrying out projects for the construction of suitable and quality housing.

-Recommendations developed for transportation;

- ✓ Repair and improvement of the existing transport system in preparation for disasters.
- ✓ Developing access planning for disasters and emergencies with disaster and emergency response in mind.
- ✓ Making maps showing emergency temporary shelters, assembly areas and evacuation routes and making them available to the public.
- ✓ Increasing port and airport usage capacities and protecting physical infrastructure.

-Recommendations developed for infrastructure;

- ✓ Upgrading critical infrastructures for drinking water distribution, electricity and natural gas systems.
- ✓ Determining the vulnerability of the water network and resources and implementing policies to reduce damage and preventing damage to water infrastructure.
- ✓ Development and implementation of methodologies including the concept of resilience in large infrastructure projects .

-Recommendations developed for important uses;

- ✓ Renovation of public buildings such as hospitals, public security buildings, municipalities, central library, opera houses, science academies, art museums, international terminals, etc. and making them earthquake resistant.
- ✓ Integrating the principles of resilience into public facilities and new projects that can be considered as strategic and encouraging the private sector for building durability.

-Recommendations developed for open and green space;

- ✓ Increasing the amount of urban open and green space.
- ✓ Integrating hazard and risk maps into urban plans and strengthening cities against possible risks.
- ✓ Minimizing the risk of disasters in the city with urban renewal and revitalization works including comprehensive policies.
- ✓ Strategies such as stopping urban development in disaster-prone areas and improving the environment and habitat conditions of non-hazardous areas and shifting urban development to these areas have been determined (Erdinç, 2018).

2.4.3 Earthquake Disaster Sensitive Planning Approach in the World within the Scope of Resilient City

Throughout history, people have been in constant contact with nature in order to meet their vital needs as a part or sub-system of the ecological system formed by nature. Especially with the transition of people to the settled order and keeping space and space for themselves, human ecology began to form. Human ecology structures itself to benefit from natural ecology and while benefiting from it, it adversely affects its ecological system. As a result of the fact that the relations between the natural ecological system and the human ecological subsystem have reached destabilizing dimensions and that human beings have increased their dominance over the natural system by relying on advancing technology, nature reacts with its own unique rules (in the form of the occurrence of disasters). Throughout history, people have experienced these disasters, tried to reduce their effects and prevent the loss of life and property. Today, disasters are a greater concern for human society than in the past. Some of the risks can be predictable, while others can be unpredictable. Although natural disasters are inevitable, damage and losses can be greatly reduced with proper planning and timely intervention against these disasters through timely warnings to the public. The occurrence of natural disasters such as earthquakes is sudden and can create problems on a national scale other than the region it affects. Sometimes the scale of the disaster becomes so great that it requires international support and attention. In this case, damage reduction and crisis management become integral components of urban planning.

Land use planning in cities is an important tool to reduce the risks arising from natural disasters. Risk-based planning provides an opportunity to plan the consequences of a hazard, rather than just planning for a natural hazard. The safety of cities against natural hazards is one of the main objectives of urban planning. Therefore, it is important to conduct research on the reliability of urban residential areas and recognize their level of vulnerability to natural hazards. Urban planning aims to prevent disasters by identifying their risky elements and strengthening environmental safety. Knowledge of urban development that explains principles and concepts and uses geographic data can greatly reduce the effects of such disasters. In addition, city managers can use this data to increase the reliability of cities against these dangers. Urban planning will be able to greatly reduce the deaths and damages caused by natural hazards.

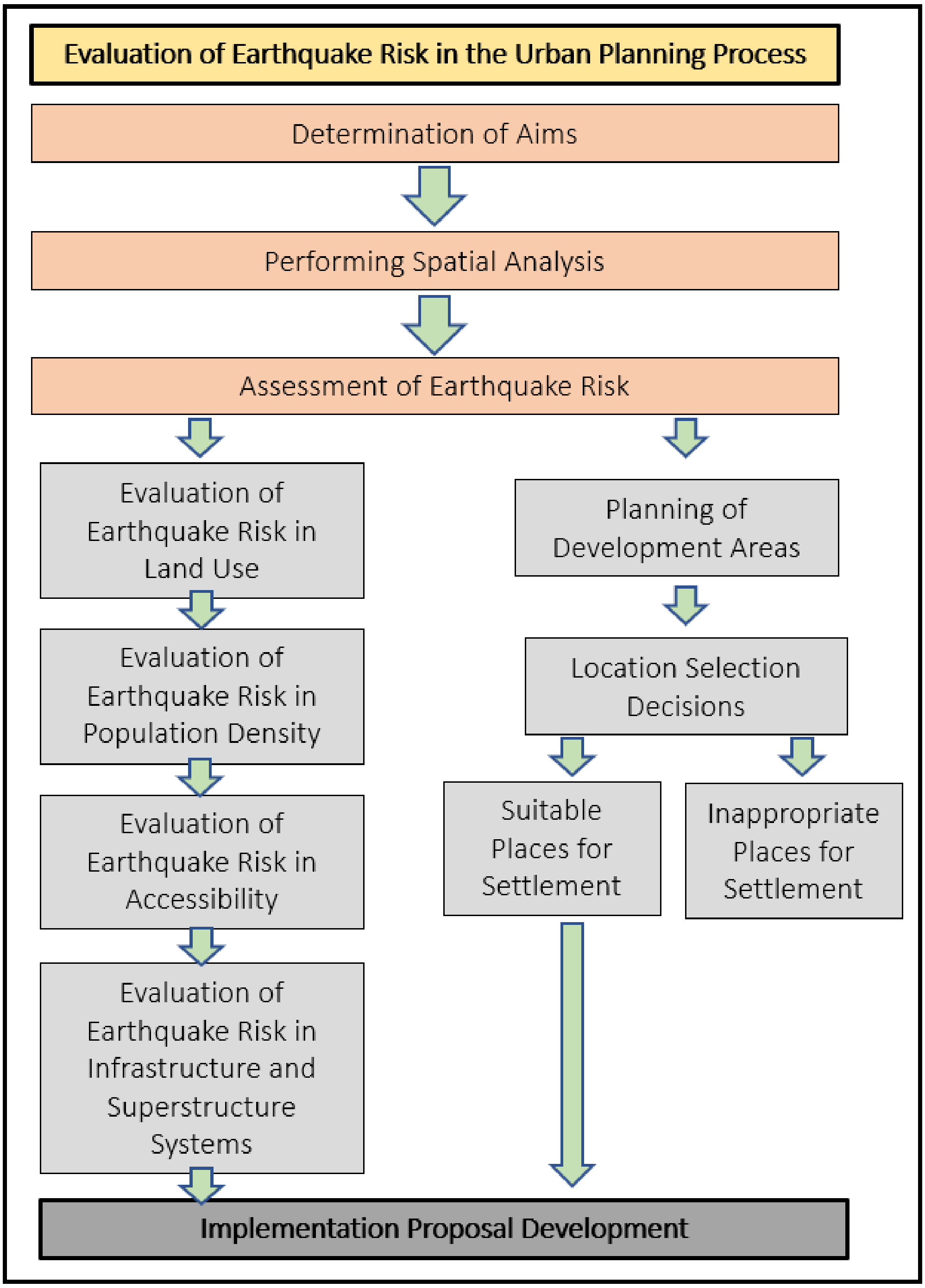


Figure 2.8: *Evaluation of Earthquake Risks in the Urban Planning Process*

Source: *(Uzer, 2002)*

Natural disaster prevention plans are carried out in leading countries in order to eliminate or reduce the long-term effects and consequences of known natural hazards on human societies or their existence within the scope of urban planning. These plans are aimed at improving current situations and preserving future developments. In these plans, methods and measures to mitigate the effects of risks include structural measures and non-structural measures (such as the development and adoption of legislation or policies related to land use).

Some of the urban patterns can be predictable, on the other hand others can be unpredictable. Therefore, in the city planning process,possible disasters that may arise in the long term should be foreseen and plans and suggestions should be prepared accordingly (Figure 2.8). Thus, the urban area will be used more effectively by minimizing the biases that will arise from the use of urban land and profiting from the requirements after the disaster. Plans prepared at all scales are the main factors that foresee urban development and urban development and develop mechanisms accordingly. These plans are the main resources that should be used to minimize possible seismic-related risks in the city. They also provide a fundamental input to the maintenance of a successful disaster management process.

2.4.4 Importance of Geological and Geotechnical Studies in Site Selection and Building Construction in the Urbanization Process

In order to realize disaster-sensitive planning approaches, it is absolutely necessary to carry out geological and geotechnical studies that will be the basis of the plan at all planning stages. Detailed field studies are required in the preparation of plans of all sizes and can be specially developed to address potential hazards associated with the proposed development. The foundation area where all kinds of engineering structures such as buildings, bridges, roads, drainage nets, dams, etc. will sit and the geological and geotechnical characteristics of the materials used in the field require detailed information for possible hazards. This also applies to effective urban planning. In fact, urban planning is a mixed, multidisciplinary process in which the geological environment must be taken into account in many ways (Hofmann, 1976).

Careful analysis of geomorphological, geological and geotechnical data is needed for accurate and sound urban planning and the development and expansion of cities. In other words, it is very important to understand the natural environment. Geological and geotechnical surveys are not completely independent of each other and are considered as studies that need to be carried out successively. In world examples, these studies are carried out first by considering regional, then local (on the basis of parcels) analysis.

2.4.4.1 Regional and Local Geological-Geotechnical Surveys Based on Planning

2.4.4.1.1 Regional Geological - Geotechnical Surveys:

Obstacles that confront people in the urban planning process;

-Obstacles that can be overcome (infrastructure, roads, economy, etc.),

-Insurmountable (physical) barriers (topography, geology, hydrogeology, seismicity, soil characteristics, soil quality and climate)

can be grouped as follows. In the second group, seismic status, geological features and ground conditions are the leading factors that control whether the land is suitable for construction. These factors, first singularly, then evaluated together, are used in the preparation of maps and reports on the region.

In particular, in the determination of new settlement areas and in the planning of the selection of the settlement area to be carried out for the new sections of the existing settlement areas to be opened to construction, the regional studies to be taken as the basis should consist of the following technical documents:

1) Topographic data (morphological map),

2) Geological data,

3) Seismicity of the region, location of active faults, extension and distance to the area planned for construction (seismotectonic map),

4) Hydrogeological assessment (groundwater map),

5) Determination of geotechnical parameters and dynamic characteristics of civil engineering design throughout the area under investigation,

6) Assessments of natural disasters:

- Potential landslide areas
- Areas that may be exposed to flood potential
- Spread of soft soils and decomposed zones
- Liquefaction potential

7) Preparation of "engineering geology" and "land use" maps by evaluating all maps together (stacked and made into a single map) (Ulusay, 1999).

The lack of these data during the preparation of development plans leads to limited sometimes inaccurate evaluations for the areas opened to construction. Therefore, the implementation of the stages outlined above is of great importance in the evaluation of the sites planned to be opened for settlement. A significant part of European countries, such as the USA and Japan, such maps are used in the process of urbanization and are constantly revised depending on the development of residential areas.

2.4.4.1.2 Local Geological - Geotechnical Surveys (Soil Surveys):

Geological-geotechnical surveys, which are foreseen for any structure in the local sense (parcel basis) and called "ground survey" in the regulations, are aimed at choosing the type of building foundation taking into account the seating behavior of the ground, determining the dynamic loads to be caused by the earthquake and deciding whether the ground needs to be improved, and are limited to the area and immediate vicinity of the planned structure. These studies play a role in the evaluation of the interaction of the ground - the building foundation and the selection of the type of foundation by determining the bearing capacity of the ground where the foundation of the planned structure will be located and its behavior against dynamic loads. It also aims to determine parameters such as groundwater that may affect the building foundation. Local geological features, distance to live faults, seismicity (seismotectonics) are the main geological and seismological factors that should be determined in such surveys (Ulusay, 1999).

The above-mentioned issues are examined and evaluated by geotechnical field and laboratory studies. Studies in the field of construction;

1) Examinations, observations and measurements to be made from the surface,

2) Drilling geotechnical surveys

are executed. This stage is followed by field and laboratory experiments in which the static and dynamic engineering parameters of the ground will be determined. According to Ulusay (1999), the parameters to be obtained and calculated are determined by the civil engineer in the basic engineering analysis;

a) Selection of the appropriate type of foundation and design of earthquake-resistant structures,

b) Planning of ground improvement works, if necessary and economical, or

c) In case of encountering very bad ground conditions, it is used for purposes such as abandoning the foreseen area and deciding to choose a new location.

The data to be obtained from these studies and the calculations to be made must be of a quality and quantity that will allow the complete selection and evaluation of the parameters and classification definitions foreseen to be taken as basis by the project engineer in the existing regulations.

2.4.5 Use of Earth Scientific Data in the Planning Process

In the light of all these data, geological and geotechnical data are guiding and determining the priority of the area to be opened to the ground, the type of use it is suitable for if it is to be opened, the layout of the grounding, density, and construction criteria. In the plans, the results, evaluations, and measures to be taken in the geoscientific studies are taken into consideration in the areas to be demolished. In the areas foreseen to be demolished in the plan, it is necessary to comply with the restrictions, criteria and precautions against the disaster hazards and risks revealed by the geological-geotechnical data. Therefore, it should be ensured that the conditions to be complied with are clearly included in the plan reports in a way that directs sub-scale plans, projects, and construction.

In the planning stage, the areas that are to be destroyed or restricted for geological reasons should be included in the plan. In the plan conditions, notes, or provisions, in addition to other factors affecting the plan, it should be stated in which cases the provisions determined in the laws and regulations in force will be applied together with the measures and decisions of the plan in terms of surface water resources, disasters, earthquakes, etc., as well as the principles of zoning, use of space and settlement order introduced in the urban area. The necessity of clarifying the decisions on use, use and prohibition and a set of measures and conditions related to urban infrastructure and equipment should be revealed (Durgun E. , 2006).

In this process, there are two stages to be implemented. The planning process should consist of the research phase, and the synthesis and transition to planning (implementation) phases.

2.4.5.1 Research and Survey Phase of the Planning Process

Geological-geotechnical data are examined under the heading of “natural structure and environmental resources” during the research phase. All subjects included in the earth science study report, which is prepared based on the nature of the planning area, planning level and type, are geological, morphological, topographic structure, water resources, seismicity, ground properties, landslide, flooding, etc. geological hazards are included in research studies, analyzed and evaluated (Durgun E. , 2006). Geoscience studies are the first studies to be done as they form the basis for plan decisions. Afterwards, it is necessary to use methods that allow the evaluation of natural disaster hazards, such as microzonation, revealed by geological studies, together with human risks arising from settlement and construction.

2.4.5.2 Synthesis and Transition to Planning Phase

During the preparation of the plans, the results of the earth science studies, the evaluations and the measures to be taken are taken into consideration when determining the areas to be settled. In the areas foreseen to be opened for settlement in the plan, it is necessary to comply with the restrictions, criteria and measures against the disaster hazards and risks revealed by the geological-geotechnical data. For this reason, it should be ensured that the conditions to be complied with are clearly included in the plan reports in a way that guides the sub-scale plans, projects and construction (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

In the transition to planning, at this stage where all data are evaluated together and synthesis and evaluations are made to guide the plan decisions, the geological-geotechnical data are evaluated within the scope of the concept of "threshold". In synthesis and transition studies, it is necessary to determine the thresholds that limit urban development, to classify them, to prioritize them according to plan policies and strategies, in other words, to reveal areas and priorities with potential for development by making "threshold analysis" (Durgun E. , 2006).

At the planning stage, areas that will be excluded from settlement or restricted due to geological reasons should be included on the plan. In these studies, the thresholds and constraints revealed by the geological-geotechnical data are synthesized together with other limiting thresholds such as agricultural areas, forest areas, water resources, protection areas, protected areas, airport obstacle plan, military security zones, so that priorities are determined by evaluating all data .

In these matters, it should be stated in which cases the provisions determined in the current laws and regulations will be applied together with the master plan measures and decisions and explanation of conditions. In this way, the settlement suitability assessments constitute the bases to be used in the long term, especially for settlements that will be considered disaster risky. In addition, with the microzonation maps using advanced geoscience data, disaster risks are evaluated in detail and the planning phase is ensured to progress in a healthy way. The geological study details used by plans at different levels should differ. Therefore, geological, geophysical and geotechnical data in urban planning is a very important issue in the identification, control and mitigation of natural disasters (Bell, Cripps, Culshaw, & O'Hara, 1987).

In the current century, urban geology has become an important component of engineering geology. In the light of geology and engineering geology, there are many studies for urban planning in many cities around the world. A wide variety of map types have been developed for many cities, particularly in Europe, East Asia, and North America (Kurnaz, 2020). Many scientists and researchers pointed out that the geology, geomorphology and hydrogeology of the relevant site or area should be known and investigated before any engineering structure is studied. Otherwise, the lack of basic information about the geological and geotechnical characteristics of the urban environment and correct planning will cause great problems during an earthquake (Berhane & Walraenevs, 2013).

In this context, the types of maps developed and used in order to guide the planning and construction process in are explained.

2.4.5.3 Use of Earth Scientific Data in the Planning Process in the USA

From this point of view, there are maps produced at various scales and topics used to determine geological and seismic risks in many countries living with earthquakes. Before examining the maps used in Türkiye and proposed by the relevant institutions to be made, the maps used for the preparation of plans at different scales in the urban planning and construction process are shown below in order to create a base for disaster risk areas in the United States, which is one of the first countries to start legal regulations on earthquake research and construction in earthquake regions (Balyemez, 2003).

2.4.5.3.1 Geology and Topography Maps

Among the many official documents available on the subject, the first to be examined are general but technical maps that show common geological features on a regional basis. The two most useful of these are those prepared for the whole state by one body of the U.S. federal government for the whole country. Although they are general, they are useful resources that provide initial identification and evaluation of fault zones and ground features. At the federal government level, the United States Geological Survey (USGS) is at the head of earthquake and geological studies. Producing topographic maps covering the entire country is one of the USGS services. In these maps, the main geological information, the general localities of the fault zones and the locations of the major cities, as well as the streets, buildings, transportation systems and other information are shown by drawing them at appropriate scales (Figure 2.9). In addition, the USGS produces more detailed earthquake maps specifically for fault lines. All these maps are extremely helpful in identifying areas with earthquake tendencies, giving architects and planners a certain picture of the general geological characteristics and risks of the land they are working on. The next stage is the maps issued by a state body. These maps are produced by a geological and natural resources unit within the state government. Just like the USGS maps, state-prepared maps provide general geological information that includes the locations of fault zones, but with a more specific approach, they contain more detailed information (Balyemez, 2003). Such a publication prepared at the state level is a geological atlas in which dense geological information is mapped in detail.

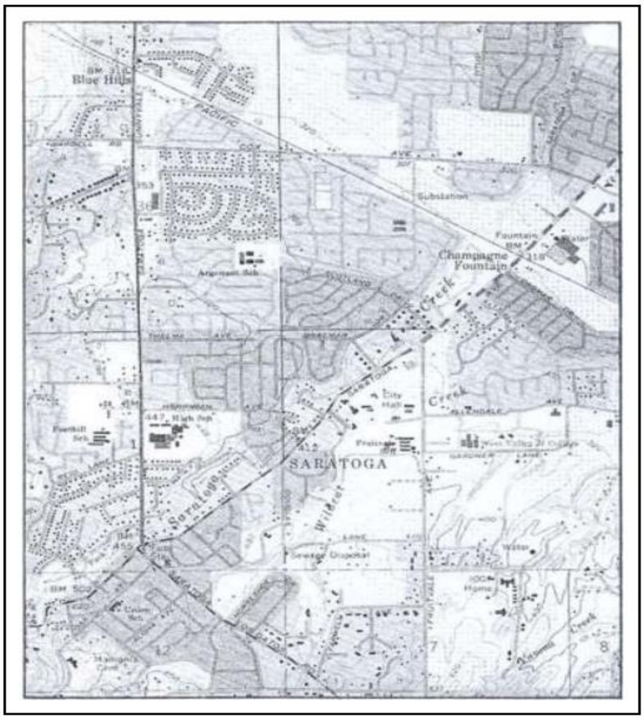


Figure 2.9: *Example of Geology and Topography Map Produced in the USA for Earthquake Risk Determination*

Source: *(Balyemez, 2003)*

2.4.5.3.2 Seismic Risk (Seismic Zones) Maps

Another type of map tries to define the earthquake risk of a region by comparing it with other regions. These maps provide the planner with a quick and visual understanding of the earthquake risk level over a large area. While the USGS geological maps mentioned above provide data on the geological characteristics of the given region and the locations of fault zones, they are not intended to express the relative risk level of the gene in question. In general terms, the simplest national seismic risk map is based on the location, number and magnitude of earthquakes that have occurred and been recorded over the past 200 years. All these data are transferred to maps to express the riskiest places where earthquakes with large magnitudes occur the most in number. These maps are very effective in comparative identification of regions with high and low earthquake risk by looking at the places where earthquakes have clustered in the past. Such maps are constantly updated every year, especially after a year of intense seismic activity. The data from the maps showing the earthquake records are used to make a map in which the risk levels in a large area are divided into segments expressed in numbers. The map of the United States earthquake zones shown in Figure 2.10 and used in the 1988 Uniform Building Code contains five regions classified from 0 to 4. Region 4 represents the areas with the highest earthquake risk (Balyemez, 2003).

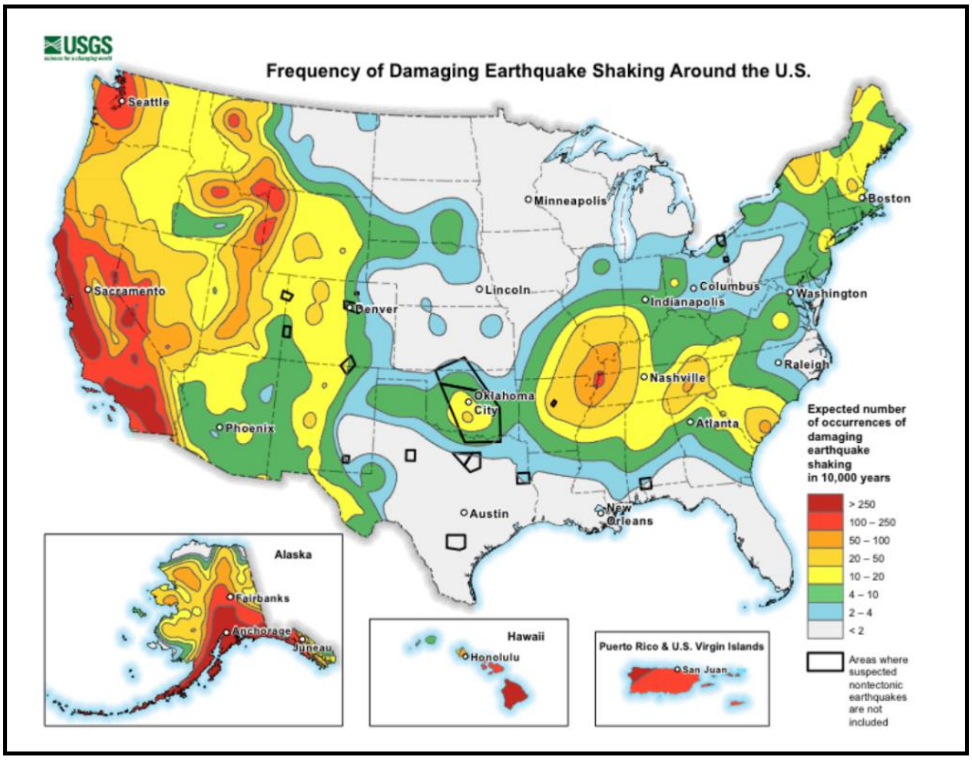


Figure 2.10: *National Seismic Hazard Map in USA*

Source: *(USGS, 2022)*

2.4.5.3.3 Active Ground Acceleration Maps

The maps described in the previous heading are limited to some extent in terms of building design because they do not contain any information that will give an idea about the frequency of recurrence of an expected earthquake, which is another measure of seismicity in the region, nor about the possible acceleration peak values in the region, even if it is very uncertain. Two new maps were prepared in 1978 that show the expected ground shaking intensity by defining them with coefficients for effective peak acceleration and velocity-related effective peak acceleration (Figure 2.11). Using all the information provided by these maps, the planner will be able to create an overall picture of the region in a short time by combining all the features of a given region, such as geological features, locations of fault zones, earthquake risk stage and power peak acceleration (Balyemez, 2003). This will be most useful in revealing the limitations imposed by the ground structure in the region on land use and building design.

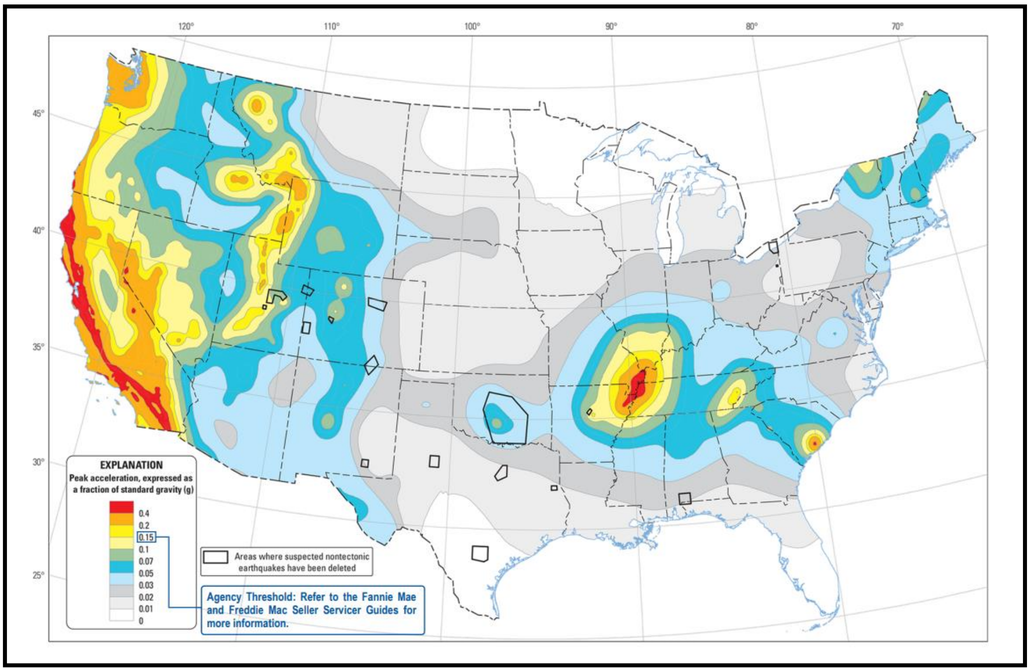


Figure 2.11: *Peak Ground Acceleration Seismic Map (10% in 50 years exceedance) in USA*

Source*: (Bawono, Ali, & Ma'arif, 2019)*

2.4.5.3.4 Weak Ground Maps

Maps showing structurally defective floors are another important component of layout planning. As a critical factor, many earthquake discovery reports mention the relationship between areas with poor ground and increased building damage. The USGS has published maps that support this information, but they have been developed at scales that somewhat constrain their use. On the other hand, maps developed by sources at the state and local level are more suitable for design experts to use. There are two types of maps in this class (Balyemez, 2003):

1) Weak Ground Type,

2) Landslide.

It goes without saying that both species, coupled with the impact of earthquakes, represent potential problem areas for construction. In this case, weak floors are classified as follows. Unengineered, loose, structurally unhealthy areas under dynamic loads, such as artificial fill areas, and water-saturated and liquefy-prone areas along the edges of waterways. The ground in these areas is considered loose and unstable, in contrast to tight, solid and reinforced ground. They consist of soft, highly compressible, water-saturated fine-grained silts, which are typically found in swampy areas. Around the former boundaries of the natural bay and ports, many such areas have been discovered that were subsequently replenished for use in urban development and growth growth. Typical examples are the cities of Boson, Seattl e, SanDiego, SanFrancisco, Los Angeles, Long Beach and Charleston, all of which are located in significantly risky earthquake zones (Balyemez, 2003). Figure 2.12 shows a map of weak grounds. This kind of information is very important when developing a layout plan. Two reasons are often underlined for the major damage to buildings in areas with weak ground;

1) Soft floors magnify the passing earthquake waves and extend their periods.

2) Due to different ground seats, the structure may have weakened before the earthquake. In any case, it is not unusual to come across dense clusters of heavily damaged buildings on areas with weak ground after a serious earthquake.

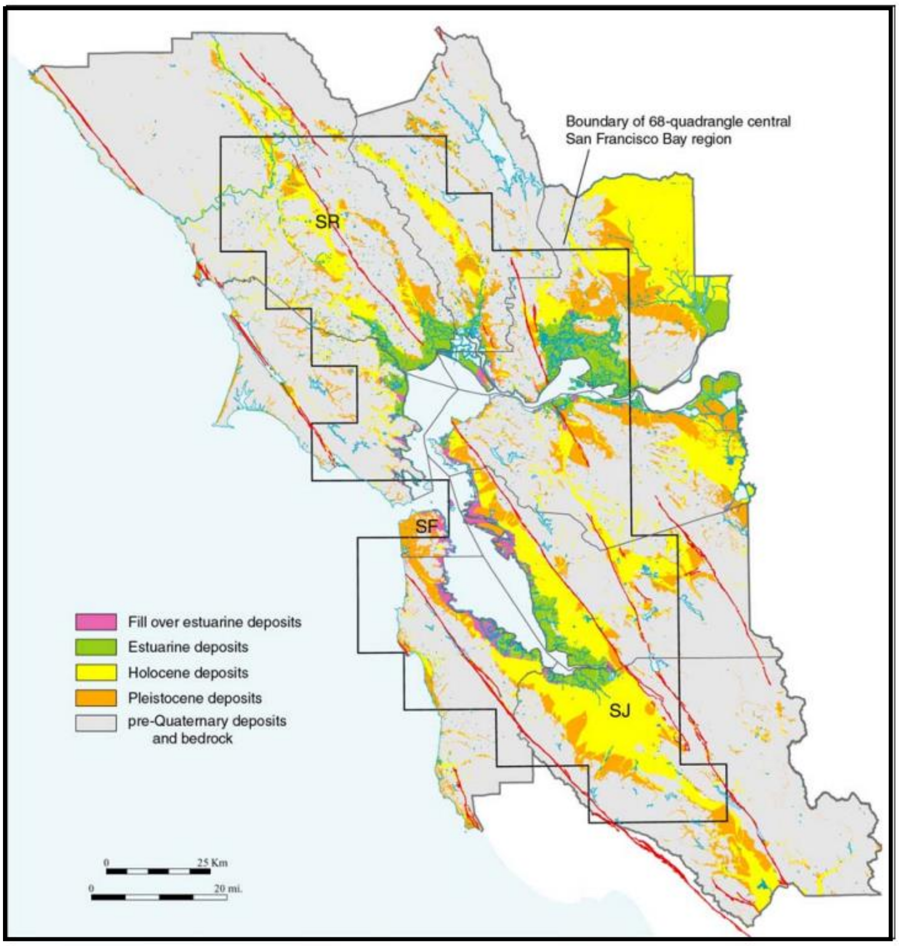


Figure 2.12: *Generalized Distribution of Geological Units in the San Francisco Bay Area*

Source: *(Robert C. Witter, 2006)*

2.4.5.3.5 Maps of Special Work Areas

In recent years, as part of the land use and development objectives of the states, tendencies have emerged to prepare maps within the framework of the main purpose of defining the locations of the faults, and in this way, "special study areas" have been created. The use of these maps is mandatory in all non-residential construction projects with large numbers in the province. These maps show in detail all the potential and still active fault lines in the State of California (Figure 2.13).

Since only active fault lines are mapped, the active word on these maps is "active". The geological definition of an active fault is made in the form of a fault with evidence that it has moved in recent geological times.

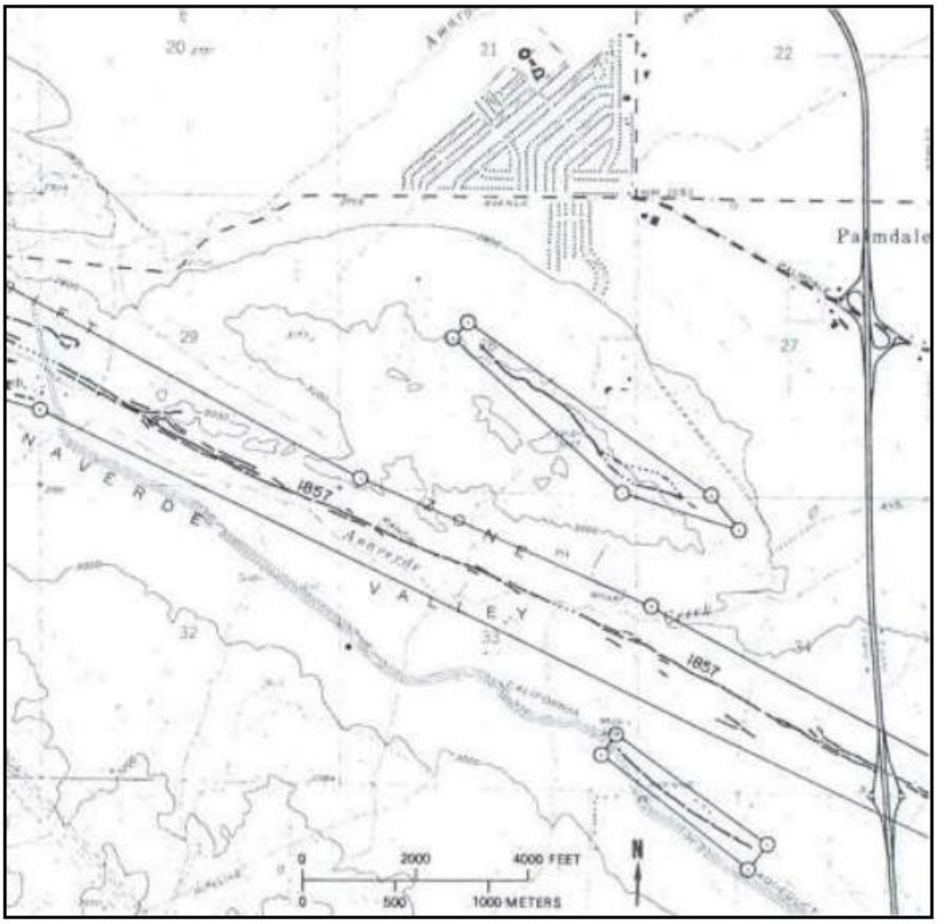


Figure 2.13: *Example of a Map Showing Specific Study Areas Along the San Andreas Fault*

Source: (Balyemez, 2003)

Geological "special working areas" are legal regulations that control the construction conditions. Special study areas, as a land use control mechanism, cover the fractures contained in known active faults as a zone. After the passage of the Alquist-Priolo Special Study Area Act following the 1971 San Fernando earthquake, fault zone mapping was completed in California. Special study areas relate to active fault zones and strictly limit what can be built directly on the fault trail of any building. In order to avoid building directly on the fault line, no plan or site selection can be made in which no special work area is declared for any basic facility without a complete geological survey. In a section within the private working area, it is ensured by law that the conditions required by the law are met before the construction permit is issued. If the land is within the special study zone, specific geological land surveys are required to determine the exact position of the fault mark on the property. At this point, the layout plan should not allow any construction directly on the fault trail by considering this data (Balyemez, 2003). In order not to risk it, it is recommended to pull the buildings to a convenient distance from the benefit. The construction of custom workspace maps is a form of microzonation process, with the limitation of the construction of specific structures along the fault zone. The location and construction of important emergency service facilities is difficult to comply with the provisions of the special work area law for land use purposes.

2.4.5.3.6 Microzonation Maps

Seismic microzonation methods require the identification, classification, assessment and characterization of all seismic and geological risks in high or average risk areas, just as they do in the development of tools that coordinate information on earthquake risk and land use policy decisions. Normally, such research results in maps based on earth science data collected on a large scale. These maps show data on the largest expected earthquake intensity, active faults, geological units, specific study areas, ground responses, liquefaction susceptibility, landslide sensitivity, and tsunami-induced flooding areas. A good microzonation map illustrates potentially seismically problematic areas, identifies problems and quantitatively expresses their impact by pointing to their likely intensity. These microzonation maps can be used as key recommendations in regional land-use plans for the appropriate location of critical emergency structures and facilities, hazardous toxic substances, industrial development areas, population centers, transportation routes, communication systems and open spaces (Figure 2.14). The main purpose of the maps is to reduce the risks caused by earthquakes through the correct land use plans at the local level, where the risk levels against functional uses are drawn (Balyemez, 2003).

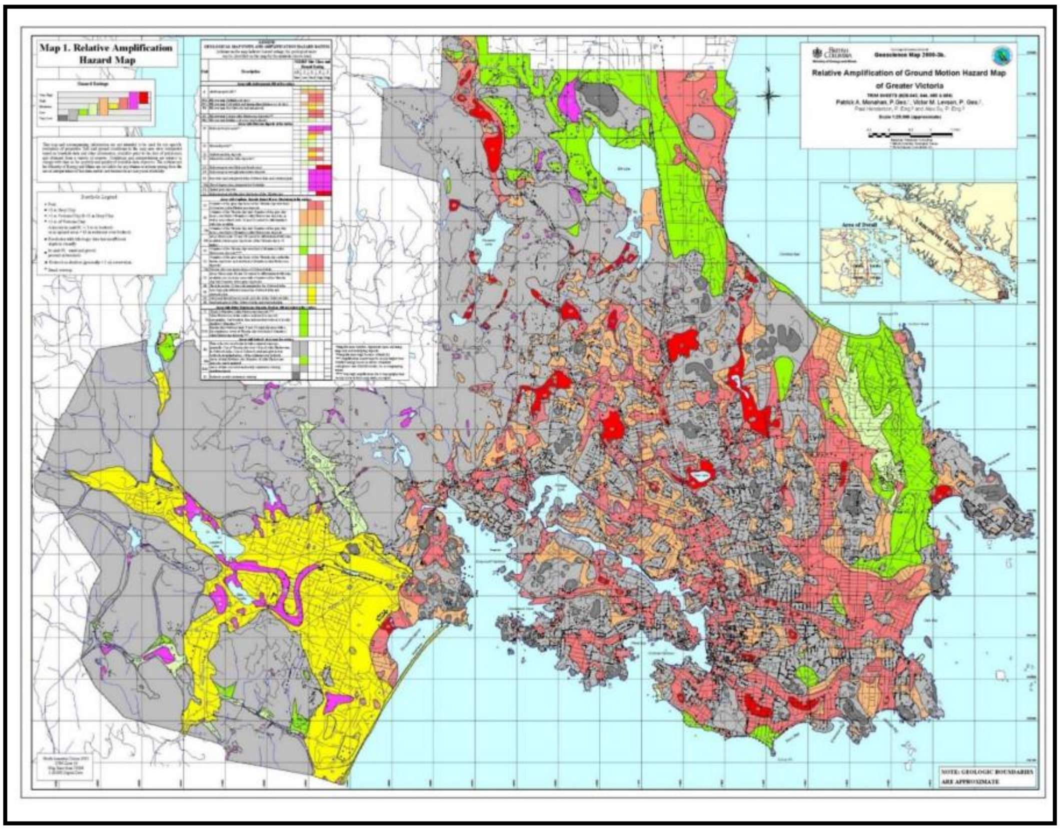


Figure 2.14: *Seismic Microzonation Maps in Canada*

Source: *(Molnar, 2019)*

2.4.5.3.7 Land Use Planning

Such pre-planning studies in seismic microzonation studies will give the planner a standing point in the discussions on whether the land subject to construction is suitable for the intended function and specific needs at a regional scale. Reports and maps related to all these studies are made available to local governments, city and regional planners, civil engineers and architects and plans are created in which certain technical restrictions and criteria are used in the planning and construction stages. In the process of urbanization, this information is constantly revised depending on the development of settlement areas.

Once the appropriate land-use perspective has been fully determined, if the construction site has not been rejected on the grounds that it does not coincide with the intended function of the structure, land-specific planning can begin. The three steps required in this endeavor are (Balyemez, 2003):

1) Evaluation of the microzonation map in the context of the suitability of land use at a regional scale,

2) Field-specific analyses and

3) Conformity assessment of the land in question.

It is important to evaluate the seismic limiters imposed on the design as the final product against the intended use, duration of use and function of the building. Before beginning any plan or architectural design preparation, it is a precautionary measure for the subject matter expert to spend time completing the land use determination of the land using seismic microzonation data. Even in emergency situations where conceptual preliminary design approaches are required as soon as possible, it is the best approach to make an earthquake risk assessment of the land first (Figure 2.15).

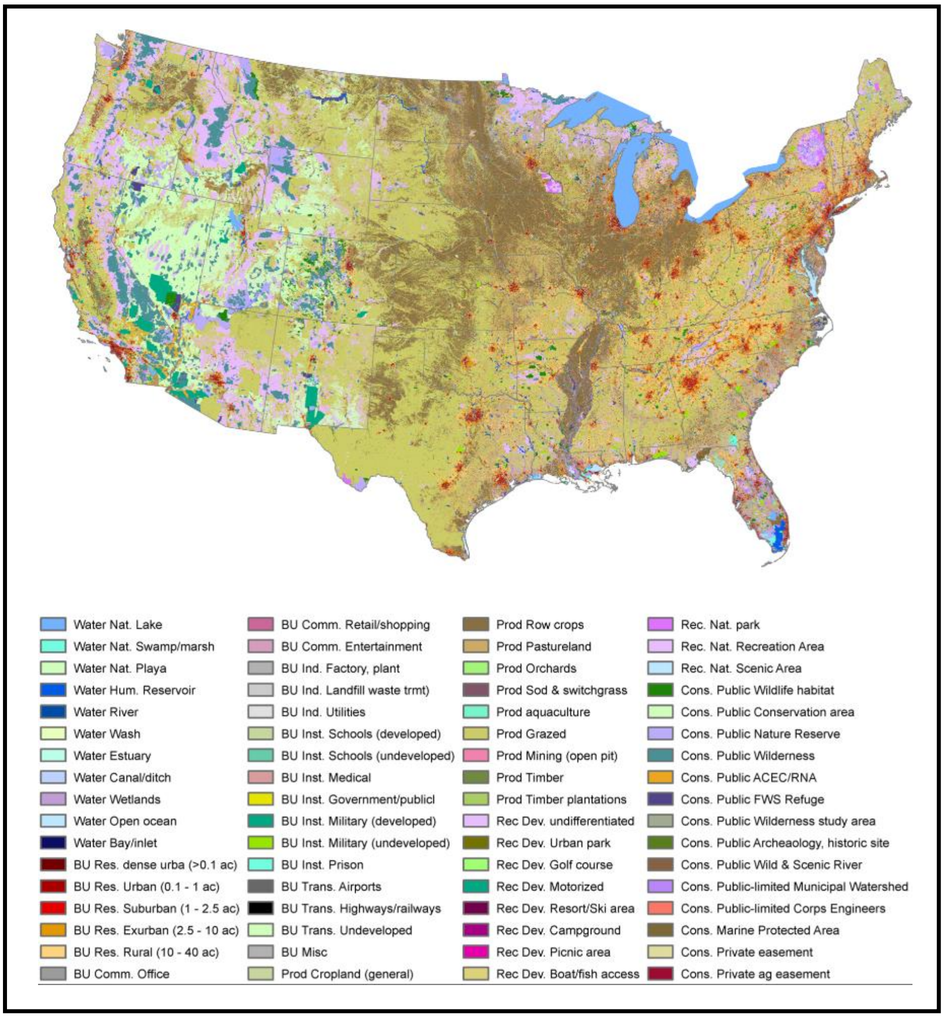


Figure 2.15: *Comprehensive Land Use Classification and Map for the USA*

Source: *(Theobald, 2014)*

The process by which detailed field studies are conducted and evaluated is a complex and multidisciplinary process that needs to be taken into account in many ways. Each factor mentioned above requires the skills of professional groups from different disciplines such as architects, civil engineers, geological engineers, urban and regional planners. Collaboration between these disciplines is of great importance for an earthquake resistant city design.

In fact, the main point to be understood is that urbanization is a phenomenon that has emerged with the joint work of urbanism, architecture and civil engineering in general. Geology, on the other hand, is an indispensable sub-discipline of urbanization, and it is the most important resource to be consulted in determining the relationship between urbanization and geology, the appropriate settlement area for the urban planner, the building type for the architect and the bearing capacity of the ground for the civil engineer (Arık, Kurt, & Çömlekçiler, 2011). Figure 2.16, shows the relationship between geology and urbanization as a source of data for city planners, geologists, geological engineers architects and civil engineers in the urbanization process.

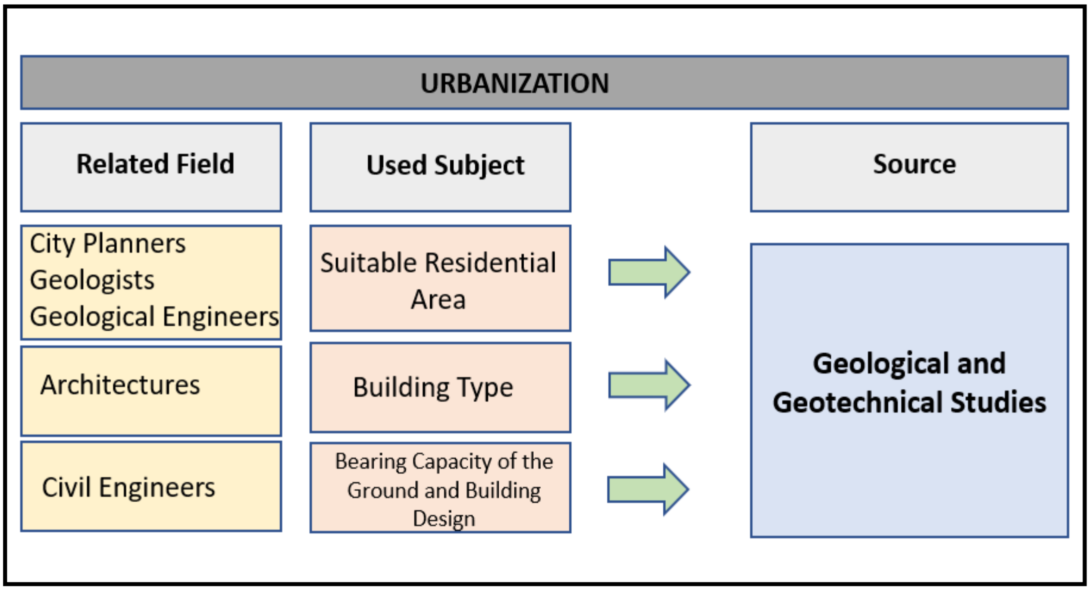


Figure 2.16: *The Relationship between Geology and Urbanization as a Source of Data for City Planners, Geologists, Geological Engineers, Architects and Civil Engineers in the Urbanization Process*

Source: *(Author Representation)*

2.5 Concluding Remarks

In this section, it is emphasized that the subject of disaster resilience in general requires a multidimensional and interdisciplinary approach. Considered in this dimension, cities are the main center points where different interactions and cycles are experienced together. The results of these effects reflect on cities both positively and negatively. For this reason, it is necessary to develop and implement various policies in different areas in order to prevent such negativities. When the concept of resilient city developed in this direction is reflected in the urban development process in different areas, these negativities will cause less damage to the city. The resilience conditions in different subjects are given in the table that has been developed as a summary in Figure 2.17. On the subject of urban seismic resilience, the mentioned needs have been revealed through international studies and the definitions of resilience have been explained. In this context, only the principles of physical seismic resilience are highlighted in this part of the thesis and throughout the thesis. The subject has been further elaborated by explaining together with the seismic resistant city principles developed in the international context.

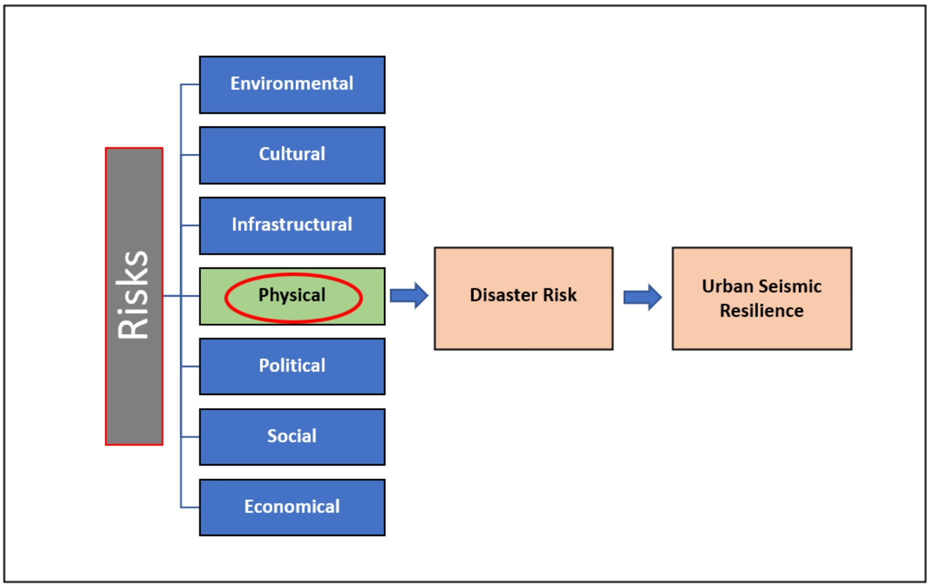


Figure 2.17: *Urban Resilience Components*

Source: *(Author Representation)*

The seismic resilience principles developed at the city and regional scale through urban planning and construction processes are the main factors to be used to develop solutions against problems of different scales and sizes. In this way, the analysis and synthesis of the existing risks in the urban area can be made. The criteria that should be taken as a basis for the evaluation of the planning and construction process within the framework of seismic resilience, which is the main focus of the thesis, are explained in this section. Based on these criteria, the establishment of a consistent conceptual and methodological approach that is defined and accepted at a high scale should be the basis. In this context, risk analysis methods in planning and construction issues should be clarified, the content of risk reduction, hazard and mitigation plans should be developed and a legal basis should be established.

In this context, the importance of the contents of the geological and geotechnical studies that should be done before the planning stage, microzonation studies that should be taken as a basic criterion for urban location selection, seismic risk maps, ground acceleration maps are mentioned. These studies and maps on a national scale are also included. The contributions of engineering science constitute the basis of the process because the basic data used in all of the planning and construction processes are obtained as a result of this type of research. For this reason, the contribution of engineering science throughout the whole processes will be the determining factor in a resilient city formation process. In this way, seismic resistant cities will be formed and possible risks will be prevented.

Based on the framework developed in this section, the data obtained from the fieldwork discussed in Chapter 4 were analyzed and evaluated.

CHAPTER 3

THE CONTEXT: EXISTING OPERATIONAL PROBLEMS AND DEVELOPED SOLUTION PROPOSALS FOR URBANIZATION AND CONSTRUCTION DECISION MAKING PROCESS IN TÜRKİYE

3.1 The Relationship between Urban Planning and Earthquake in Türkiye

Due to the earthquake reality of our country, it cannot be denied that one of our priorities as a country is to work on disaster damage reduction in the planning of the increasing population and the growing settlement areas accordingly. Planning Systematics was needed to eliminate the conflicts between natural and artificial environmental systems and to develop relations between human masses and natural resources that would make their own existence sustainable in human-nature conflicts in order to ensure the relations of the two systems that would feed each other and sustain their existence and to ensure sustainability. The planning studies carried out within the framework of the development law numbered 3194 in our country are carried out with the traditional planning method dominated by the understanding of the design of physical spaces in urban areas. However, after the earthquake of August 17, 1999, it was understood that the reduction of disaster risks could not be solved by traditional planning methods. Instead of this understanding, the concept of "disaster sensitive planning" has started to be discussed. In our country, which is located in a sensitive geography in terms of disaster hazards, it is known that the most rational and effective method of preventing disaster hazards and reducing damages in residential areas is to design the planning and implementation process in a way that includes disaster-sensitive planning approaches and risk management.

The planning, zoning and construction system in our country is criticized for its inability to effectively direct urban development for the benefit of the public and society and its inadequacies. One of the negative consequences of this situation is the lack of development of methods and tools that take into account disaster hazards and risks in the planning, implementation and construction process and the formation of disaster-resistant settlement environments and building stock, especially in urban settlement areas. Planning of all types and scales is an important tool in disaster damage reduction, and disaster sensitive planning can be defined as a planning process and approach that takes into account the dangers and risks of natural disasters and aims to prevent and reduce disasters. Designing urban planning as a problem-solving, dynamic process for the formation of a healthy, safe, livable urban environment instead of a "zoning planning" approach that reduces it to a purely static environmental design and land use decisions; the inclusion of risk-reducing measures in the planning process is the main purpose of disaster sensitive planning. To realize a fet sensitive planning approach, it is necessary to integrate geoscientific data into planning of all types and scales. Urban planning is usually realized at three levels: national, regional and local. The groups involved in this process are government bodies, local governments, and institutions such as special planning industry agencies. In Türkiye, plans are structured from the upper level plan to the lower level plan according to the purposes and the areas they cover;

- Spatial Strategy Plan (Regional Plans),
- Territorial Plan,
- Development Master Plan,
- Implementation Plan

respectively. Regional plans must be prepared in harmony with each other within a certain system. Each plan must conform to the current higher-tier plan. In the plans, each of which is prepared at different scales, the boundaries of the urban area in general are determined by the upper tier plans. While determining, the changes to be made in the 1/5000 and 1/1000 scale lower level plans such as the Development Master Plan and the Implementation Plan must form a whole. There are three main criteria in order for the plans of different scales to be consistent with each other and to be in a mutual feeding relationship at the stage of making city planning decisions. The first of these criteria is consistency between different plan tiers. Accordingly, every plan in the lower scale should be consistent with the plans in the upper scale.

Because every plan in the upper scale forms a general framework of the plans in the lower scale. Another main criterion is the consistency of each plan made. This criterion, known as functional unity in the planning language, emphasizes that consistent decisions should be made regarding the plan's urban macroform, urban land use, transportation network and development decisions. The last criterion is that the urban uses are suitable for the place where they are planned. In this context, upper-scale plans should determine the general zoning and urban development principles that will form the basis for lower-scale plans. Decisions taken within the framework of general zoning and development decisions constitute an input for lower-scale plans. In other words, lower-scale plans (especially implementation plans) are site-specific development and implementation of plan decisions from upper-scale but it is not an exact translation. If it was implemented exactly, there would be no need to make plans from lower scales and upper scale plans would be sufficient. For this reason, it is necessary for every scale plan to remain at its own implementation level and to develop a plan decision accordingly. The most important reason for this situation is that the basis of a plan prepared for the upper scale and the basis of a plan prepared for the lower scale (i.e. the plan for direct implementation) are at different levels. It is necessary to make a plan prepared for the subscale more concrete and specific to the place. The main data taken as input from the upper scale plans to the lower scale plans are the determination of the urban development zones, the determination of the main development directions and the general strategies regarding the different development-protection areas in the city and urban transformation etc. identifying areas of intervention. The lower scale plans are the plans in which the suitability of the decisions coming from the upper scale and the urban uses are brought together in a certain hierarchy. In this context, the general plan framework from the upper scale and the conditions of suitability for the place taken at the lower scale are brought together and made consistent within itself. The general plan decisions coming from the upper scale are developed and implemented for a specific area selected at the lower scale (Balaban Şenol, 2017).

3.2 The Relationship between Spatial Plans and Disaster Management in Türkiye

The understanding of urban planning, which is correct in our country, is the traditional physical planning understanding. The legal framework and managerial procedures on which planning is based reflect the understanding of physical planning. Urban planning in the modern sense in our country has a very long history of about 150 years. In this period, although there were minor changes in terms of city planning purposes and tools, there were no radical changes in terms of spatial planning tools.

The construction of spatial plans, which are prepared to protect and develop physical, natural, historical and cultural values, to ensure the balance of protection and use, to support sustainable development at the country, region and city level, to create healthy and safe environments with a high quality of life, and to bring land use and construction decisions. In order to determine the procedures and principles regarding its implementation, the Spatial Plans Construction Regulation entered into force by being published in the Official Gazette dated 14.6.2014 and numbered 29030. With this regulation, spatial plans are classified as Spatial Strategy Plans, from upper level to lower level, as Spatial Strategy Plan, Territorial Plan, Master Development Plan and Implementation Plan in terms of the area they cover and their purposes (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

In the Spatial Plans Construction Regulation, the spatial strategy plan, which relates the country's development policies and regional development strategies at the spatial level, evaluates the regional plans by taking into account the economic and social potential, targets and strategies, transportation relations and physical thresholds, settlements, transportation system and urban, social It is the whole plan with sectoral and thematic maps and report, which can be prepared throughout the country and in the regions deemed necessary, which determines the spatial strategies for the direction of the technical infrastructure and the technical infrastructure, prepared using schematic and graphic language on 1/250.000, 1/500.000 or higher scale maps (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

On the other hand, territorial plans are the general land use related to sectors such as urban and rural settlements, development areas, industry, agriculture, tourism, transportation, energy, where basic geographical data such as forests, rivers, lakes and agricultural lands are shown in accordance with the target and strategy decisions of the spatial strategy plans. It is defined as the plans made as a whole with plan notes and a report, which can be prepared at the level of the region, basin or province by using the appropriate display on the 1/50.000 or 1/100.000 scale maps that determine the decisions of the settlements and sectors, provide the balance between protection and use (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

Master development plans, which are the last step of the planning hierarchy, on the other hand, in accordance with the general principles, objectives and decisions of the territorial plan, include the general usage patterns of the land plots, the main region types, the future population density of the regions, the development directions and sizes of various urban and rural settlements and their principles. To show the urban, social and technical infrastructure areas, transportation systems and to prepare the implementation plans, at 1/5.000 scale with the cadastral status, if any, at every scale between 1/5.000 and 1/25.000 in metropolitan municipalities, on approved existing maps, These are the plans prepared as a whole with their notes and detailed report (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

Taking into account the implementation plans, the conditions of the region and the general characteristics of the planning area in accordance with the principles and principles of the master plan, the purpose and need for the use of the building, accessibility, sustainability and its impact on the environment; building islands, uses, building layout, building height, floor area coefficient, floor area number or precedent, building approach distance, front facade line, city block separation line, vehicle, pedestrian and bicycle paths, transportation relations, parks, squares, urban, social and technical infrastructure areas, when necessary; parcel sizes, parcel facade and depth, rear facade line, road elevation and the number of floors below this elevation, the number of independent sections, such as the decisions regarding the construction and implementation, the application stages that will be the basis for the zoning application programs required for the application and other information in detail, and the cadastral status is processed on the approved existing maps, plan notes and detailed report prepared as a whole.

In the Spatial Plans Construction Regulation, it is stated that before spatial plans of all scales are made, urban risk analysis studies will be carried out for settlements where disaster and other urban risks are high or for the built urban environment and disaster, geological and natural data will be taken as basis if deemed necessary during the research and analysis phase. The importance of taking into account the existing reports and geological surveys on disaster hazards was mentioned when preparing territorial plans. While preparing the development plans, firstly, by performing threshold analysis and topographical, geological-geotechnical, hydrogeological structure features and land use, agricultural and forest areas, drinking water basins, sites and other protected areas, sensitive areas, coastal, infrastructure, natural and physical data and analyzing disaster hazards, taking into account the open space, road and other spatial needs that may be needed in disasters and emergencies, and directly or indirectly negative on human health and safety. It was emphasized that the opinions of institutions and organizations regarding energy transmission lines, stream protection zones, flood risk areas, disaster exposed areas and similar areas should be taken into consideration and reflected in the plans. Table 3.1 shows the details of this differentiation according to the stages of plans.

Table 3.1: *Plan Hierarchy in the Disaster Responsive Urbanization Process*

Regional Plans	**Territorial Plans**

Accordingly, the studies that are the basis for regional-scale plans are observational geological studies. At this stage, disaster hazard maps should also be taken as a basis. Observational geological studies and disaster hazard maps are taken as the basis in strategic decisions such as site selection of important facilities, regional infrastructure facilities, regional distribution of population and activities, settlement and development policies.	Territorial plans made at 1/25.000, 1/50.000 and 1/100.000 scales are a critical plan stage where settlement decisions are made at the provincial and basin scale. At this scale, disaster hazard maps are prepared based on observational geological studies or geological-geotechnical studies. Based on disaster hazard maps, decisions and strategies regarding the spatial distribution of population and activities, infrastructure, and the distribution of residential areas are developed within the framework of basic strategies for disaster prevention and mitigation, and objectives and policies appropriate to this strategy.
Master Development Plans Master development plans are the planning stage where basic settlement and usage decisions such as macroform development of the settlement, usage types, densities, transportation, open-green area system and infrastructure are made. Basic strategic decisions such as urban transformation, protection, improvement and renewal regarding settled areas are also made at this stage.	**Implementation Plans** Implementation plan is a type of plan with cadastral status on it, which shapes the building blocks, the division forms of the building blocks, roads, squares, landscaping areas, the silhouette features of the city and the coastline, and consists of plan notes, detailed explanation report attachments. This plan type should be based on geological

Table 3.1: (Continued)

Depending on the size, development potential and problems of the settlement, geological-geotechnical studies and microzonation studies are used in master development plans.	and geotechnical surveys and microzonation studies, depending on the size and potential of the settlement, as they include decisions about structuring (building densities, number of floors, etc.). Microzonation studies and the settlement suitability maps created as a result of these studies gain importance especially in the planning of settled areas where urban risks are high and therefore preventive and damage reduction methods are needed.

Source: *(Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006)*

3.2.1 Geoscientific Studies Based on Settlement Planning Process in Türkiye

The geologic survey reports used in urban planning in Türkiye have had to improve over time in terms of their content and planning guidance. Especially the Marmara and Düzce earthquakes in 1999 were effective in the laws and regulations enacted to make these survey studies compulsory. In this context, the studies carried out as "Observational Geological Survey Reports" have been effective in directing plan decisions through "Settlement Suitability Assessment", which has developed as "Geological-Geotechnical Survey Reports for Settlement Purposes Based on Development Plans" over time and is a kind of synthesis of geoscientific data. Later, with the developments in earth sciences, it was possible to apply different methods. The developed methods have allowed precise measurements and evaluations to be made using more parameters. In this way, detailed databases can be developed that can be used for high-risk regions with the current conditions. At this point, "microzonation maps", in which disaster hazards and risks are evaluated by using advanced geoscientific data, are the main studies that will guide urban planning.

In our country, new definitions have been made in the Draft Planning and Development Law on the geoscientific data that are the basis for planning. At this stage, maps containing basic information to be used as a base for planning are explained.

Disaster Assessment Map, as one of the data groups based on planning, is a document prepared on standard topographic or existing maps, which reveals all kinds of disaster hazards that may occur in the planning area, evaluates and is a whole with its report, and is prepared in the form of "disaster hazard map" and "microzonation map" according to the types and scales required by the plan. Disaster Assessment Maps are defined as "disaster hazard map" in regional or territorial plans and as "microzonation map" at the settlement level (Kubin, Sönmez, Kubin, & Kubin, 2007).

- The Disaster Hazard Map is prepared to include all kinds of disaster hazard assessments based on topographic maps, including regional, spatial strategy plan or territorial plan. These maps are prepared by the Ministry or the Special Provincial Administration or the Metropolitan Municipalities.
- Microzonation Map is the data prepared on standard topographic or large-scale existing maps numerically, as a basis for the master or application zoning plan, including local ground conditions and all kinds of disaster hazard assessments (Kubin, Sönmez, Kubin, & Kubin, 2007). Microzonation studies are multidisciplinary studies that create data for planning studies, determine all disaster hazards in areas that are planned to be opened to settlement and all disaster risks in built environments on large-scale maps, and provide input to the determination of strategic

objectives, targets and priorities for urban transformation and harm reduction planning studies in making safe land use and zoning decisions. These studies are developed to determine the disaster hazard at the local level.

Geoscientific surveys, which are taken as the basis for planning in Türkiye, in terms of their scope and qualities are;

1. Observational Geological Surveys
2. Geological-Geotechnical Surveys
3. Microzonation Studies

Geoscientific studies according to plan stages and areas of use;

- The studies that are the basis for the plans at the regional and territorial order scale are observational geological surveys. These studies can also be called disaster hazard maps or integrated disaster hazard maps.

-The studies used as a basis for the plans at the scale of the master and application master plan are geological-geotechnical surveys and microzonation maps.

-The studies that should be taken as a basis for construction are ground and foundation studies. As a result of geoscientific studies of different scope, content and format, "Suitability for Settlement Assessment" is carried out as a kind of synthesis of all geoscientific data. Suitability for placement assessment is a synthesis study that includes field definitions that guide plan decisions in planning studies at different scales and the measures to be taken in these areas (Kubin, Sönmez, Kubin, & Kubin, 2007).

Table 3.2: *Geoscientific Survey Types According to Plan Levels*

Plan Stages		Types of Studies	
Plan Name	**Scale**	**First,Second and Third Degree Earthquake Zones and Population≥50.000**	**Other Areas**
Regional Plans	1/250.000-1/100.000	Observational Geological Studies	Observational Geological Studies
Territorial Plans	1/100.000-1/25.000	Observational Geological Studies	Observational Geological Studies
Master Development Plans	1/25.000-1/5.000	Microzonation Studies	Observational Geological Studies,Geological-Geotechnical Studies
Implementation Plans	1/1.000	Microzonation Studies	Observational Geological Studies, Geological-Geotechnical Studies

Source*: (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006)*

3.2.1.1 Suitability for Settlement Assessment

The main purpose of the geological studies carried out in different content and detail is actually to determine the disaster hazards and risks of the area to be planned. These studies are used to carry out settlement suitability assessments that provide basic input to planning studies of different types and scales in order to prevent disasters and reduce their damage. is to do. To put it more clearly, settlement suitability assessments are the results of geoscientific studies that are the basis for planning studies. As in many countries of the world, the area examined in these evaluations in our country;

-accommodating areas (AA),

-areas that can be opened to settlement by taking various precautions (PA),

-grouped as unsuitable for settlement (UA).

The suitability assessment of the geologic survey reports for settlement is used as the basis for the planners in the preparation of the development plan. At this stage, land use decisions, usage densities and construction decisions are determined by taking into account other thresholds and analytical studies (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

Table 3.3: *Settlement Assessment Criterias*

Suitable Areas for Settlement	**Areas to be Opened for Settlement by Taking Precautions**	**Unsuitable Areas for Settlement**
These are the areas that do not carry any natural disaster hazard potential including earthquake conditions (ground growth hazard, liquefaction hazard and active fault fracture history), no engineering problems that may affect the suitability of the settlement in terms of geological-geotechnical features, and allow construction without the need to take any precautions. In the application practice of our country, these areas	These are the areas that may affect the suitability for settlement due to natural disaster hazards and geological-geotechnical characteristics within the area examined, and where construction can be made provided that certain measures are taken before or during construction. The special precautions to be taken in these areas, their reasons and details are explained in the settlement suitability reports. In the practice of our country, it	These are the areas that should not be planned and opened to construction for natural disaster hazards, geotechnical problems or technical and economic reasons within the area examined. In the practice of our country, areas that are “unsuitable for settlement, (UA)” are shown with the symbol.

Table 3.3: (Continued)

are indicated by the symbol "appropriate area, (AA)" on the maps and reports where suitability for settlement is evaluated.	is shown with the symbol of “precautionary areas, (PA)”.	

Source*: (Kubin, Sönmez, Kubin, & Kubin, 2007)*

3.2.2 Geoscientific Studies Based on Settlement Planning Process in Türkiye

The planning process in Türkiye consists of the synthesis stage, which must first be combined with research and then the data obtained. Then, the planning stage started.

Research Phase: This stage is the stage where geoscientific data are obtained. Geoscientific data are detailed at this stage according to the nature of the area to be planned. The characteristics of the area such as ground features, topographic structure, seismicity are examined in detail. This data is used as the main source for plan decisions.
Data Synthesis: The geologic data obtained at this stage are evaluated by considering urban thresholds. Because thresholds are the factors that direct the development of settlements and limit development. Uses such as sloping areas, coasts, valleys, forests, agricultural and irrigation areas, nature reserve areas, airports, military areas, energy transmission lines and some pipelines are considered as areas that can be defined as thresholds. After these thresholds are determined by data synthesis, they are evaluated together in the light of the geoscientific data from the first stage. Then, in the planning phase, the priority order of the thresholds is evaluated according to the changes in legal regulations, planning principles and policies, the size and distribution of development areas, the objectives of planning, space needs and macroform policies.

Planning Stage: In the plans to be made in the development areas, the geoscientific data are guiding and determining the priority of opening the area to settlement, the type of use it is suitable for if it is to be opened, the settlement order, density and construction criteria. In the plans, the results, evaluations and measures to be taken in the geoscientific studies are taken into consideration in the areas to be opened for settlement. Studies such as identifying, prioritizing and synthesizing thresholds are carried out with the aim of determining development areas and priorities within the scope of macroform development of settlement. According to these evaluations, relevant decisions are taken in the areas foreseen to be opened to settlement in the plan, taking into account the limitations, criteria and measures set forth by the geoscientific data, and when necessary, the compliance with detailed geological studies. Therefore, the conditions to be complied with must be clearly included in the plans, plan conditions and plan reports in a way that directs sub-scale plans, projects and construction. The reflection of geoscientific data in plan decisions takes place through the zoning plan, its design and plan notes or conditions. The plans include decisions such as land use, densities, transportation, infrastructure as well as strategic decisions for the implementation of the plan in line with the proposed macroform based on plan objectives, spatial requirements, thresholds and limitations. In development plans, depending on the geologic data, the measures against disaster hazards and risks and the decisions regarding natural and artificial thresholds are usually arranged with the plan conditions together with the drawn document. Applications in this regard are often carried out by referring to the relevant legal regulation, technical rules, norms and standards, if any. In some cases, especially in the conditions of the upper scale plans, the opinions and studies to be taken are defined as well as the rules to be followed in the lower scale plans. In the planning, the areas that will be excluded from settlement or restricted for geologic reasons should be included in the plan. In the plan conditions, notes or provisions, among other factors affecting the plan, surface water resources, disasters, earthquakes, etc. In the matters, it is stated in which cases the provisions determined in the laws and regulations in force will be applied together with the measures and decisions of the master plan (Durgun E. , 2006).

3.3 Main Problems Encountered in Urban Location Selection and Settlement Decisions Process in Türkiye

As a result of population growth in the world, planning appears as an important activity in urban areas. As a side effect of the increasing population over time, the balance between human settlements and the natural environment has therefore begun to deteriorate (De Mulder, 1996).

In order to improve the general welfare and quality of life of the society, urban planning practices must reduce these conflicts, imbalances and destructions (Bell, Environmental Geology, 1998). Such a planning must also be in a multi-disciplinary approach for various human needs (De Mulder, 1996).

3.3.1 Inadequacies Arising from Legislation and Practice in Türkiye

Organizing and creating the environment in the most defensive way against such destruction is one of the main purposes of physical planning and narrowly urban planning. The basic element of the plans to be prepared in this process is to ensure the highest level of security against disasters, while requiring the maximum use of the land. The development plans to be created for this purpose in our country constitute the focal point of the measures that can be taken in advance against all disasters, especially earthquakes (Uzunçıbuk, 2009). These plans, which address smaller areas, will be able to achieve their purpose if they can be produced in accordance with the settlement plans prepared on a national, regional and even national scale. Unfortunately, due to this situation, which we have not experienced in our country, plans that are inconsistent with each other on the upper and lower scales are produced (Uzunçıbuk, 2009). As a result, it has become impossible to talk about harmony in this process.

The following results emerge in Türkiye regarding today's legal regulations, laws, regulations, circulars and strategies, geoscientific data-planning relationship. In practice, the relationship of geoscientific data with planning is more pronounced and defined at lower scales, while it is undefined and uncertain at higher scales (Kubin, Sönmez, Kubin, & Kubin, 2007).

Table 3.4: *Plan Levels- Geoscience Data Relationship*

Plan Stages	Plan Name	Scale	Geoscience Data	Explanation
Upper Scale Plans	**Regional Plans**	1/250.000-1/100.000	Uncertain	Geoscience Data-Planning Relation Undefined
	Territorial Plans	1/100.000-1/25.000	Uncertain	Geoscience Data-Planning Relation Undefined
Development Plans	**Master Development Plans**	1/25.000-1/5.000	Geological and geotechnical studies for residential purposes	Geoscience Data-Planning Relationship Insufficient
	Implementation Plans	1/2.000-1/1.000	Geological and geotechnical studies for residential purposes	Geoscience Data-Planning Relationship Insufficient

Source: *(Kubin, Sönmez, Kubin, & Kubin, 2007)*

The Metropolitan Municipality Law No. 5216, which was enacted in 2004, defines the Development Master Plan scale for Metropolitan Cities as 1/25.000. However, the geoscientific studies that will constitute data for the 1/25.000 scale Development Master Plan of the Metropolitan Municipality are not defined in the law. On the other hand, there is no clarity in the development legislation regarding the nature and use of geologic data in the process of preparing higher-scale plans, the regional plan and the territorial plan. This is an important deficiency in high-scale planning that makes it difficult to identify risk factors based on the danger of natural disasters within the scope of geoscientific data and to develop a plan strategy related to this

(Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

When the development legislation in force is evaluated in terms of the integration of geoscientific data into the planning, it is a legal deficiency that there is no clear provision in the Development Law that guides this issue at the level of principle and substance. It is seen that the deficiencies in this regard are mostly directed by the Ministry circulars. The legal basis of the geological-geotechnical surveys based on these development plans is weak. It should be ensured that the legislation in force has clear and unambiguous guidance in the Development Law as a basis for the planning phase on the integration of geoscientific data into planning.

In addition, alternative development and evaluation methods that need to be done during the transition to plan decisions are part of the planning process. At this stage, macroform or development alternatives should be developed to include differences in decision in exceeding thresholds or taking priority. This issue is ignored in the planning studies carried out in our country and often directly to the plan decisions. However, the issue of alternative production and evaluation is an important stage of planning, where all threshold and structural factors affecting plan decisions based on plan objectives are evaluated together, and in this context, all factors affecting the formation of strategic plan decisions such as macroform, use, intensity and transformation, including disaster hazard and risk reduction strategies, can be addressed together and in a participatory process. The fact that alternative production and evaluation techniques are not sufficiently included in the specifications, the inability to internalize this subject in planning education and practice, and the expectations of the planning administrations focusing on the final product rather than the process, the habits of the planners in practice, emerge as the main negativities in the alternative development and evaluation phase (Kubin, Sönmez, Kubin, & Kubin, 2007).

For this reason, instead of the traditional planning approach in our country, it is necessary to develop a disaster-responsive planning approach in order to prevent disaster hazards and reduce disaster risks. The planning and implementation process should be implemented from the largest scale to the smallest scale, covering disaster sensitive planning principles and risk management. In this type of planning and implementation process, plans of all scales for disaster areas should first be prepared by taking into account the geological and geotechnical studies. In this way, it is ensured that urban hazards and risks are determined. In this way, it is ensured that urban hazards and risks are determined. In the planning process, starting from the site selection decisions regarding different land use types in the upper scale plans, to the settlement, construction and density decisions in the lower scale plans, the settlement areas will not be affected by the existing dangers and risks, or at least requires planning to be affected. (Durgun E. , 2006). In the traditional planning approach carried out in our country, "geological and geotechnical studies that form the basis for the zoning plan" are used in order to form a basis for plans of different scales. However, in our country, the necessity of these studies to vary according to the type, scale, scope and content of the plan is ignored. The studies that should be activated at this stage should be “microzonation” studies. Geological and geotechnical studies to be used as a base for upper scale plans and microzonation studies for lower scale plans must be done. The identification of the competent institutions for the preparation of microzonation maps as administration, public institutions and organizations and ministries prepares the ground for conflicts of authority between the Ministry and local administrations. In addition, considering the lack of coordination and communication between institutions in Türkiye, the preparation of microzonation maps by different institutions for the same areas may be on the agenda. This situation will lead to waste of time, labor and resources, and there may be problems arising from differences in approach and method both in the preparation of microzonation maps and in the integration of these data into planning (Afet İşleri Genel Müdürlüğü, Yerbilimsel Verilerin Planlamaya Entegrasyonu El Kitabı, 2006).

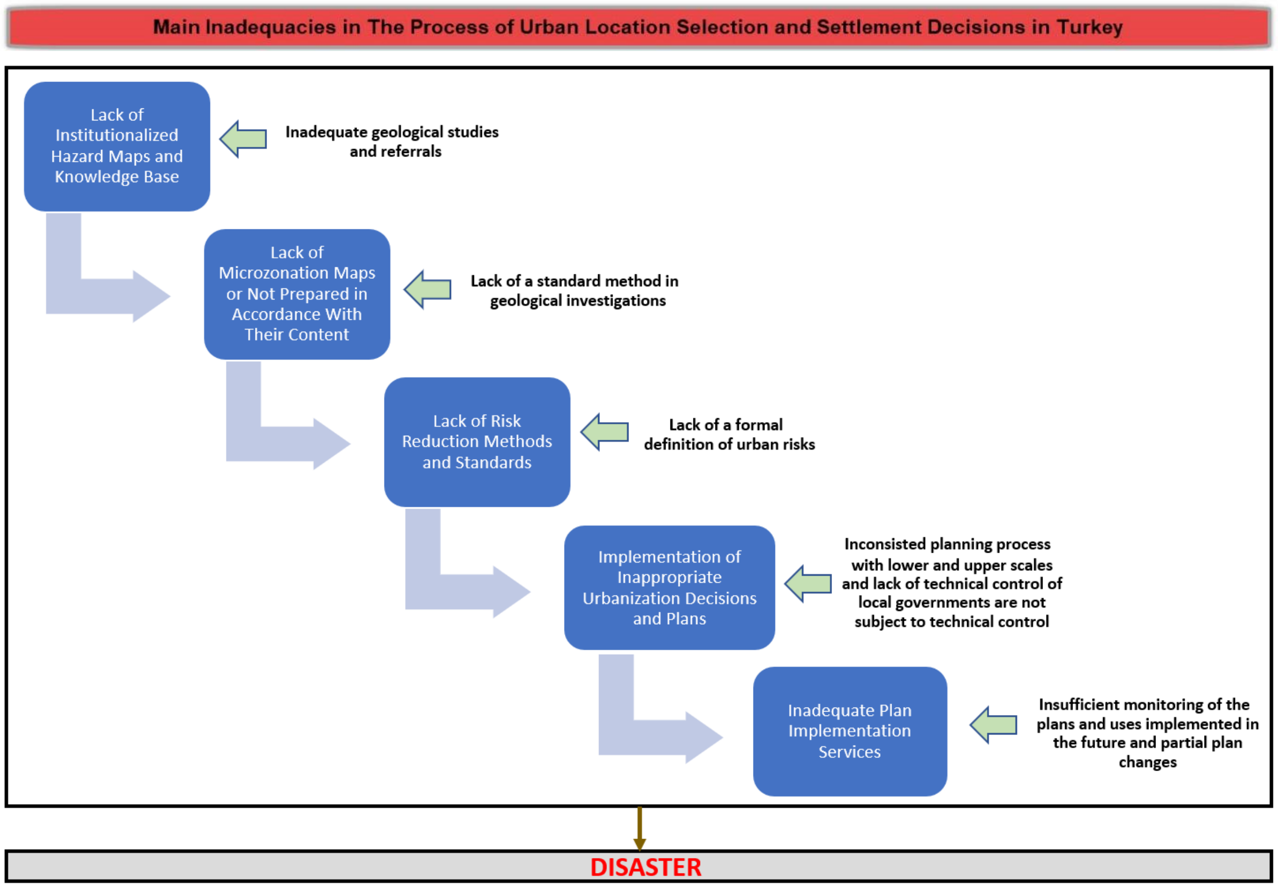


Figure 3.1: *Main Inadequacies in the Process of Urban Site Selection and Settlement decisions in Türkiye*

Source: *(Author Representation)*

In the schematic model above, the main problems or inadequacies that are observed in the processes of urban site selection and settlement decisions in Türkiye are presented in Figure 3.1. According to this figure, "areas of high disaster risk" have been formed in urban areas in our country, with disaster hazards arising from geological structure, land use, construction, infrastructure and defects arising from inspection. In today's planning process, the planning methods applied for the areas to be developed are also insufficient. While making settlement decisions, it is seen that the problems cannot be solved with traditional planning methods. In the plans to be made for the areas to be opened for development, issues such as geological and geotechnical data, priority of opening the area to settlement, type of use, settlement pattern, density and construction criteria are guiding and determining. In this process, there are two stages to be implemented.

In the rapid urbanization process of Türkiye, many city plans have been prepared and put into effect. In order to solve the housing problems that arise with the increasing population in the cities, either the expansion of the existing settlement area or the reuse of the areas that were previously excluded from planning because of their geological structure and physical characteristics are on the agenda (Arık, 2004). In this process, the limitations of areas that are found to be risky especially for disaster hazards have been ignored. In order to prevent possible damages that may arise from this situation, it is necessary to control the effects of such a development on the natural environment. For this, the geological and geotechnical conditions of that region should be evaluated very well.

In this process, the information that city planners will ask from geologists or geological engineers for an area they are considering to develop can be grouped into two main categories:

1. Land use potential of the mentioned areas,
2. The geological constraints controlling this potential (Kasapoğlu, 1998).

The flowchart of this process is shown in Figure 3.2.

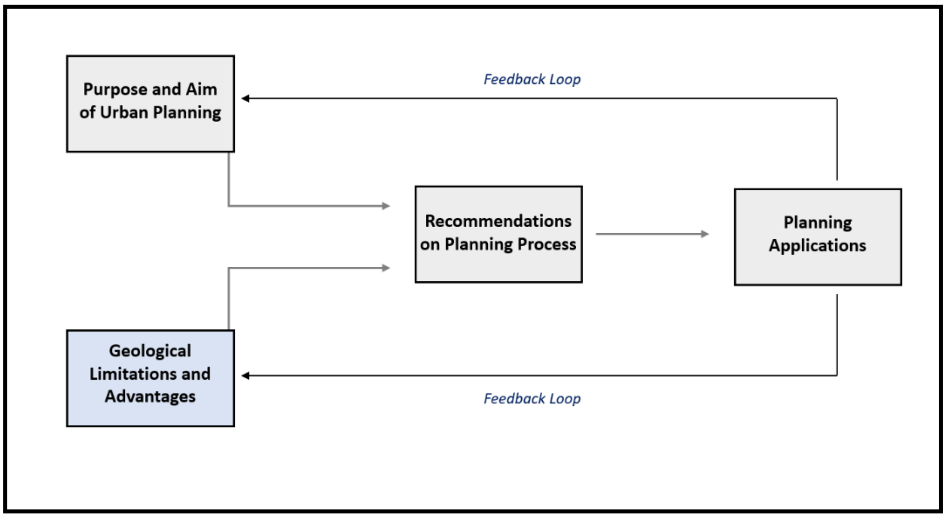


Figure 3.2: *Flow Chart of Planning Process*

Source: *(Author Representation)*

However, after this information is obtained, another problem occurs in our country. The geology and geotechnical features of a region, rather than controlling the use of that region; it significantly affects the economy of the urbanization project by revealing the geological limitations and/or advantages related to the physical characteristics of the region. Therefore, local ground conditions integrated with technical information must be taken into account in the analysis process of the planning. The determination of the procedures and principles for the preparation of disaster assessment maps, geological and geotechnical survey reports by the regulations issued by the Ministry creates significant problems in practice. In fact, the necessity of sharing powers over the preparation of geoscientific studies among different engineering disciplines has been overlooked. For this reason, it has become necessary to re-evaluate the issue in order to ensure its internal integrity and to prevent uncertainties in practice and conflicts of authority (Kubin, Sönmez, Kubin, & Kubin, 2007).

The effect of soil conditions on damage in a possible disaster is not only a one-way relationship depending on the ground, but a two-way relationship depending on the interaction of the structure and soil properties. In order to prevent possible damage that may arise from this interaction, it is imperative that the effects of such a development on the natural environment be controlled. For this reason, by determining the construction conditions suitable for the soil types to be revealed in the research, significant cost advantages will be provided and the increase of damage will be prevented at the same time. However, such a solution will require interdisciplinary work. However, in our country, this is done only in line with the recommendations of the geological engineers together with the planners, and the planners take full responsibility in this process.

At this stage, as a problem affecting the whole process, although geological studies are also taken as data in the plan preparation process, local pressure groups always find ways to arrange these determinations and reports in a way that does not interfere with their own interests, within the scope of the zoning planning process in our country. For this reason, it is of great importance that the determinations of the ground be obtained independently from the preparation process of the development plan. The fact that geoscience determinations are open and accessible to everyone will turn the relations upside down and lead investments to be directed to safe areas (Balamir & Bayhan, 2011).

Unfortunately, the lack of using today's scientific and technical possibilities and advanced methods that guide planning in the urban planning process can be considered as another problem in this process. However, technological developments in earth sciences allow geoscience studies to be measured with deeper and more variables. In this respect, a long-term geoscience database can be developed, especially for high-risk settlements (Durgun E. , 2006). "Microzonation maps", in which disaster hazards and risks are evaluated using advanced geoscience data, are studies and documents that will guide planning with sound data (Durgun E. , 2006).

Earth science studies, which should be taken as a basis in the planning process, in terms of their content and characteristics; it can be divided into 'Observational Geological Studies' first, then 'Geological-Geotechnical Studies' and, at the smallest scale, 'Microzonation Studies'. Geoscience studies according to plan levels and usage areas; the studies that are the basis of the plans at the scale of the region and territorial order are observational geological studies. These are also called disaster hazard maps or integrated disaster hazard maps. Geological-geotechnical surveys and microzonation maps are the basis for studies at the scale of master and implementation plans. Based on the results of all these study reports, the "Settlement Suitability Evaluation", which is a synthesis, is carried out. Settlement suitability assessment is a synthesis study that includes definitions of areas that guide plan decisions in planning studies at different scales and precautions to be taken in these areas (Durgun E. , 2006). In order for this evaluation to be made correctly, the studies that are the basis for plans of different scales must exist separately. However, another fundamental problem in making site selection and settlement decisions in our country is the lack of integrated hazard maps and microzonation maps, which are more detailed and specific studies for all settlements under disaster risk. It should be well known that consistent, stable and real disaster management is possible by knowing the disaster plan of that city very well from the highest scale to the lowest scale and by preparing the disaster plan very well. Microzonation studies, which will be the basis of this study, will be one of the most important components in the preparation of disaster plans, since they are the studies that will form the basis of the disaster reduction phase of disaster plans.

These studies are also called “seismic or seismic microzonation” (Ergünay, 2006). “Seismic Microzoning (Earthquake / Seismic Microzoning)” is defined by Sherif (1984) as “a process aiming at regular land use to reduce earthquake damages” and “to realize the regular use of lands in a plan, in the face of earthquake effect, geological, seismological (geophysical) and geotechnical factors to deal with the creation of economically, socially and politically cohesive and usable regions”. Microzonation against earthquake hazards has been defined by Hays (1980) and Sharma and Kovacs (1980) as the division of a geographical region into small regions according to the behavior of the ground under ground shaking or slope sensitivity. Nigg (1982) stated that the purpose of microzonation is to divide the risky areas into small parts in order to implement the right plans and policies that can minimize the damage that may occur after the earthquake. Finn (1991) defines microzonation as procedures involving the development of calculations for seismic hazards for building design, taking into account local soil conditions.

Within the scope of microzonation maps, this concept in our country started as studies aiming to estimate the earthquake hazard at local scale and to reduce earthquake damages by making appropriate urban use decisions in areas to be opened for new construction after 1999. In this context, as a product of a joint effort with the financial support of the Swiss Development and Cooperation Organization (SDC) under the management of the Disaster Risk Management Institute and the General Directorate of Disaster Affairs of the Ministry of Public Works and Settlement, two guide studies which are called, “Microzonation for Municipalities: Handbook” and “Microzonation for Municipalities: Latest Scientific Situation” were conducted (World Institute for Disaster Risk Management, 2004). However, these studies could not be spread throughout the country and could not be translated into practice. Most of the disasters we have experienced prove this situation. The factors affecting the site selection decisions in this process in our country and the flow diagram of urban design are given in Figure 3.3.

In Figure 3.4, during the evaluation of seismotechnical data, the preparation of microzonation maps during the determination of urban risk factors on a micro scale is one of the most important stages affecting this process. The usefulness of these maps also depends on their effective use in land use decisions and in the creation of infrastructure systems. In other words, the existence of such maps is not enough. Density and land use decisions of the buildings to be taken under the guidance of these maps, the physical form of the buildings, transportation arrangements will be the binding elements in the creation of a disaster-resistant physical environment. At the same time, the integration of the disaster factor into physical planning at the local scale is necessary not only in urban and town-scale settlements, but also in neighborhood unit and even block and parcel scale planning (Uzunçıbuk, 2009).

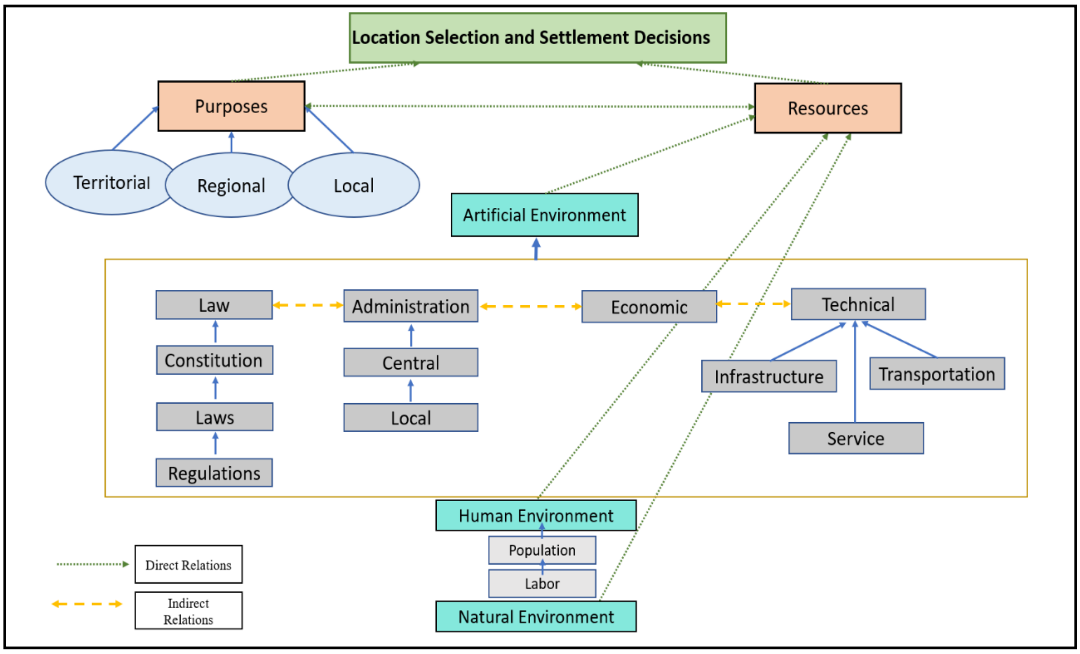


Figure 3.3: *Factors Affecting the Location Selection and Settlement Decisions*

Source: *(Author Representation)*

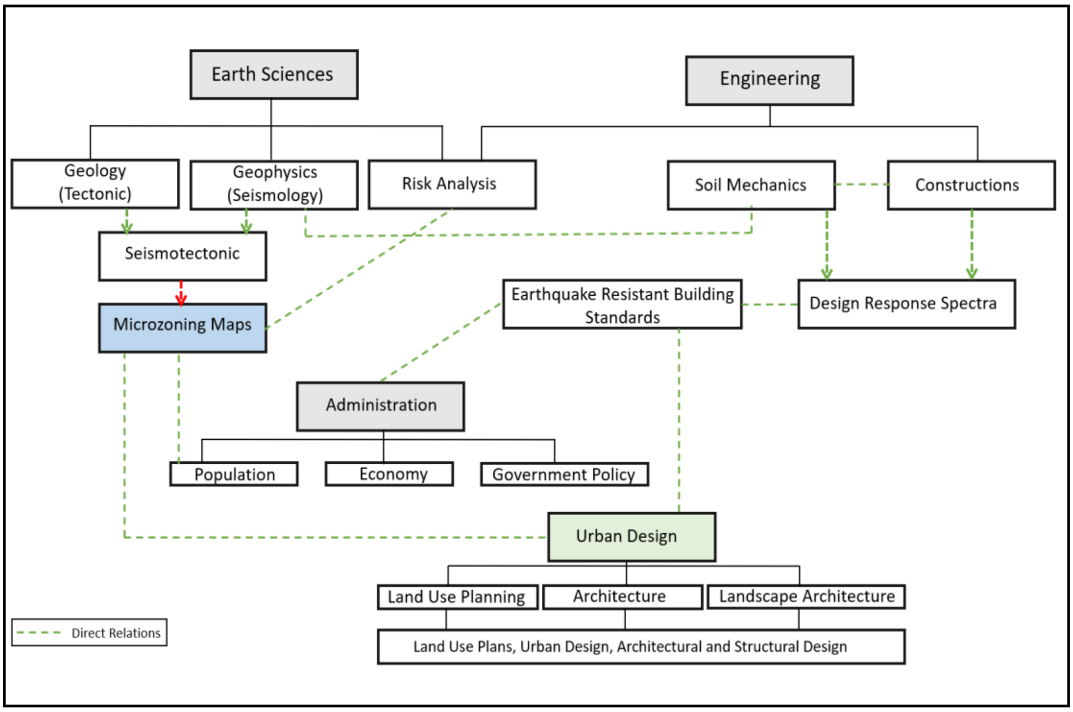


Figure 3.4: *Developed Urbanization Process Flow Chart*

Source: *(Author Representation)*

In 1993, microzonation for the three key events "soil amplification","slope sensitivity" and "liquefaction" was introduced by members of the Earthquake Geotechnical Engineering Committee of the International Association of Soil Mechanics and 'Foundation Engineering' (later 'Geotechnical Engineering'). A guide study was conducted in which the principles were explained (Özçep, 2007) . In order to reduce the risk caused by earthquakes and to ensure the safety of structures under earthquake loads, dynamic effects are taken into account in earthquake resistant building design regulations in many countries of the world (Özçep, 2021). Unlike this case, in the microzonation guide study, evaluations for zoning purposes are made for three types of parameters such as local ground response, slope sensitivity and liquefaction.

Stages of the Microzoning

	First Stage (General Zoning)	**Second Stage (Detailed Zoning)**	**Third Stage (More Detailed Zoning)**
Soil Amplification	Historical earthquakes, tectonic and geological structure of the region, geological maps and interviews with local people	✓ Geotechnical investigations ✓ Microtremor measurements	✓ Detailed geotechnical investigations ✓ Soil behavior analysis ✓ 1 and 2 dimensional analyzes of soil layers
Slope Stability	Historical earthquakes, tectonic and geological structure of the region, geological maps and interviews with local people	✓ Aerial photographs ✓ Land survey with remote sensing methods ✓ Vegetation and precipitation information of the region	✓ Detailed geotechnical investigations ✓ Slope stability analyzes
Liquefaction	Historical earthquakes, tectonic and geological structure of the region, geological maps and interviews with local people	✓ Aerial photographs ✓ Land survey with remote sensing methods ✓ Interviews with local people	✓ Detailed geotechnical investigations ✓ Liquefaction analyzes
Map Scale	Between **1/1.000.000 - 1/500.000**	Between **1/100.000 - 1/10.000**	Between **1/25.000 - 1/5.000**

Figure 3.5: *Stages and Criteria in Microzonation Studies*

Source*: (Lav, 1994)*

Evaluations that will be the basis of the implementation plans regarding possible variations in earthquake intensity even in very small urban areas or possible successive disaster types such as landslides and soil liquefaction after an earthquake form the basis of this study (Özçep, 2021). In this way, a detailed study will be the main determining map during the urban settlement decisions. The maximum levels that the ground motion parameters will reach during the earthquake and the boundaries of the secondary effects such as ground liquefaction, landslides, and floods that will occur due to this effect can be shown in detail by means of these maps. In fact, these maps should be used as a guide in distinguishing earthquake scenarios that will occur even in different parts of the same city. Seismic Microzonation Criteria or stages are given in terms of "Soil Amplification" or "Ground Motion Level", "Liquefaction", "Slope Stability" parameters in Figure 3.5.

As can be seen, microzonation studies are a multidisciplinary team work. In this context, task distribution should be made in the studies to be done on the preparation of microzonation maps. From the point of view of the distribution of authority and responsibility; to geological engineers for the determination of active faults, possible surface fractures and surface geology, and other natural disaster hazards such as landslides, avalanches, rockfalls; geophysical engineers for the determination of features such as seismicity in the region, historical earthquakes, attenuation relations, underground structure of the area, P and S wave velocities, ground dominant periods, soil amplification, behavior spectra; civil engineers are needed to determine the mechanical properties, liquefaction, differential settlement and lateral spreading of the soils forming the area (Ergünay, 2006).

As a result, microzoning maps are not prepared, which are the basic measures in land use and urban planning, even in most units with high earthquake risk, although they are unfortunately under the jurisdiction of local governments in our country (Şengezer, 1999). On the other hand, there is no provision in the zoning legislation such as making micro-zoning maps or stipulating construction based on them. Only the ground and geology reports that have become procedural are considered sufficient (Genç, 2007). As a result, disaster plans and development plans remained unrelated to each other. For this reason, it is inevitable that the margin of error in the planning decisions taken at the local scale is very large.

Another fundamental problem we encounter in our country during the site selection and settlement decisions is that the urban risk phenomenon is often overlooked in the development plans prepared. While international urban risk reduction efforts are seen as the most important policy implementation area in the world and comprehensive measures are encouraged and implemented even in small settlements, disaster policy in Türkiye continues to be a subject that cannot be talked about and unfortunately almost censored (Balamir, 2011). As a result of this situation, the society is excluded from this process, the principle that the issue of urban security will be achieved through participatory processes is not recognized, and the society is only seen as a customer.

Despite the fact that many new measures were taken with the motto "nothing will be the same" after the 1999 Kocaeli Earthquake in Türkiye, it is debatable how much of the measures taken serve to prevent and eliminate seismic hazards at the urban scale (Balamir & Bayhan, 2011). The main indicator of this is that the seismic hazard measures taken after the 1999 earthquake that we experienced in our country remained only at the size of a single structure. As a result of the belief that the measures at the individual building scale are sufficient and that there is no other issue or party regarding the earthquake hazard, it defines urban risk in Türkiye based only on the engineering perspective and professional practices. In other words, this approach considers seismic safety in cities only in terms of building units, and makes the assumption that this can only be provided by a certain occupational group. In other words, the needs at the urban scale are not addressed. The "Regulation on the structures to be built in disaster areas", which only focuses on the settlement decisions, does not deal with the periods before and after the construction (Balamir, 1999). In this regulation, it is not mentioned how the necessary regulations will be made, how the measures will be taken and inspected.

At the stage of identifying these risks, the need to produce new policies that adopt the principles of participatory preparatory and decision-making studies with local communities, taking multifaceted measures and seeing local governments as responsible units is not implemented in Türkiye. Against the applied understanding and approach, it is a very clear fact that urban risks are determined not only by unstable buildings, but also by many factors. Making collective revisions with the participation of local communities and administrations instead of strengthening policies on the basis of individual buildings will be the key to creating more qualified and safe urban areas. At this stage, the risks that may be encountered in the urban dimension will be minimized by the development and implementation of the necessary "control" mechanisms. With this approach, establishing a system that is compatible with the new international disaster policy and where responsibilities are shared in risk reduction through participatory efforts will form the basis of the disaster planning.

It has been mentioned before that local governments in our country are the main units that direct urban development due to the decisions they take on cities. However, among these decisions, insufficient control over the ones related to urbanization, ignoring the priorities such as local political relations, social benefits and security is another problem we encounter in the process of urban location selection and settlement. Unfortunately, the inability of local governments to fully fulfill their duties regarding supervision, zoning and construction paves the way for urban developments that are not resistant to disasters. The different levels of participation that should be in this process are still not clearly defined in our country. Although there are some definitions (city council, etc.) in local administration laws, they are either passive or under arbitrary use.

According to the planners, the pressure of the approval authority on the planner, the direct intervention of politics and capital in the plans; it causes the formation of plans that prioritize the interests of certain power groups instead of the public interest, or the plans are changed in a way that takes these interests into account (Öktem Ünsal & Aksümer, Türkiye’deki Serbest Planlama Bürolarının Coğrafyası: Mekansal ve

Sektörel Analiz,, 2021). The tendency of various groups to stay out of the planning decisions and populism (Tekeli, 1991); as a result of the division of physical planning among various ministries, partial and sectoral approaches in the plans come to the fore and the effectiveness of the plans decreases (Eke, 1998); local characteristics (climate, disasters, etc.) of the region where the planning is made are not taken into account; the inability of the plans to predict the situations that the city may face in the future can also be listed as the reasons why the plans made could not reach their goals (Genç, 2007). For such reasons, plans are produced that can be considered unqualified and do not serve the main purpose.

In urbanization plans prepared at different geographical scales, hazard identification, risk priorities, and the definition and programming of projects within the scope of avoidance plans are subjects that require separate expertise and cooperation. It is clear that the plans that deal with the subject in different dimensions will be produced as plans that serve the purpose. In this case, first of all, it may be possible to minimize the risk of disaster when it is ensured that there is no external pressure or intervention in any of the teamwork to be carried out with different disciplines. Because urbanization and construction are closely related to the cycles of the capital accumulation system. From this, the forces and mechanisms that prevent disaster-sensitive and technical mindset behaviors and solutions arise. Ensuring the superiority of technical intelligence and on-site inspections, guidance and institutionalization supporting this process are of great importance in this process. Necessary institutions and organizations, social organizations and consciousness are needed for the control mechanisms to be developed after this application is brought down to the local level. When all these decisions taken afterwards are put into practice, it will be impossible to talk about the inaccuracy of the site selection decisions that cause the crucial consequences of disasters, the wrong relationship between the soil and the structure in relation to the settlement decisions, and the insensitivity of the construction decisions to the disaster phenomenon as a result.

In addition, the biggest mistake made after the preparation of the master plans, where urban settlement decisions are taken, is the fragmentary plans, which are defined as zoning plan changes. Local governments and people who can be described as capital-rich have a high determinant on such plans. Because, the decisions taken regarding the plan change are taken by politics and capital. In our country, the duty of planners is to plan these decisions or to comply with the legislation. It is expected from the planners to solve the local property-related demands without frightening the citizens and to produce plans in accordance with the legislation, and the plans that realize these are called successful both by many planning bureaus and by local administrations (Uysal, 2021). However, we know that the politicians who are active in the approval process of the plans generally do not have sufficient information on the subject. In today's Türkiye, city planners or other technical staff working in local governments or other public institutions have little influence on politicians. Again, many planners stated that local governments see the planning as a system that controls the rent and the planning as a system that distributes the rent states that they have signed under the rent-oriented plan decisions that contradict (Öktem Ünsal & Aksümer, 2019). The planners, whose duties are instrumentalized by the rent-seeking actors in the process, are prevented from preparing plans in a way that will prioritize the technical mind in this oppressive environment. In this case, cities driven by rent-based pressures are the main reason for disasters to turn into crises. Overcoming this crisis environment in the cities will only be possible if the existing social and urban policies are replaced by policies that put nature and the society in general (Uysal, 2021).

In this context, it is necessary to remove the political and capital pressure on the planners so that the plans to be prepared considering the urban risk factors in Türkiye can be prepared in a qualified manner. In this way, it will be possible for planners to produce plans in which they demonstrate their professional knowledge and values. Otherwise, the pressure created by the current policy on city planners means not only the erosion of a profession, but also the irreversible destruction that threatens our living spaces (Uysal, 2021).

3.4 Evaluation of Building Stock in Türkiye in terms of Earthquake Performance

It is the responsibility of urban planners, architects and engineers to create seismically resilient cities in cities within tectonically active regions and thus to secure the related communities. However, since the structural design process in Türkiye is not conducted within an ideal interdisciplinary approach, the responsibility for earthquake resilience is left only to the engineers. As a result of the disconnected development of disaster-related professional relationships in our country, the disasters that occur cause great losses. In order to prevent such losses, the resilient design should receive the necessary input from related disciplines and the dynamic behavior of the structure should be decided correctly. Seismic design codes used as a guide in this process are of great importance. The earthquake codes draw attention to the consequences for any situation that will create irregularity in terms of the seismic behavior of the building. As a result, buildings that are designed and built in accordance with seismic resistance design principles emerge.

The Turkish building stock has undergone quantitative and qualitative changes in the last 50 years in order to meet the housing needs of the rapidly growing population and immigration. The performance of the cheap and large numbers of buildings produced between 1970 and 2000 in the earthquakes clearly demonstrated the existence of our housing stock with poor seismic performance. The buildings produced after 2000 have differentiated from the existing building stock due to the current earthquake codes, changing social needs, developing construction techniques and advances in material technology. Therefore, this situation has led to a change in the general characteristics of the Turkish building stock.

The existing building stock in Turkey has been determined according to the Building Census Survey data of 2000 (TIS and the Building Occupancy Permit Statistics of 2001-2015 provided by the Turkish Statistical Institute. According to this data, the percentage distribution of buildings at the provincial level in Turkey according to their intended use is shown in Figure 3.6. In particular, residential buildings built before 2000 constitute the largest part of Turkey in general.

According to the 2000 Building Census Survey, it is seen that the residential buildings are 85.9%. On the other hand, it is also seen that this rate is 85.7% according to 2001-2015 data. Based on this comparison, it can be concluded that the distribution of the Turkish building stock according to the intended use of the building is independent of time. Buildings used for residential purposes correspond to approximately 86% of the entire building stock. In this context, it can be said that most of the buildings that make up the Turkish building stock are residential buildings designed according to the old earthquake specifications (Ay & Eroğlu Azak, 2021).

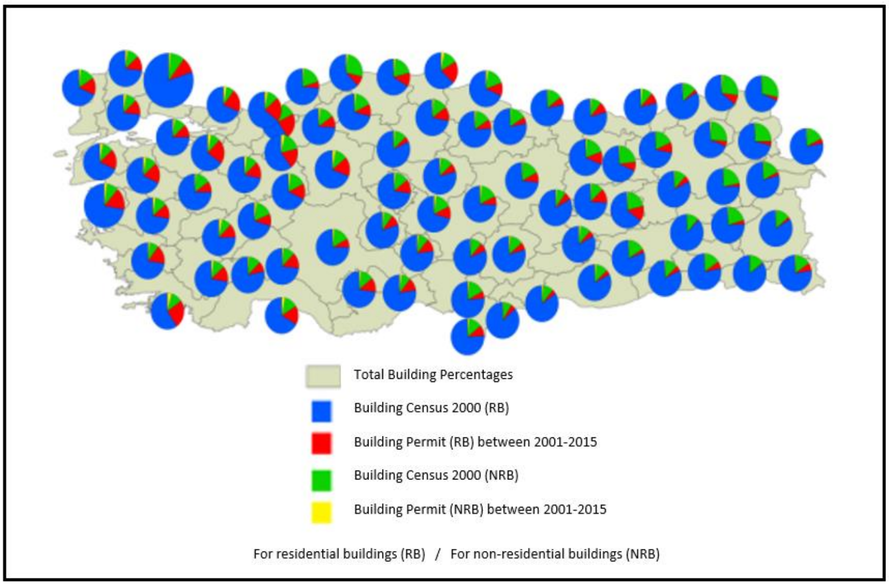


Figure 3.6: *Proportional Distribution of The Buildings in the Combined Building Database According to the Purpose of Use on the basis of Provinces*

Source: *(Ay & Eroğlu Azak, 2021)*

When the data obtained according to the same studies are examined, the building census data for the year 2000 and the building occupancy permit statistics for the years 2001-2015 show great differences in the building structural system. Table 3.5 shows the ratios of buildings included in the 2000 Building Census Survey statistics according to their intended use and structural system types. On the other hand, the distribution of buildings with building occupancy permits between 2001-2015 according to their intended use and structural system type is presented in Table 3.6.

Table 3.5: *The percentage of buildings with respect to building use and structural system in 2000*

Purpose of usage	**Masonry**	**RC Frame**	**Prefabricated**	**Tunnel Formwork**	**Total Percentage (%)**
Residential	44.43%	41.29%	0.17%	0.076%	85.97%
Non-residential	6.72%	7.18%	0.12%	0.005%	14.03%

Source: *(Ay & Eroğlu Azak, 2021)*

Table 3.6: *The percentage of buildings with respect to building use and structural system between 2001-2015*

Purpose of usage	**Masonry**	**Steel Frame**	**Wood Frame**	**RC Frame**	**Composite**	**Prefabricated**	**Total Percentage (%)**
Residential	5.19%	0.18%	0.20%	79.29%	0.51%	0.30%	85.67%
Non-residential	0.51%	0.91%	0.06%	11.51%	0.36%	1.00%	14.33%

Source: *(Ay & Eroğlu Azak, 2021)*

As seen in Table 3.5, approximately 86% of the building stock built before 2000 consists of masonry and reinforced concrete frame type buildings used for residence purposes. When viewed independently of the purpose of use, it is seen that the buildings with masonry and reinforced concrete frame type system constitute 99.6% of the building stock before 2000. The data presented in Table 3.6 reveal that approximately 91% of the buildings that have received building occupancy permits between 2001-2015 are made of reinforced concrete buildings. On the other hand, it has been observed that buildings with masonry type of buildings have a very low rate (5.7%) in the building stock produced after 2000. Buildings with other type of structural systems constitute only 3.5% of the building stock in Turkey (Ay & Eroğlu Azak, 2021). In this context, it can be said that reinforced concrete frame types of buildings have a great importance in the seismic performance calculations for the building stock after 2000.

In addition to these information, the number of stories is a parameter that significantly affects the seismic performance of reinforced concrete frame structures. Data from the 2000 Building Census Survey classified buildings as 1 to 3, 4 to 6, and 7+ storeys as low, medium, and high rise, respectively. Figure 3.7 shows the relative change in the percentage of buildings with different storey numbers by years. The graph on the right of this figure shows that as of 2015, mid-rise buildings constitute the majority of the inventory in Turkey (Ay, Eroğlu Azak, & Erberik, 2016).

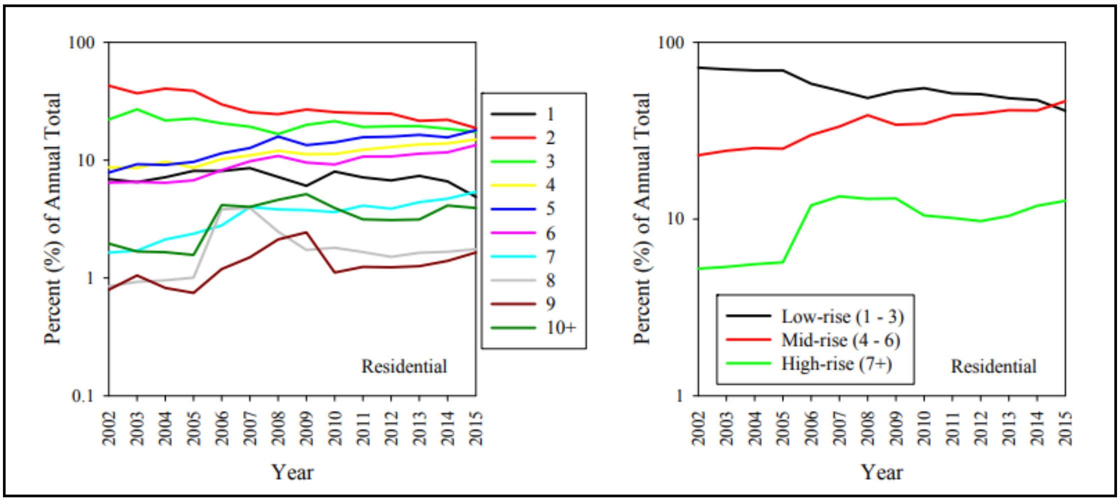


Figure 3.7: *Annual Variation of Residential Building Number of Stories Percentage*

Source: *(Ay, Eroğlu Azak, & Erberik, 2016)*

Furthermore, Figures 3.8 and Figure 3.9 show the percentages of low-rise and mid-rise buildings at the provincial level, respectively. While low-rise buildings constitute approximately 53% of the inventory, 36% of the buildings for which occupancy permits were obtained between 2002-2015 are medium-rise buildings. Figures 3 and Figure 4 present the majority of low-rise buildings in the Turkish building stock. However, the last data shown in the right panel of Figure 3.7 indicate a changing trend (Ay, Eroğlu Azak, & Erberik, 2016).

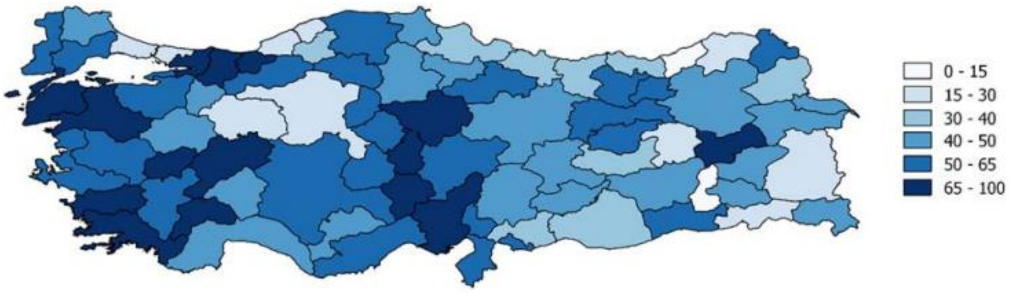


Figure 3.8: *Low-rise Building Percentages in Turkey (at province level)*

Source: *(Ay, Eroğlu Azak, & Erberik, 2016)*

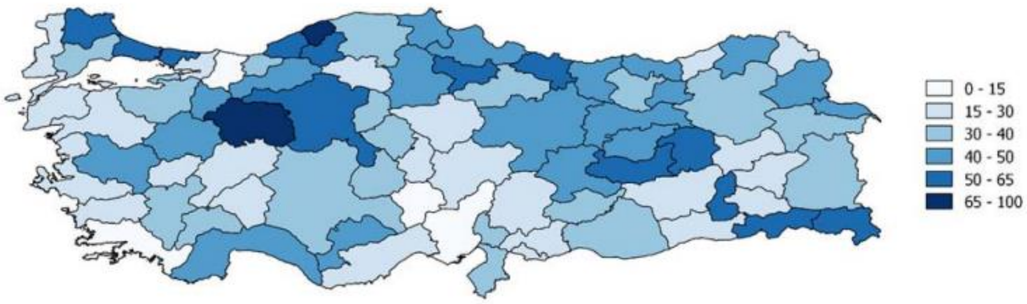


Figure 3.9: *Mid-rise Building Percentages in Turkey (at province level)*

Source: *(Ay, Eroğlu Azak, & Erberik, 2016)*

When all these data are examined, reinforced concrete is the construction material of our age in terms of its ease of application, economy and easy material supply. However, issues such as inadequate engineering service (inadequate structural system, wrong structural member layout, inadequate detailing of structural members), architectural problems (building irregularities, adjacency/pounding, soft storey, discontinuous frame, overhang and torsional problems), poor workmanship and poor material quality, lack of building audit and development plan amnesties have made reinforced concrete structures produced between 1980 and 2000 the most vulnerable group in our building stock.

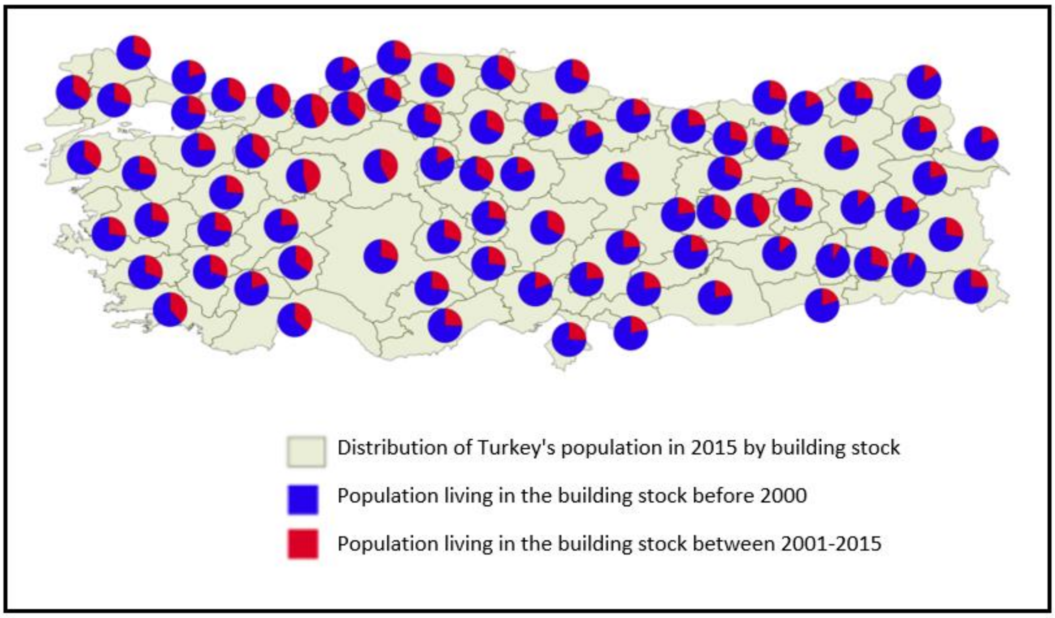


Figure 3.10: *Distribution of the Population in 2015 to the Building Stock Produced Before 2000 and Between 2001-2015 on a Provincial Basis*

Source: (Ay & Eroğlu Azak, 2021)

Figure 3.10 shows the distribution of Turkey's population to the building stock produced before 2000 and between 2001-2015 on a provincial basis. Accordingly, as of 2015, it is seen that a large part of the population lives in buildings produced before 2000, which are thought to be poorer in terms of earthquake performance. It has been observed that this rate which is approximately 75% for Turkey in general, is also valid for many provinces and mostly varies between 60% and 85% (Ay & Eroğlu Azak, 2021). In this context, it can be said that the population of the country under the risk of earthquake has a large proportion.

3.4.1 Main Problems Encountered During the Construction Decision Making Process in Türkiye

At the initial stage of a project, whether it is a single building or a layout, the entire plan and its constituent masses and details on the scale of the building are determined to meet the needs and demands. All the decisions taken at this stage affect the earthquake behavior deeply. Since earthquake waves can reach the region from any direction, structures must be able to withstand lateral and vertical loads. Obviously, the best approach to this type of problem is to design structures and layout to withstand all anticipated forces, whatever their source. Accordingly, the plan would be symmetrical in both axes and there should be no irregularities like in Figure 3.11. In other words, buildings that can be characterized as structurally irregular, especially in the event of an earthquake, will face higher risks. Constraints imposed by terrain conditions, demands, regulations and other criteria constantly interfere with the realization of such a formal design approach that requires symmetry in all directions. On the other hand, it is undeniable that buildings that are architecturally designed more smoothly and symmetrically are deemed to be more resistant to earthquake forces.

Depending on the magnitude and severity of the earthquake in the earth's crust, structural damage may occur. At the core of avoiding severe structural damages is the issue of earthquake resistant building design. When it comes to earthquake resistant structure, the rigidity, strength, ductility and energy consumption properties of the structure are of importance. Because the earthquake creates different effects on the structures with some additional forces and mostly horizontal effects. Structures that cannot resist these lateral effects are either completely destroyed or damaged slightly or moderately. This situation ultimately causes loss of property and life. In order to prevent the losses, the loads affecting the structures during an earthquake should be determined beforehand and taken into consideration.

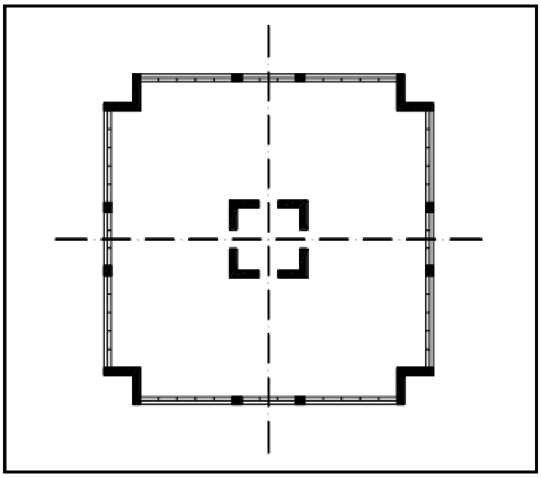


Figure 3.11: *One Symmetrical Building Plan Example*

Therefore, it is absolutely necessary to have a comprehensive knowledge of how structural variations affect fundamental seismic behavior from the very beginning of the design process. From this point of view, it should be strongly defended that from the beginning of the plan-design process, urban planners and designers should work in contact with architects and civil engineers of both disciplines. Working together at the very beginning of the decision-making process and with many more design options available will also avoid design strategies that are detrimental to the purpose that could lead to the opposite of the desired result. At this point, this unity should be ensured not only in the design phase of the building but also in the building audit phase. Unfortunately, this situation cannot be carried out as interdisciplinarily as it should be in our country.

In this context, the main encountered problems or inadequacies that are observed in the processes of urban site selection and settlement decisions in Türkiye are presented in Figure 3.12.

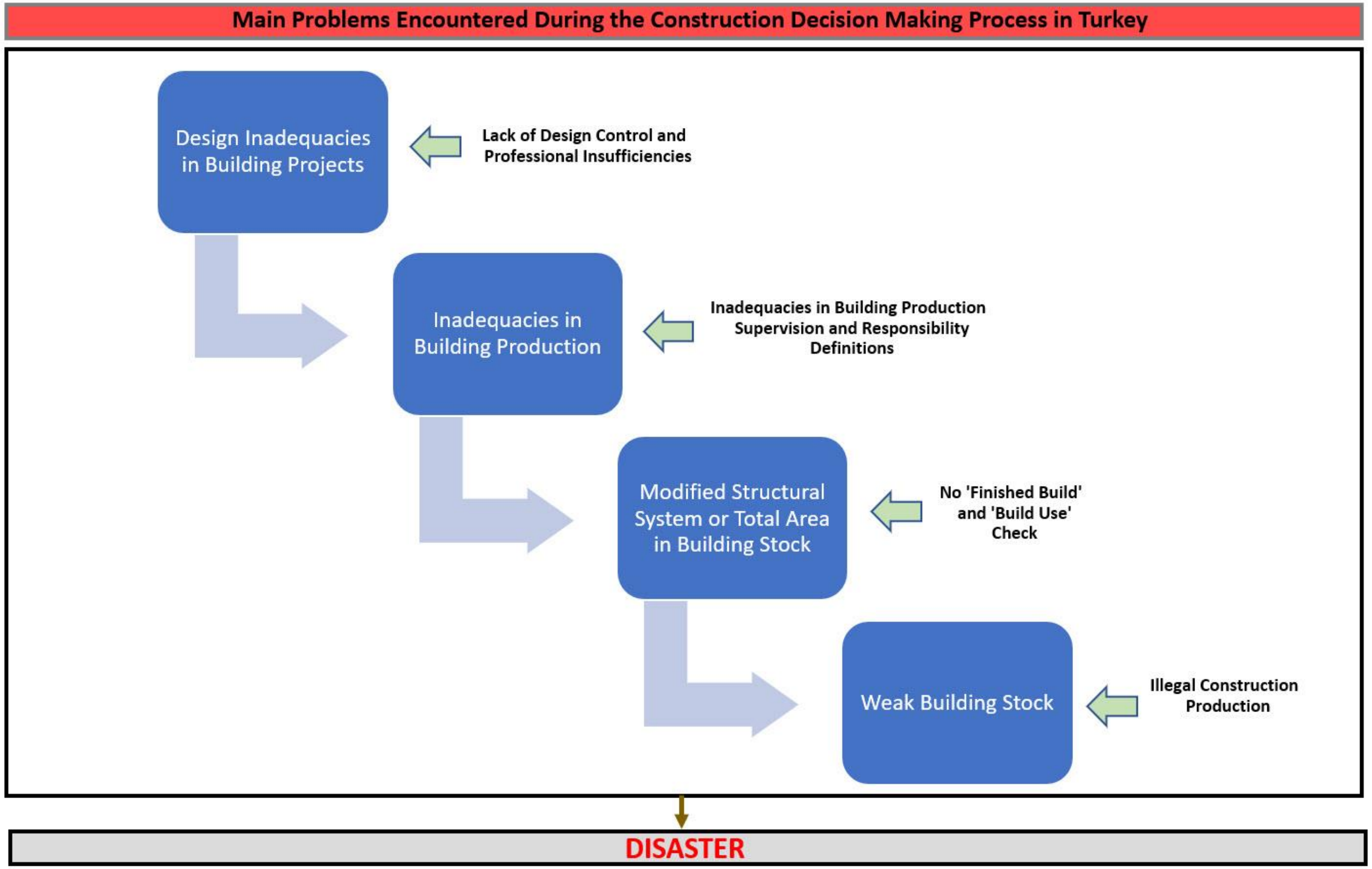


Figure 3.12: *Main Problems Encountered during the Construction Decision Making Process in Türkiye*

Source: *(Author Representation)*

The common cause of life losses during earthquakes is poor seismic performance of existing building stock. We can say that there are multiple reasons for this situation. In the face of an earthquake, design and construction defects as well as environmental effects may cause weaknesses in the structural system. In addition, as a result of the negative bearing factors caused by the change of the building function, additional damages may occur during the earthquakes. Design, material, workmanship and audit defects that are not suitable for earthquakes also constitute destructive roles of damages.

3.4.1.1 Observed Main Problems During the Building Inspection Process in Türkiye

Many laws have been enacted until today in order to create an earthquake-resistant living environment that can be lived safely within the scope of building inspection in Türkiye. However, although the concept of building audits has been shaped over time in Türkiye, it cannot fulfill its requirements today. Studies on this subject can be counted as the "Municipal Law" and "Public Health Law", which were first enacted in 1930, the Zoning Law No. Especially after the 1999 Gölcük Earthquake in our country, the importance given to the subject of building inspection, which should be done by the relevant persons and institutions, has increased even more. Because the studies carried out after this earthquake show that the most important reason for the loss of life and property was the existence of buildings that were produced without control. For this reason, a new legal regulation for the supervision of the Building Supervision Law was made in 2001, during the period from the very beginning of the construction process of the buildings until the final point was put on the structure (Yılmaz & Köymen, 2020).

The main purpose of the implemented building inspection system is to share information between the institutions and organizations that do the work and the public institutions and organizations that carry out the inspection. In this way, it is to guarantee that the necessary safety conditions for the building to be created are provided and that it can fulfill certain standards. The 'Law on Building Inspection', which came into effect in 2001 in our country, is actively implemented in 19 pilot provinces (Erdiş & Gerek, 2012). This law aims to control the conformity of the building, which is produced in accordance with the purpose of the building inspection, to the zoning plan. In addition, it specifies the principles of how the building inspection is carried out (main duties and responsibilities of the relevant municipality, special provincial administration, building inspection organizations, contractor, project author, inspectors, site manager and building owner). In this way, the institutions undertaking the building inspection were also allowed to gather under a common denominator.

In Figure 3.13, the usual operating scheme of the existing building audit system is given. Considering the functioning of this system, although it seems consistent within itself, there are major problems in the functioning of the building inspection process in our country. According to the given scheme, the failing parts of all legislation need to be reconsidered. Accordingly, first of all, the concepts of project and project control and building and building control should be separated (Özkan, 2005). In the building audit phase, a system that encourages the coordinated work of different professional groups involved in all processes of building production should be based on. For this reason, it is necessary for the participants in the building production process to interact and to implement all the elements of the control mechanism holistically.

In order for this process to continue in a healthy way, the audit process have to start from the drafting stage of the project. Only in this way, the architectural project to be prepared by the architect and the static design to be designed by the civil engineer can be continued with consistent progress (Özkan, 2005). However, in our country, such inspections are not implemented from the beginning of the process. For this reason, projects emerge that need to be changed in the process. Since this will prolong the process, it causes projects not to be reorganized and ultimately leads to inappropriate projects.

As another problem, even if the building inspection company terminates the contract and ceases to work for buildings that are required to be inspected by law, it is clear that the construction of the building will continue. Because in this case, the ongoing construction continues to be done illegally and therefore illegal construction becomes supported. When faced with such a situation, the relevant penalties should be strictly defined in the laws and regulations enacted.

The inclusion of contractors in this process is another frequently encountered problem in Türkiye. It is not enough to become a contractor just by registering with the Chamber of Commerce. It is a big problem that the qualification for this job is just this record. It is necessary to make new arrangements in the relevant control mechanism and to explain the problems very clearly.

Another problem is related to the qualifications of the companies that make building inspections. It is also not controlled by professional chambers, representatives of building inspection organizations and organizations that issue building permits, whether the inspections of building inspection companies are carried out in accordance with certain laws and regulations (Özkan, 2005). Failure to carry out these controls as a precaution against companies that do not do their job well disrupts the operation. It will be beneficial to prevent unfair competition that may occur between these companies, and regular checks will make a great contribution to the system. In addition, depending on a provision, building inspection companies will gather on a common denominator.

Another measure that will affect the process more positively is to evaluate the professional competencies of the technical staff who will be actively involved throughout the building inspection process, and to support them in keeping up with the developing technology and knowledge.

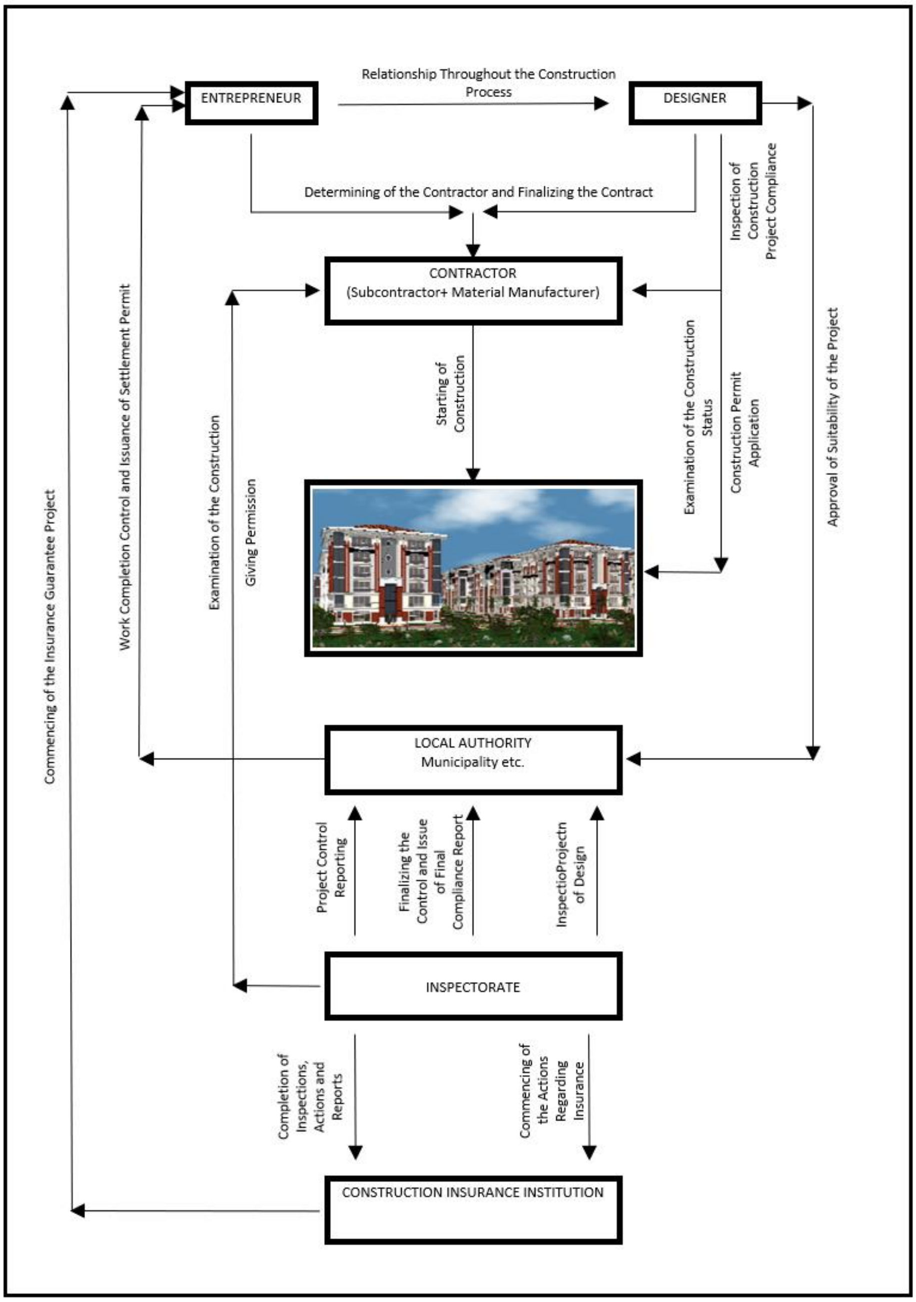


Figure 3.13: *The Operational Chart of the Existing Building Audit System in Türkiye*

Source: *(Özkan, 2005)*

In addition to the problems mentioned above, one of the biggest shortcomings of the building inspection process in Türkiye is that this process is only applied to certain provinces within earthquake zones (Özkan, 2005). This situation undermines the integrity of the relevant law. Considering that a large part of our country is in the earthquake zone, the implementation of this practice throughout the country should be made compulsory. In fact, it is necessary to make the control mechanism applicable not only for urban areas but also for rural settlements above certain standards. In addition, public and private structures should also be included in the system and their controls should be carried out impartially. Only in this way can the destructive effects of the earthquake be minimized throughout the country. It is a fact that some municipalities and governorships are inadequate in terms of building audits in Türkiye. In this case, these institutions should be encouraged to work with independent engineers and architects for the detailed technical control of the projects and to check the suitability of the projects only with the development plans.

By addressing and implementing all these problems in detail, a quality and controlled building system will be developed, in addition to creating seismically resilient cities. Considering the economic return for the country in the long run, it is certain that it will have positive effects. Insuring the buildings at the end of the process will lay the groundwork for sustainable urban development. The establishment of such a building inspection system can only be completed if all relevant institutions and organizations contribute seriously to the process.

3.4.1.2 Common Issues in Structural Design Process Resulting in Poor Performance in Türkiye

It is a well-known fact that structural damage varies according to the characteristics of the structure and related design or construction defects. According to Karaesmen (2014), a general classification of the causes of poor seismic performance of structures in Türkiye can be made as follows:

- Lack of universal knowledge in the sciences related to earthquake engineering.

• The indifference of the public and some members of the engineering and architectural community to the earthquake hazard.

• Structural defects in masonry structures resulting from a general lack of understanding of this structural system and poor construction quality.

• Structural defects in reinforced concrete buildings constructed at any scale.

The 1999 Marmara Earthquake in Türkiye emphasized that quality in the construction sector should be questioned and a serious change is necessary. The main causes of loss of life and property due to this large earthquake can be summarized as structural system deficiencies (design problems), wrong type of material selection, mistakes made during field application and ignorance for seismic actions in general. Buildings with such design and application problems have generally not benefited sufficiently from architectural and engineering services.

In fact, detailed earthquake regulations which were developed to assist the designer have been applied from past to present in our country. The purpose of these regulations is to prevent architects and engineers from making critical design mistakes that could endanger the lives of building occupants. In other words, the purpose of the earthquake codes used is to determine the necessary conditions to produce seismically safe and functional buildings.

According to official data, after the great Erzincan Earthquake that occurred in Türkiye in 1939, it is known that officially 32.962 people lost their lives and 116.720 buildings were destroyed or damaged (Harmankaya & Soyluk, 2012). After such a major disaster, the government of the time needed a legal regulation and the first seismic design codes for buildings were published in 1940. Accordingly, on January 17, 1940, the Law No. 3773 on "Aids to the Erzincan Earthquake Zone" was enacted (Dogal Afetlerde Meydana Gelen Can ve Mal Kaybını En Aza İndirmek için Alınması Gereken Tedbirlere ait Meclis Araştırma Komisyonu Raporu, 1997). This law is shown as the first disaster law in the history of our republic. However, it was basically prepared on the basis of the post-disaster response part. Subsequently, seismic codes have evolved as a result of major destructive earthquakes in Türkiye (Harmankaya & Soyluk, 2012). These building codes have been put into action in the years 1940, 1944, 1949, 1953, 1961, 1968, 1975, 1998 and 2007 and they were revised 9 times (Cansız, 2022). Finally, Türkiye Building Earthquake Code (TBEC 2018), which has been in act since the beginning of 2019, focuses in detail on the earthquake resistant design of reinforced concrete, steel and masonry building systems.

In TBEC 2018, various geometrical arrangements and structural behavior patterns in the plans and elevations of buildings are defined as irregularities in terms of seismic design. The main purpose of the relevant regulation is to completely avoid the structural irregularities specified for designers or to present the measures to be taken in case of such irregularities in the structure to the designer. Because the structures defined as irregular are the structures that can be damaged the most in case of severe ground shaking. For this reason, there are various factors that should be taken into account while designing these kinds of buildings. The precautions to be taken to protect human life are also clearly stated in the regulation.

These irregularities are mostly caused within the design phase of the project, or there may be structural problems that may occur later with human intervention. Figure 3.14 shows schematically the frequently encountered problems in the seismic design of structures in our country.

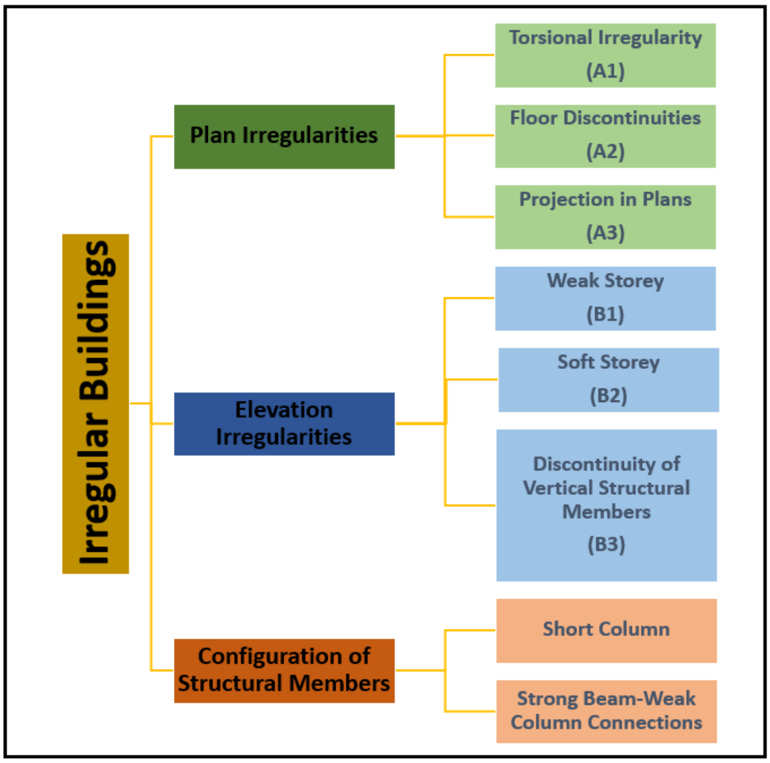


Figure 3.14: *Building Irregularities According to 2018 Turkish Building Earthquake Code*

3.4.1.2.1 Seismic Design Mistakes in the Plan (Plan Irregularities)

Many field studies carried out after the earthquakes reveal the adverse consequences of the plan irregularities in the building plan. This type of structural irregularity can create a torsion effect during a severe earthquake. As a result, this situation can be shown as one of the main causes of major damage during the earthquake.

3.4.1.2.1.1 Torsional Irregularity

There are two separate centers in a structure, the center of rigidity and the center of mass. In general, the center of mass in the building is accepted as the geometric center of the building, while the center of rigidity is accepted as the center of the load-bearing elements within the vertical system including columns and shear walls.

If the columns and shear walls are placed regularly in the plan to create symmetry in both axes, the rigidity center of the structure and the geometric center will be close to each other. On the other hand, if the columns and walls are not in a symmetrical order in the plan, the center of rigidity and the center of mass move away from each other. In a design where these two centers do not coincide, extra stress concentrations will occur when the building is subjected to lateral seismic loads. The eccentricity caused by how far these centers are from each other causes the structure to rotate under the effect of seismic forces. When the center of mass does not coincide with the center of rigidity, a structure subjected to dynamic forces tends to rotate around the center of rigidity and torsional irregularity occurs in the structure.

Figure 3.15 shows the condition of shear wall structures under the earthquake action. It has been observed that earthquake action increases the effect of lateral forces on the structural components in direct proportion to the distance from the center of rotation.. That is, the element placed further away from the center of rigidity has a greater torsional load. In other words, symmetry in a building plan must be provided not only by shape but also by the structural details in the load-bearing system (Celep, 2000).

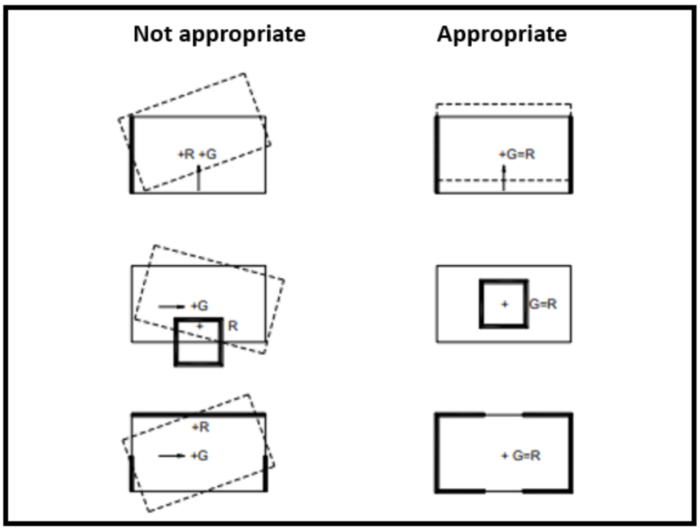


Figure 3.15*: The situation of Structures with Shear Walls in terms of Earthquake Affect Behavior in the Building Plan*

Source: *(TBEC, 2018)*

Figure 3.16: *Collapse due to Torsion*

In various countries of the world, the complexities in the building plan diagrams are defined in the relevant design regulations where certain criteria are stated to express the critical values related to the plan irregularities that may cause torsion. TBEC (2018) explains torsional eccentricity and its limiting value as shown in Figure 3.17.

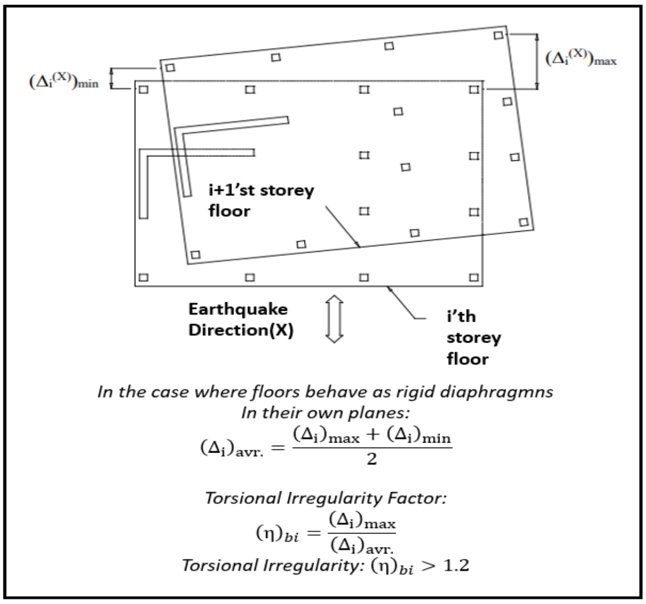


Figure 3.17: *Torsional Irregularity (A1) Drawing*

Source: *(TBEC, 2018)*

In summary, to avoid torsional irregularities, symmetry in both the building model and the distribution of structural elements is the most basic solution. The distribution of the members in the vertical system against lateral forces should be adjusted so that the center of mass and stiffness coincide. Or, these two centers should be positioned as close as possible, and the distribution of vertical structural members should be arranged in such a way as to produce high resistance to torsional effects during seismic actions.

3.4.1.2.1.2 Floor Discontinuities

In general, diaphragms are used to transfer forces to the vertically defined members in structures. In the case of a horizontally oriented force, the diaphragms allow columns and shear walls to act as a single structure. This way, the force acting horizontally is resisted. In some cases, disconnections may occur in the definition of the diaphragm due to the architectural requirements in the buildings. As an example for this situation, the openings defined in the projects are stairs, elevators, duct (plumbing) gaps, etc. The locations, shapes and dimensions of such architectural requirements are of vital importance due to the irregularity they will cause in the building. Because these geometric irregularities in buildings diminish the diaphragm effect and reduce the load carrying capacity of the building. In other words, it is critical to transmit the earthquake forces on the floors where the mass is concentrated in the building, to the members such as beams, columns and shear walls. At this stage, existence of gaps will complicate the force transfer and sudden changes in slab thickness will cause problematic stress concentrations on structural members (Celep, 2000).

This type of irregularity is defined in TBEC 2018 by the constraints shown in Figure 3.18. Irregularities, such as spaces with galleries created on the ground and first floors in most commercial buildings can cause these structures to suffer heavy and beyond damage (Şengezer, 1999). Since it is difficult to ensure the continuity of the floors in every project in today's buildings, it is not completely forbidden to have such irregularities in the structure. However, it is obligatory to demonstrate with calculations that the transfer of earthquake loads to vertical elements is done safely.

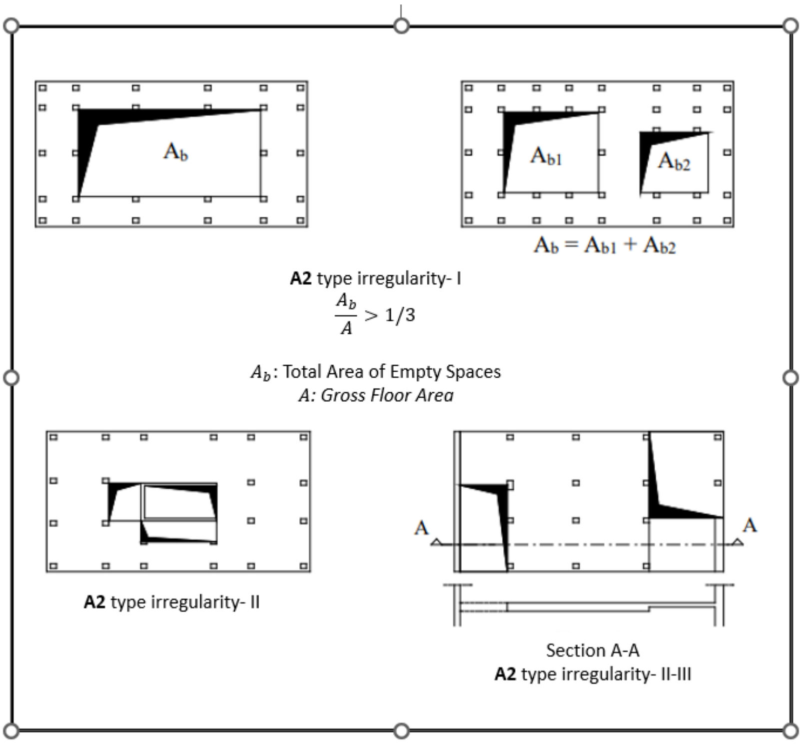


Figure 3.18: *Floor Discontinuities (A2) Drawing*

Source: *(TBEC, 2018)*

Especially in the structures where the openings are modeled, the places where the diaphragm effect is interrupted should be carefully considered and detailed. Reinforcement calculations should be made correctly at the edges as well as corner openings, and the extra forces created by the horizontal forces in the opening should be taken into account. Even in structures where the openings are much larger, dividing the diaphragm into small and smooth pieces will be effective in terms of the strength of the structure in order to ensure the continuity of the diaphragm. In this way, it will be possible to ensure the integrity of the diaphragm within the whole structure.

3.4.1.2.1.3 Projections in Plan

The dynamic behavior of a building during an earthquake is closely related to the architectural form of the building. Architectural form is a key factor for its strength during earthquakes. When we consider the forces that occur during the earthquake, symmetrical, simple and regular buildings exhibit positive effects in terms of strength. However, designing a symmetrical building is not always desirable or possible from an architectural point of view. Nowadays, projects that are observed to be complex or irregular due to functional and aesthetic concerns are encountered more frequently. However, in such more complex and unsymmetrical structures, great stresses will occur, especially in the corners of the building where the symmetry is violated. It is named as A3 type irregularity or namely "the presence of projections in the plan" and it is defined as in Figure 3.19 in TBEC 2018.

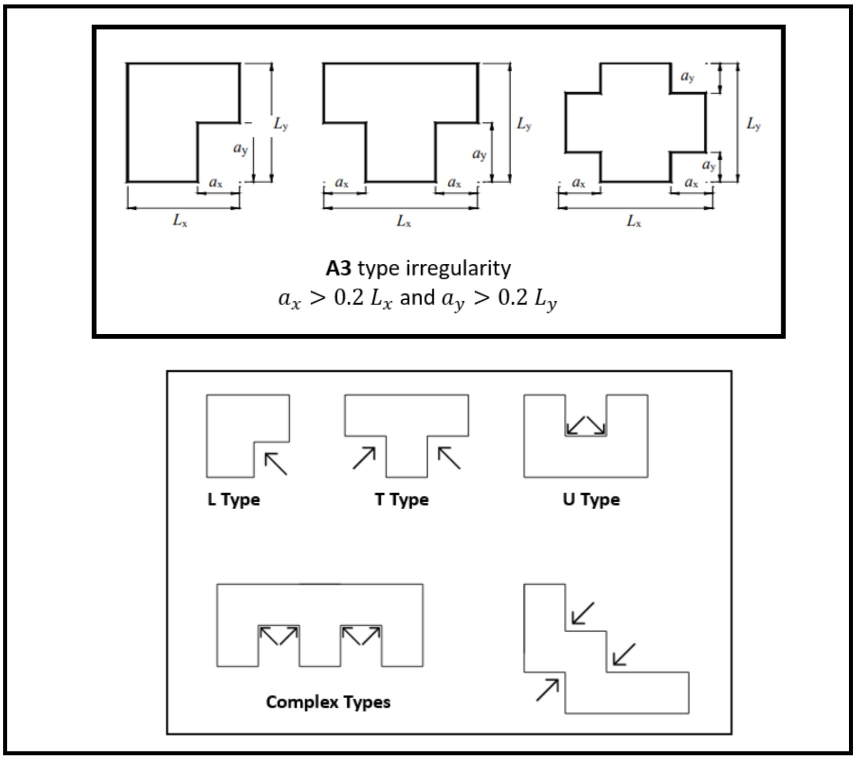


Figure 3.19: *Irregular Plan Schemes (A3) and Problematic Indented Corners*

Source: *(TBEC, 2018)*

This type of irregularity becomes even more important in structures consisting of more than one block because these blocks will move separately in the event of an earthquake. Due to the blocks with different periods and stiffnesses, damage potential may increase. In the design of such structures, adding extra reinforcements increases the strength of the structure in case of earthquakes. Separating the structure using structural joints will result in a positive effect when building blocks are exposed to earthquake forces (Figure 3.20).

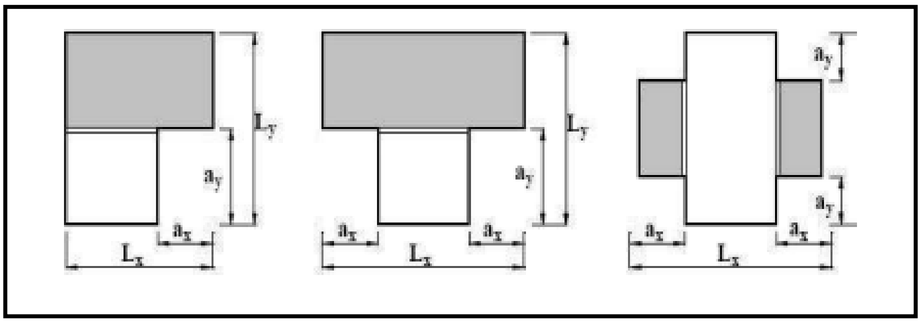


Figure 3.20: *Dividing Building into Several Sections*

Source: *(TBEC, 2018)*

3.4.1.2.2 Seismic Design Errors in Elevation

Under this heading, irregularities in reinforced concrete buildings that occur with variations or transformations in elevation will be discussed. Such structural irregularities are those causing a weakening of the strength of the structure, irreparable damage or even complete destruction due to lateral seismic loads.

3.4.1.2.2.1 Weak Storey (Strength Irregularity) and Soft Storey (Stiffness Irregularity)

In general, weak storey irregularity is related to the total cross-sectional area of the vertical load-bearing members which are the columns and shear walls in the plan (Harmankaya & Soyluk, 2012). The horizontal seismic forces affect each floor of the buildings at different levels. The shear force acting on the structure increases towards the lower floors. The basic building elements resist the horizontal force and this force is transferred to the lower floors and finally to the foundation. In this case, the strength of the structural elements of the lower storeys is of great importance. In order to transfer this force to the foundation safely, the storeys must have sufficient shear strength. Otherwise, this force cannot even be transferred to the foundation. The amount of force that can be resisted will increase as the total cross-sectional area of the columns and shear walls, which are defined as the basic load-bearing members in the building, increases. In general, the sum of the column and shear walls on the relevant storey must be greater than the area of the columns and shear walls on the next storey. Otherwise, a more flexible building configuration will be created on the lower storeys, where the area of the vertical load-bearing elements is less than on the upper one. This situation is inconvenient for structures in terms of seismic behavior and shown in Figure 3.21 by providing different irregularity cases.

However, as a situation we see frequently in our country, the absence of walls or columns due to the commercial use of the ground floors and the removal of the walls for aesthetic reasons play a negative role in the transmission of the horizontal load. This situation causes the structure to be weak in terms of shear strength capacity. Since sufficient structural rigidity is not provided in the system, the stability of the structure will not be ensured and the deformations in the structure will increase. In this case, weak storey irregularity might be occurred. It should be known that such structures will be the buildings that will be adversely affected in terms of stability in the event of an earthquake.

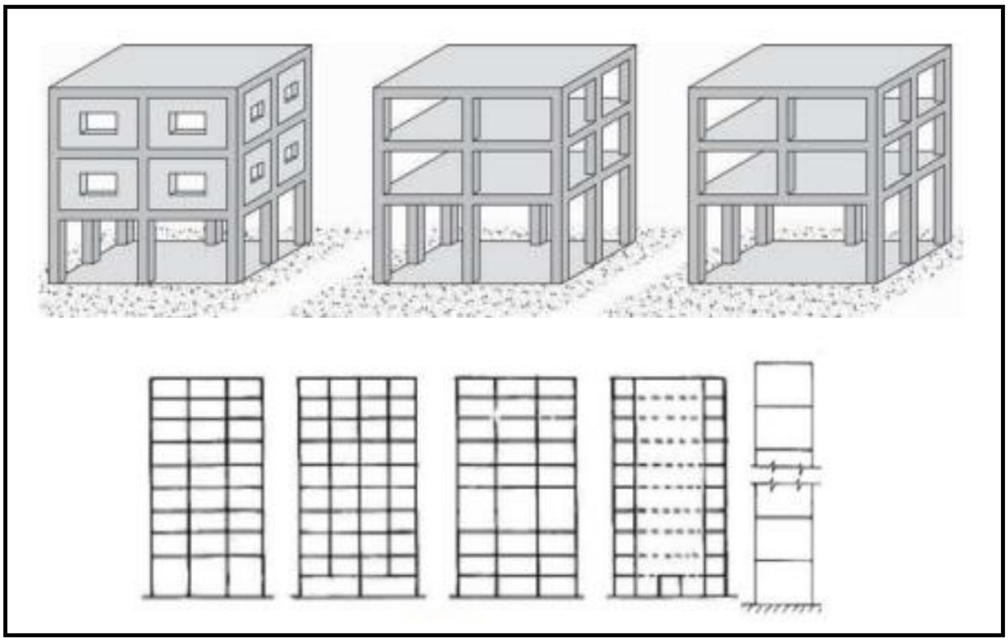


Figure 3.21: *Examples of Soft Storey and Weak Storey Configurations: a) Stiff Upper Floor due to Infill Walls, b) Different Storey Height, c) Discontinuous Column*

Source: *(TBEC, 2018)*

On the other hand, the soft storey problems are quite common in our cities. Because by leaving as much space as possible on the ground floor, gaining more showcase space and attracting the attention of passers-by at the highest level is a situation preferred by today's commercial understanding. Car dealerships, shops and many other commercial activities are typical activities that want to engage in this type of outward behavior on the ground floor (Lagorio, 1990). The soft storey problem is stated as an irregularity that occurs in relation to the relative displacement of the structure. Earthquake effects in buildings increase towards the lower storeys. While the load carried from the upper storeys to the lowest storey must be directed regularly to the connection point, a structural discontinuity occurs between the upper floors and the open lower floor. Failure is inevitable if the junction is not constructed in a way to absorb this stress concentration and/or transfer the force to the vertical structural members on the lower storeys (Lagorio, 1990).

The fact that the lower storey is easily displaceable than the upper storeys in a building causes the earthquake damage to intensify on the lower storeys, the structural system is severely damaged. Columns carrying the forces acting on the structure vertically are the main elements in this type of irregularity. Especially on storeys where column lengths are usually longer, such as installation floors and basements, sudden changes occur in the rigidity of this floor when partition walls are also removed. This creates an inelastic behavior in the structure and causes the stress to be concentrated at the upper ends of the columns. The hinges that occur at these nodes cause large displacements as the structure does not show ductile behavior. In other words, due to the rotations in the soft story column joints, the upper floors act like a rigid mass and make large lateral translations. Thus, it is inevitable that this large amount of displacement will cause a loss of stability in the structure. This type of irregularity is called soft storey irregularity (Figure 3.22).

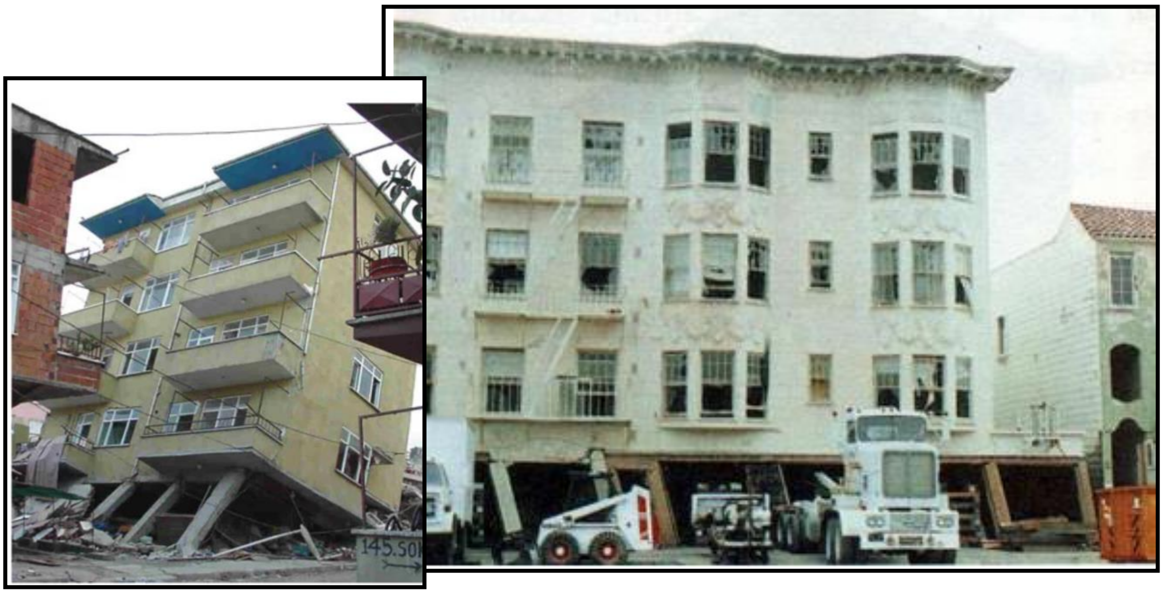


Figure 3.22: *Collapse due to Soft Story Failure*

This irregularity, especially caused by architectural design, is very critical since all energy consumption appears on a single floor and occurs suddenly.

However, there are some suggested methods to avoid this kind of irregularity. According to Ambrose and Vergun (1985), in structures with such irregularities (Figure 3.23);

1. Increasing the ground floor wall area,
2. Designing the ground floor of the building to be more rigid by increasing the ground floor column sections and increasing number or stiffness of columns in the ground floor (using tapered or arched forms section types),
3. Using braces and braced frames (trusses) systems that support the strength of the structure,
4. Separating the blocks with earthquake joints, maintaining the strength balance between the floors of the building, leaving joints between the column and the wall

are some measures which may help reduce such irregularities.

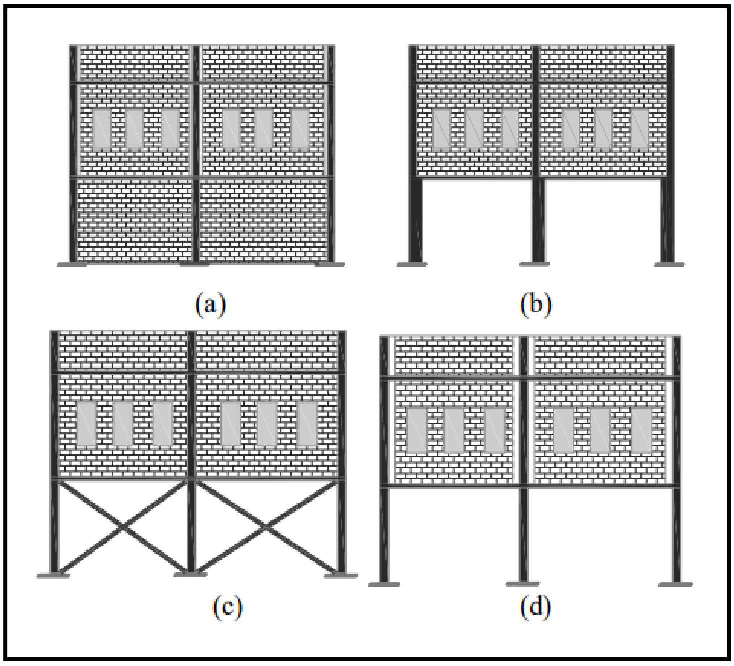


Figure 3.23: *Explanatory Figures for Soft Storey Irregularity Suggested in This Study*

Source: *(Ambrose & Vergun, 1985)*

3.4.1.2.2.2 Discontinuity of Vertical Structural Members

During the process of transferring the forces acting on the structure to the foundation floor in building design, the basic rule is that the vertically defined elements are continuous along the height of the building. Thus, in a stable structure, the forces occurring or applied in the system must move towards the ground. That is, the flow path of the force must be certain. Otherwise, high tensile forces occur at the points where the vertical elements are interrupted and the forces acting on the structure cannot be transferred to the lower floors. If there is an interruption at any point during this load transmission, different problems will occur in the stability of the structure (Figure 3.24). The case of disconnection in any of the structural members between the ground where the vertical force transmission starts and ends is an undesirable irregularity in the building design. For this reason, it is essential to ensure continuity in columns and shear walls. In addition, the displacement (deterioration of symmetry) or complete destruction of the shear walls and columns in the storey plan will cause extra displacements in the structure during the earthquake actions, as it will disrupt the structural integrity. The main reason for such cases is the architectural reasons, as wide openings, areas and volumes are used frequently in our country. Thus, the restrictions on the vertical continuity are clearly stated in the TBEC 2018.

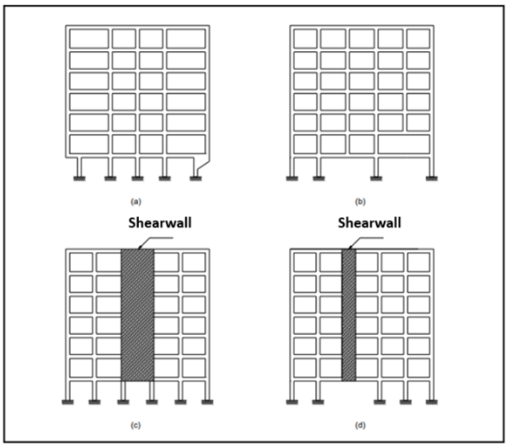


Figure 3.24: *Vertical Discontinuity of Structural Members*

Source: *(TBEC, 2018)*

3.4.1.2.3 Seismic Design Effects Caused by the Placement of Structural Members (Vertical Geometric Irregularity)

In general, continuity, symmetry and simplicity in horizontal and vertical geometry are the most basic features for the seismic design. However, in today's architecture, such requirements are not satisfied in every project. The issue of stability remains in the background, especially due to the changing and developing architectural design searches, aesthetic concerns and new building form ideas. Therefore, in addition to the continuity and adequacy of the main structural members defined in the building, their positions and dimensions in the building are also critical issues. These members, which are not sufficient in number, and/or which are positioned or dimensioned incorrectly, may cause an increase in the force acting on the structure during shaking. In this case, the stress on the structural members may cause damage to the structure. This problem, especially in our country, is caused by two main configuration errors.

3.4.1.2.3.1 Short Columns

As a building design-specific situation, in the case of columns of different lengths in the same storey plan, each column does not have the same shear force shown in Figure 3.25 and Figure 3.26 (Harmankaya & Soyluk, 2012). Therefore, the load distribution will not be the same for each column. The transferred force will be concentrated in the shorter columns. In this case, short columns will be more easily deformed and even more vulnerable to cracking in the face of excessive shear force. The regressions in the building geometry or building plan sizes varying between storeys which are generally applied in order not to exceed certain limits of the storey areas can be examples of this type of irregularity (Lieping & Zhe, 2009).

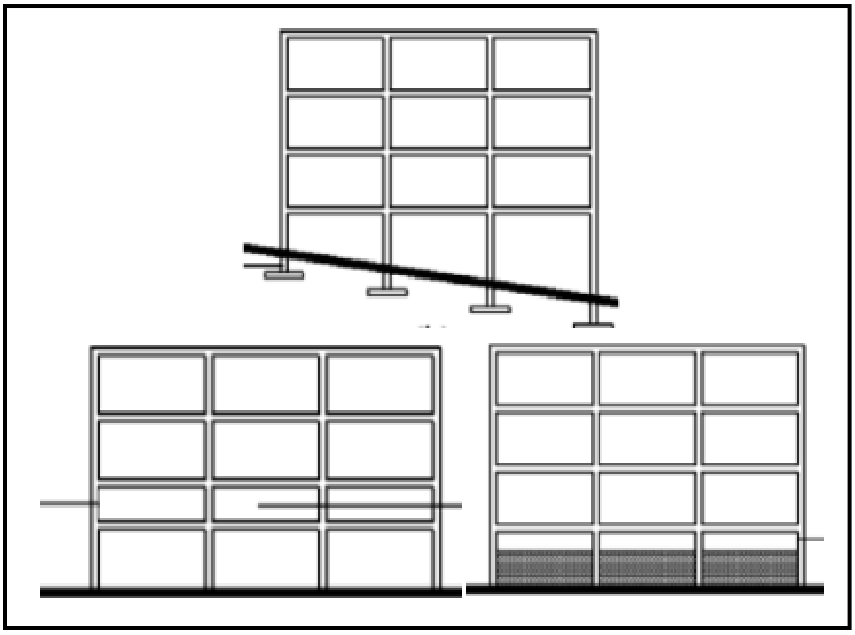


Figure 3.25: *Short Column Occuring due to Several Reasons: a)Due to Sloping Site*, *b)Due to Beam Intersections*, *c)Due to Infill Walls*

Source: *(TBEC, 2018)*

Figure 3.26: *Damaged Building due to Short Column Effect*

Source: *(Lieping & Zhe, 2009)*

Another short column behavior occurs when non-load bearing rigid members prevent the column from deforming during the earthquake, the rigid partition wall shortens the effective length of the column and the column has to resist larger horizontal forces than anticipated (Figure 3.27), (Celep, 2000).

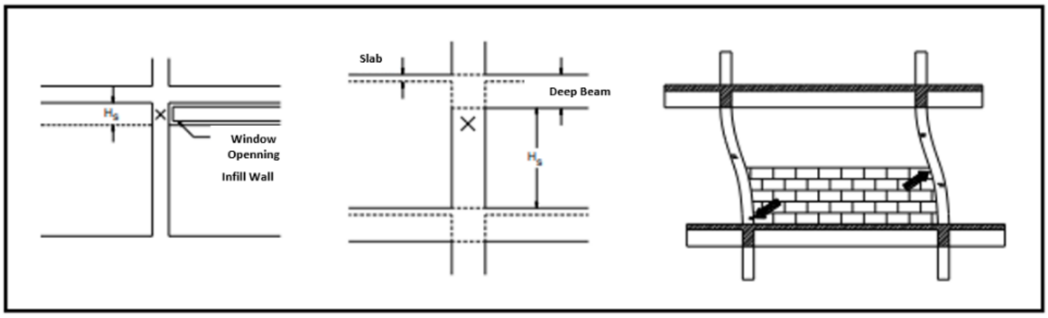


Figure 3.27: *Short Column Formation due to Masonry or Infill Walls*

Source: *(Celep, 2000)*

In order to prevent this kind of irregularity, especially the height of the facade columns where the shear force is higher, should be equal. If such a necessity is required from an architectural point of view, the horizontal braces can be reversed to equalize the stiffnesses of columns at different heights. Or, the desired appearance can be obtained by keeping the column lengths the same, that is, by using non-structural architectural elements without creating structural differences. Finally, changing the short columns into shear walls can be an another solution (Gönençen, 2000).

3.4.1.2.3.2 The Strong Column - Weak Beam Principle

Due to the lateral forces generated during the earthquake, deformations will occur at the connection points of the columns and beams. These deformations must be of ductile character and the structure must absorb the incoming energy. Otherwise, brittle deformations may cause sudden stability losses. In addition to the deformations, when the beams in a structure are more rigid than the columns, extra moments will be created at the joints. In the meantime, plastic hinges occur at the upper points of the vertical structural elements that may cause inelastic displacements leading to a sudden deterioration in the stability of the structure (Figure 3.28 (a)-(b)). As a result, the lateral stability of the columns is damaged.

Since the greatest earthquake force will occur in such columns, it is highly expected that they may fail first. This causes a loss of stability in the entire structure. This is a serious type of irregularity that may eventually cause the building to collapse.

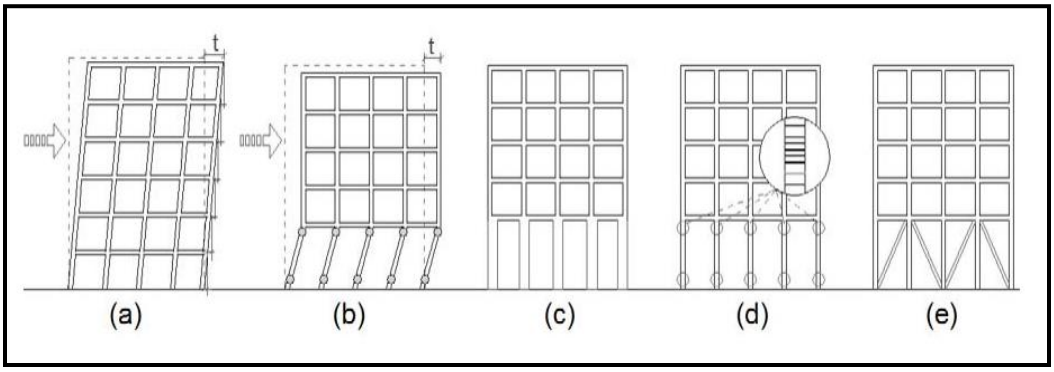


Figure 3.28: *Failure Mechanisms and Solutions of "Strong Column-Weak Beam" Design Principle*

Source: (*Lieping & Zhe, 2009)*

In order to prevent this type of irregularity in a structure, the regulation is to have the columns more rigid than the beams. In this case, ductile deformations occur at the beam ends and a large part of the energy is absorbed by the beams without any loss in the strength of the structure. Thus, in order to prevent this irregularity on the stories where the earthquake load is most affected, the plastic hinge formation has to occur on the beams instead of the columns, as shown in Figure 3.29. Therefore, before any collapse occurs on the ground floor, beam and column connection points are deformed one by one and sudden collapse is not experienced. Such a pattern of deformation that will occur in the structure is the most desirable type of possible deformation.

In addition, in cases where such irregularities are experienced, increasing the cross-sections of the vertical structural elements (Figure 3.28 (c)) or placing the links closer (Figure 3.28 (d)) are among the extra precautions that could be taken. In addition, additional vertical loading members and braces can have positive roles in preventing this type irregularity (Figure 3.28 (e)). It should also be known that the strong column-weak beam application is not only a recommendation in the TBEC 2018, its application is mandatory.

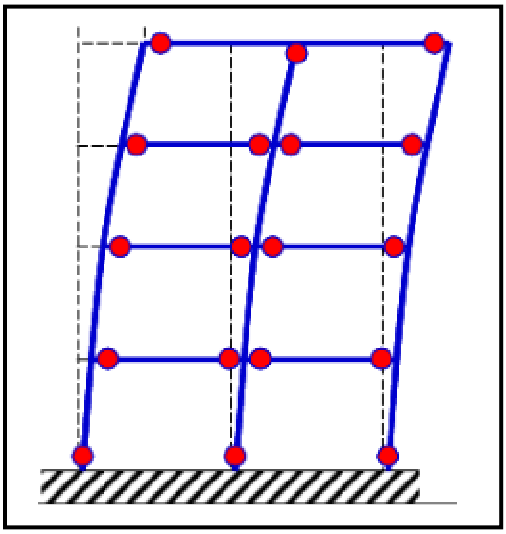


Figure 3.29: *Plastic Hinge Formation in "Strong Column-Weak Beam" Design Principle*

Source: (*Lieping & Zhe, 2009*)

3.5 Concluding Remarks for Türkiye's Urbanization and Construction Process

The problems experienced in our country within the context of urbanization and construction decisions regarding earthquake risk reduction are summarized above. It is clear that the resulting achievement should be process planning. This process should consist of stages that are very intertwined with each other. In order to minimize the damage and losses that may occur in the settlement areas in the event of an earthquake, certain precautions must be taken beforehand. Accordingly, in seismically dangerous places, risk analysis should be made before the potential earthquakes and vulnerability studies should be carried out according to the developed disaster scenarios. In this context, it is necessary to evaluate the related data obtained for the existing settlements and to develop and apply certain strategies in areas of high seismic risk. Urban settlement decisions for the future should also be developed in line with the regional data obtained. These strategies should be developed with opinions from all related disciplines. Because these activities are studies that make it necessary for many different kinds of discipline to work towards a specific purpose regarding seismic safety and resilience. In addition these studies and decisions concern all segments of the society. These strategies must be developed with input from different institutions and organizations (Ergünay, 2006).

In this context, as observed in Figure 3.30, geological surveys and related analyses constitute the first step of this stage. In the first stage, the task of geological and geophysical engineers is to carry out studies within an area with a foresight as an urban development area. All the feasibility studies for urban settlement should be completed as a result of the coordinated work of city planners, geologists and geological engineers. In this process, disaster risk maps of the planned city and risk maps prepared to the smallest possible and feasible scale should be examined and site selection decisions should be taken in this direction. The accuracy and technical consistency of these studies is one of the most important points of this process since city planners give way to urban plans based on this information. For this reason, it is essential that the bond between the two disciplines be strong and based on an understandable information sharing. The city planner develops land use decisions by considering results of geological and geotechnical studies. Only in this way can the development of safe cities in terms of ground be provided. If the base information at the upper scales is insufficient, it is inevitable that the plan decisions will be made incompletely and/or incorrectly in this direction. Therefore, at this stage, city planners and geoscientists need to work in harmony.

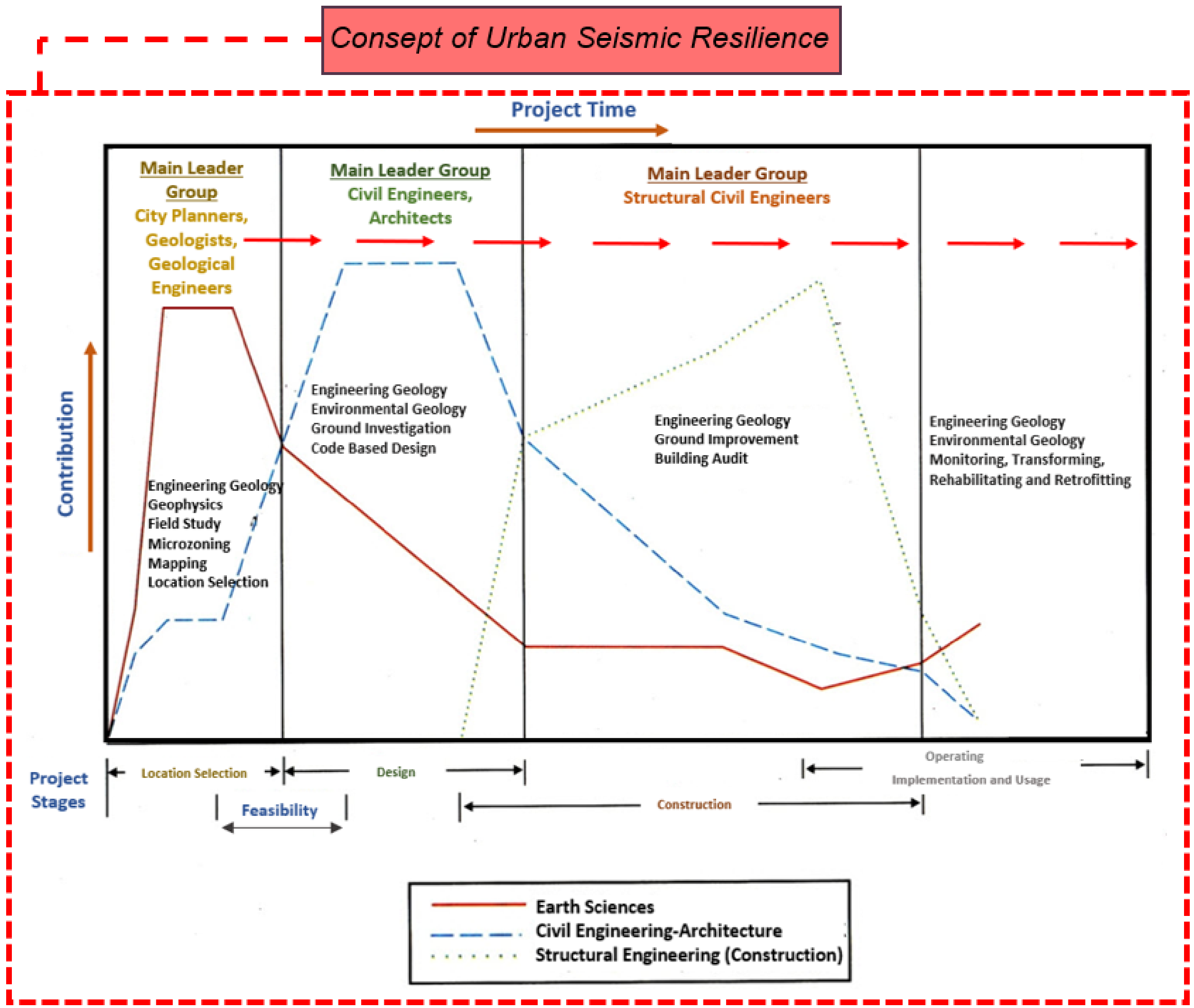


Figure 3.30: *The Contribution of Different Disciplines in Urbanization and Construction Process*

Source: *(Author Representation)*

The task of building design suitable for the chosen location should be left to architects and civil engineers. The geological and geotechnical studies, which are made in addition to the plan decisions, provide the most basic data for civil engineers that should be used when calculating the soil bearing capacity. In addition, they are the basic data sources that architects take as criteria when determining the type of building suitable for the relevant area. At this stage, the necessary regulations and site-specific design requirements should be applied based on the data from the previous stage. At this stage and the next stage, namely the design and implementation stage, the role of civil engineers is significant. Especially in the design phase, the one-to-one application and control of the data constitutes an important point within the whole process. The controls and audits carried out at this stage should be applied differently for each discipline. The process, application and usage controls to be done after this stage is an application that should be done with interdisciplinary work throughout the country. It is necessary to carry out inspections and controls by considering the seismic resilience criteria and to control their compliance with the whole process. In this way, it can be checked whether the process is applied correctly from the beginning to the end. Operation, application and usage controls that should be done after this stage is a crucial application that should be done with interdisciplinary work throughout the country. In this way, it will be possible to demolish or rehabilitate structures that are deemed inadequate in terms of operation within a controlled manner.

In this context, a building audit system that can be recommended for Türkiye is given in the Figure 3.31 (Özkan, 2005). Healthy and planned construction conditions require such a control mechanism. In the project audit phase of qualified housing production, inspectors working in different professional disciplines working in the building audit organization and inspectors should be in coordination with the project authors in order to correct the deficient and faulty projects envisaged. Besides working together, especially civil engineers and architects in charge of these two different processes should be supervised by a higher committee to be formed. This process should not be considered as a process carried out only with building inspection companies. In fact, if it is considered as a collective activity in which more than one stakeholder (civil engineers, architects, city planners and people in charge of legal science) should take part, the most secure building conditions will be provided. While this system is being set up, it is imperative to prevent possible malfunctions immediately and to close the gaps. Because the earthquake event is a phenomenon that requires serious consideration. Addressing the legislation in line with this information and developing the inspection mechanism will be a step that will have a positive impact on the process. Especially in rural areas of our country, there are many regions where the necessary engineering services are not received, material quality control is carried out, poor quality workmanship is carried out, and the building construction process continues with conventional methods. In such cases, it would be meaningless to talk about any control. However, today, the developing technological conditions and the increase in material types require a qualified workforce during the construction process. For this reason, reaching the desired level of building audit will be possible by increasing the personal equipment of the master, journeyman and other staff who play a fundamental role in this process. Otherwise, it is inevitable that there will be serious differences in the quality of the buildings produced due to the problems experienced in building audits. For this reason, the production of quality buildings should be based on the conscious behavior of the people involved in this process, the materials meeting the required standards, a qualified workforce, and a method in which occupational safety issues are not ignored. In this way, it is possible to provide qualified housing production with building audit activities carried out within the framework of legal legislation, where project and application control elements are evaluated holistically, which are shaped by the sense of duty and responsibility of those involved in the production process, and interdisciplinary interaction is at the forefront in projects and applications in accordance with the relevant legislation and standards will be possible (Yağız, 2019).

In addition to the institutions and organizations that will accompany the whole process, non-governmental organizations should also take an active role in the process. In the political context of the seismically resilient city formation process in our country, it should be ensured that non-governmental organizations act as institutions responsible for the development and execution of seismic risk reduction strategies. In particular, the functions of informing, raising awareness and supporting all segments (technical and non-technical people) involved in this process should be provided by non-governmental organizations. Such functions make non-governmental organizations an important actor not only in management but also in almost every aspect of urban life in the seismically resistant city formation process. For this reason, in the process of making and implementing urbanization and construction decisions, the issues of disseminating disaster awareness to all segments of the society, providing necessary training for harm reduction, preparedness, response and recovery stages, increasing the capacity of the society to combat disasters by developing skills, and ensuring the organization of civil society should be issues. Particularly in educational studies, it should be important to carry out systematic, sustainable and standardized studies that emphasize the issues of earthquake mitigation and preparedness. With such an interdisciplinary approach, the formation of seismically resilient cities can be achieved.

When this whole process is examined, it is observed that these stages, which should be implemented in our country, are not implemented accurately. The city of Kahramanmaraş, which should be prioritized due to the disaster risk it carries in our country, is also a developed city without these practices. For this reason, in the rest of the study, the problems we encounter at the country level will be addressed specifically for the city of Kahramanmaraş and suggestions will be made to reduce the disaster risks of the city.

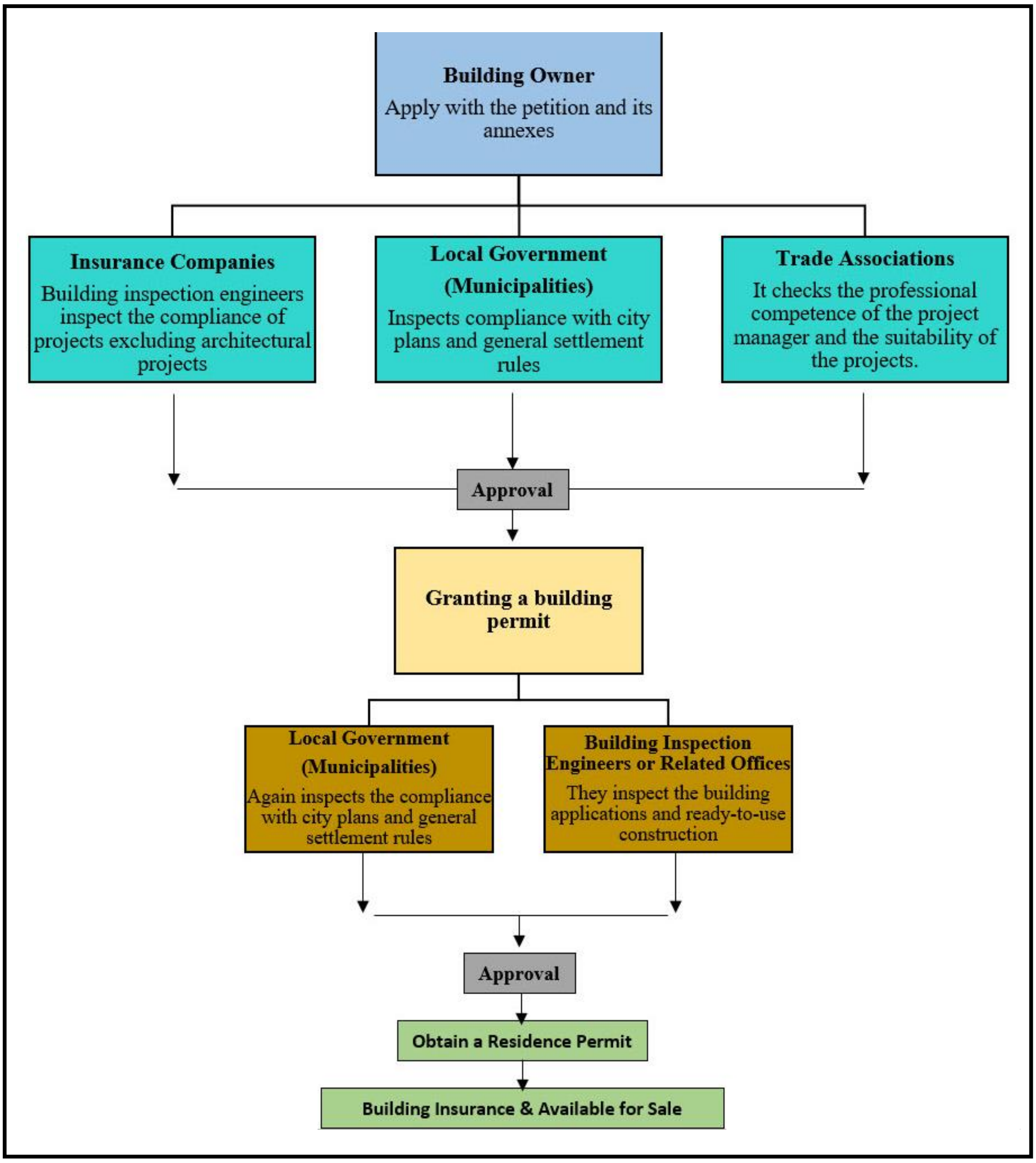


Figure 3.31: *A Building Inspection System Model Applicable for Türkiye*

Source: *(Özkan, 2005)*

CHAPTER 4

REFLECTION OF THE OBTAINED GAPS ON THE SPACE: KAHRAMANMARAŞ CASE STUDY ANALYSIS

Earthquakes on the Eastern Anatolian Fault Line, which has an important place in Türkiye's tectonics, have affected many provinces throughout history. Considering the impact area of this fault, many cities in Türkiye can be considered within the scope of this study. One of these cities is the city of Kahramanmaraş.

Kahramanmaraş Province has been under the influence of major earthquakes from past to present due to its geological location. Some of these earthquakes are given in Table 4.1 in historical order. When the table is examined, it can be concluded that there is a region where seismic activities are observed intensely before 1890 (historical period) and after 1890 (instrumental period) in and around Kahramanmaraş Province. Looking at the western part of the East Anatolian Fault, it is observed that it did not produce a major earthquake in the instrumental period. In particular, this situation poses a great risk for the city of Kahramanmaraş, which is located close to the Gölbaşı-Türkoğlu and Türkoğlu-Antakya (Karasu segment of the Dead Sea Fault) segments of the fault.

Tablo 4.1: *Occurred Earthquakes along the Eastern Anatolian Fault (1900-2020)*

Date	**Epicenter**		**M_s**	**Location**
	N	**E**		
12.04.1905	39.0000	39.0000	6.8	Pütürge-Malatya
21.11.1939	39.8200	39.7100	5.9	Tercan-Erzincan
26.12.1939	39.8000	39.5100	7.9	Erzincan
20.02.1940	38.4000	35.3000	6.7	Develi-Kayseri

Table 4.1: (Continued)

Date	Epicenter		M_s	Location
	N	E		
11.12.1941	39.7400	39.4300	5.9	Erzincan
20.03.1945	37.1100	35.7000	6.0	Ceyhan-Adana
31.05.1946	39.2900	41.2100	5.7	Varto-Hınıs-Muş
17.08.1949	39.6000	40.6000	7.0	Karlıova-Bingöl
04.08.1951	36.5800	35.8500	5.7	İskenderun-Hatay
22.10.1952	37.2500	35.1500	5.5	Misis-Adana
07.07.1957	39.3700	40.4600	5.1	Başköy-Erzincan
14.06.1964	38.1300	38.5100	6.0	Malatya
31.08.1965	39.3000	40.7900	5.6	Karlıova-Bingöl
03.07.1966	39.2000	41.6000	5.6	Varto-Muş
19.08.1966	39.1700	41.5600	6.9	Varto-Muş
04.07.1967	37.4000	36.2000	5.3	Bahçe-Adana
26.07.1967	39.5400	40.3800	6.2	Pülümür-Tunceli
24.09.1968	39.2000	40.2000	5.1	Bingöl-Elazığ
22.05.1971	38.8500	40.5200	6.7	Bingöl
09.06.1975	38.4700	40.7200	6.9	Lice-Diyarbakır
05.05.1986	37.9500	37.8000	5.8	Sürgü-Malatya
06.06.1986	38.0100	37.9100	5.6	Sürgü-Malatya
13.03.1992	39.6800	39.5600	6.8	Erzincan-Tunceli
22.01.1997	36.2500	36.0000	5.5	Antakya
13.04.1998	39.3200	41.0500	5.0	Karlıova-Bingöl
27.06.1998	36.8500	35.5500	5.9	Ceyhan-Adana
27.01.2003	39.4100	39.8000	6.4	Pülümür-Tunceli
01.05.2003	38.9400	40.5100	6.1	Merkez-Bingöl
13.07.2003	38.2700	38.9500	5.7	Doğanyol-Malatya
26.02.2004	37.8624	38.2261	5.1	Merkez-Adıyaman
03.03.2004	39.0535	40.3334	5.0	Merkez-Bingöl
11.08.2004	38.3680	39.1461	5.3	Sivrice-Elazığ
12.03.2005	39.4165	40.8672	5.6	Karlıova-Bingöl

Table 4.1: (Continued)

Date	Epicenter		M_s	Location
	N	E		
14.03.2005	39.4186	40.8183	5.9	Karlıova-Bingöl
26.11.2005	38.2143	38.8755	5.2	Pötürge-Mlatya
10.12.2005	39.3976	40.8547	5.2	Yedisu-Bingöl
21.02.2007	38.3600	39.2900	5.4	Sivrice-Elazığ
03.09.2008	37.4350	38.5860	5.2	Bozova-Şanlıurfa
22.07.2012	37.574	36.3707	5.0	Andırın-Kahramanmaraş
19.09.2012	37.2838	37.1398	5.1	Pazarcık-Kahramanmaraş
02.03.2017	37.5955	38.4866	5.5	Samsat-Adıyaman
24.04.2018	37.5836	38.5036	5.1	Samsat-Adıyaman
04.04.2019	38.3865	39.1205	5.2	Sivrice-Elazığ
24.01.2020	38.3593	39.063	6.8	Sivrice-Elazığ
25.01.2020	38.374	39.131	5.1	Sivrice-Elazığ
19.03.2020	38.3720	39.1041	5.0	Sivrice-Elazığ

Source: *(AFAD, 2020)*

For all these reasons, it can be said that Kahramanmaraş Province and its surroundings are located in a very risky region in terms of seismicity. Due to the seismic preservation of the Eastern Anatolia and the Dead Sea Fault and the fact that there is an energy accumulation of approximately 200 years on the faults, the risk of possible earthquake hazard for the province of Kahramanmaraş increases. Especially since these two faults come together in the southern part of Kahramanmaraş and then split into different branches, the probability of being the focus of a large-magnitude earthquake in the city increases. This will further increase the effects of a possible earthquake in the city. For this reason, within the scope of this study, firstly, the current situation will be determined and then the problem analysis will be made for the city of Kahramanmaraş.

4.1 Geographical Location and Population of Kahramanmaraş Province

Kahramanmaraş province is located in the Eastern Mediterranean region between 37-38 North parallels and 36-37 East meridians. Kahramanmaraş is a city settlement located on the southern slope of Ahır Mountain in the Eastern Mediterranean, at an average altitude of 650 m (Figure 4.1). There is Maraş Plain in the south and Ahır Mountain in the north. About 2/3 of its territory is mountainous, the rest consists of plateaus and wide plains (Temiz, Binici, Köse, & Kuşat Gürün, 2011). In other words, 59.7% of the province's territory is mountains, 24% is plateaus and 16.3% is plains (Kahramanmaraş Governorship, 2021). Landforms in Kahramanmaraş province, which is located in the area where three different geographical regions (Mediterranean, Eastern Anatolia and Southeastern Anatolia regions) come closest to each other, generally consist of mountains that are extensions of the Southeast Taurus Mountains and the rift zone between them (Kahramanmaraş Valiliği, 2021). Located in the north of the railway line connecting Çukurova to Eastern Anatolia and on the highway connecting Southeastern Anatolia to Central Anatolia, the city is a socio-economic center compared to the smaller settlements around it. It has a surface area of 14.346 km² and 11 districts and 710 neighborhoods (Coşkun, 2022). Its population is 1.171.289 and it is the 18th most populous province of our country. (TÜİK, 2021). The average number of people per km² in Kahramanmaraş is 70 people. In terms of population density, the densest settlements are 157 persons/km² in the central district in Kahramanmaraş (Kahramanmaraş Governorship, 2021).

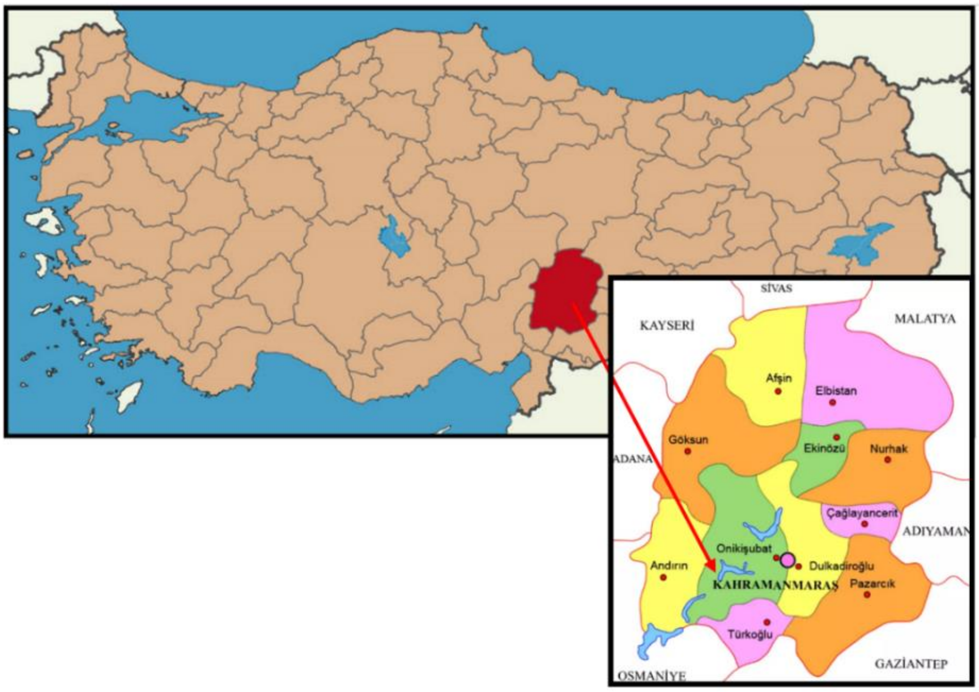


Figure 4.1: *Representation of Study Area Location and Provincial Borders on Türkiye Map*

Source: *(Coğrafya Harita, 2022)*

4.2 Kahramanmaraş Province Urban Development

Kahramanmaraş Plain contains very fertile agricultural lands. However, this productive plain is rapidly being reduced by industrial establishments, houses, roads and official institutions. There are 109 neighborhoods in the center of Kahramanmaraş, and a total population of 542.715 people live in 109 neighborhoods (İRAP, 2020). While the urban area covered the area between the Mağaralı and Kayabaşı districts and Kıbrıs Square on the southern slope of Ahır Mountain before 1950, it showed a development especially in the south direction towards the 1960s (Sandal & Karademir, 2013).

In the city, the covered bazaar and historical trade zone area where commercial activities took place in the historical process; with the preparation of the development plan in 1978, it was moved to the southern parts of the city with the municipality and different large public institutions. At the same time, the Central Business District (CBD), which developed on an axis about two kilometers long around the castle and in the northeastern part, shifted to the axis between the Ulu Mosque and Bahçelievler Mosque (Sandal & Karademir, 2013). The increase in land rents and the revival of commercial activities in these regions caused the housing function to shift to the development area of the city.

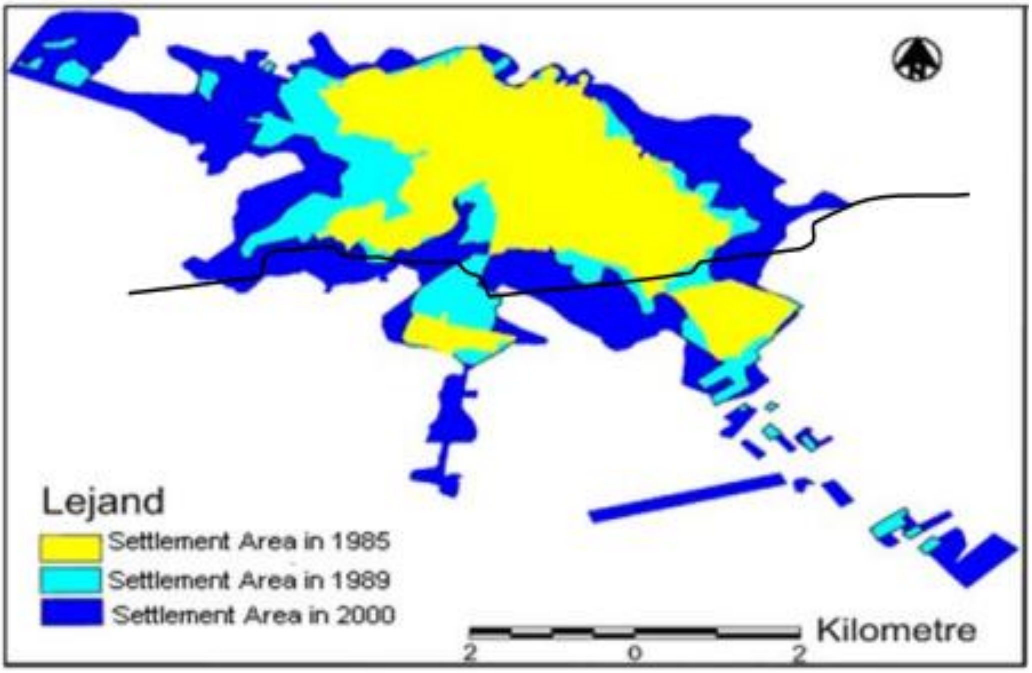


Figure 4.2: *Changes of Urban Areas in 1985, 1989 and 2000*

Source: *(Karabulut, Küçükönder, Gürbüz, & Sandal, 2006)*

Figure 4.2, which is the study of Karabulut and others, shows the change in the development of settlement areas in the province of Kahramanmaraş for the years 1985, 1989 and 2000. (Karabulut, Küçükönder, Gürbüz, & Sandal, 2006)

Accordingly, until the 1980s, the city spread between Serintepe-Gazipaşa in the north and Dumlupınar-Yenişehir neighborhoods in the south, and after 1980 it expanded in the east and especially in the west direction. In other words, it is seen in Figure 33 that the development took place in the direction of the roads, depending on the central industrial facilities (Kahramanmaraş Organized Industrial Zone) established on the Adana, Kayseri and Gaziantep transportation lines, where the city showed a development trend towards the West. Due to the sloping hills of Mount Ahir, which borders the north of the city, the urban settlement has developed in the east-west direction. The additional development plan, which came into effect in 1986, had a great impact on this situation (Sandal & Karademir, 2013). In addition, Kahramanmaraş Organized Industrial Zone, where planning studies were started in 1992, and Sütçü İmam University Avşar Campus, the foundation of which was laid in 1995, can be cited among the other reasons for the westward development. The new Courthouse construction and Güzel Evler Mass Housing Project which affected urban development in 2011, also supports the westward development of urban housing areas (Figure 4.3).

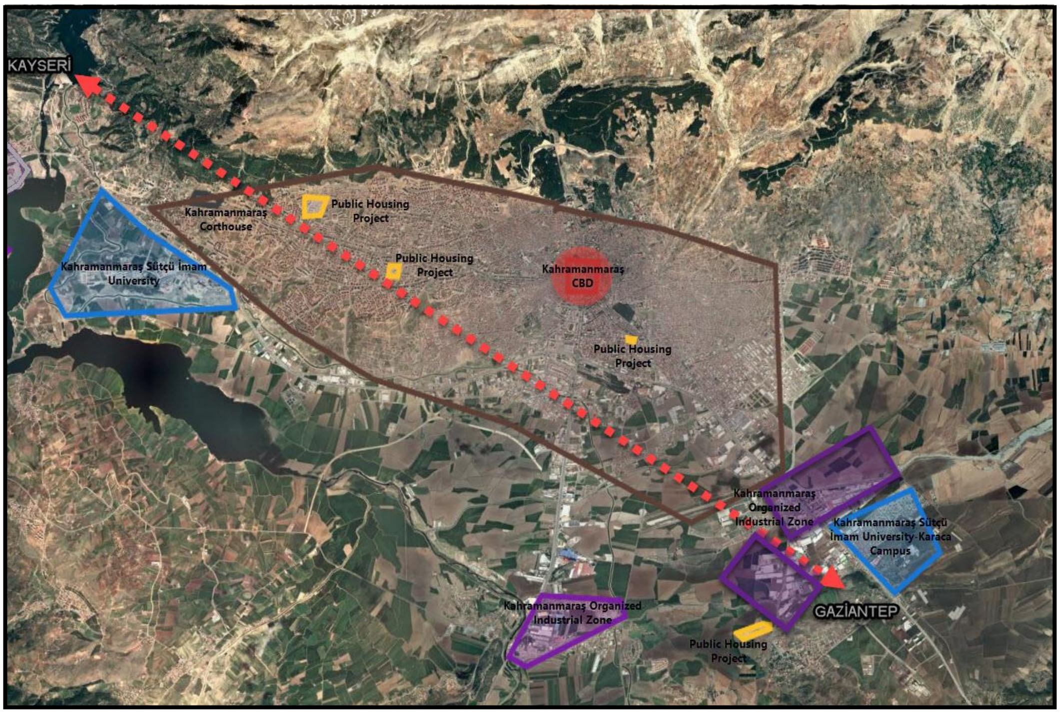


Figure 4.3: *Urban Development Corridor*

Source: *(Auther Representation - Google Earth, 2022)*

When evaluated in general, the population is quite high in the old quarters of the city and in the Eastern and Western parts of the city, which were later opened to settlement, in the area up to Üngüt. The heights of floors and the number of apartments per building are quite high in the districts of İsmet Paşa and Şazibey, which developed in the 1980s and in the newly established neighborhoods of Haydarbey, Şehit Abdullah Çavuş and Akif İnan. On the other hand, the neighborhoods such as Yusuflar, Dumlupınar, Ertuğrul Gazi, Mevlana and Piri Reis Neighborhoods lying around the Maraş Castle and its southwest, and Mağaralı, Yörük Selim and Serintepe located in the north have low floor heights and housing densities. In addition, in villages and towns that later joined the city and turned into neighborhood status, the building height and housing density are quite low. When the population density per residence is examined, while the density is low in the neighborhoods established after the 1990s, the number of households is above the average in neighborhoods such as Serintepe, Şeyh Adil, Namık Kemal and Çamlık, and in the Kırım, Aksu and Erkenez Neighborhoods (Figure 4.4).

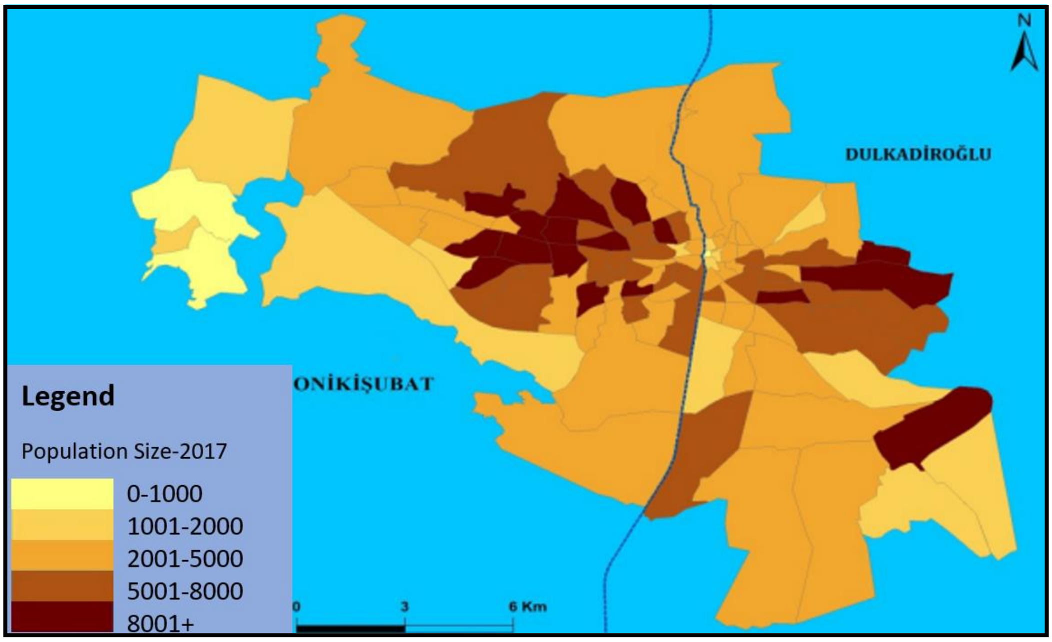


Figure 4.4: *Distribution of Population Size by Neighborhood (2017)*

Source: *(Karabörk & Sandal, 2018)*

4.3 Kahramanmaraş Province Seismicity

Kahramanmaraş is in a critical region in terms of earthquakes due to its geological and geophysical conditions. The city is located at the junction of Mediterranean, Eastern Anatolia and Southeastern Anatolia regions (Biricik & Korkmaz, 2001). This region, called the Maraş triple joint, covers the northwest corner of the Arabian plate as well as the deformed Eurasian and African plates, and contains all the characteristic features that can be seen in a continental collision zone (Gülen, Barka, & Toksöz, 1987); (Westaway, 2003).

Kahramanmaraş province is located in an area where the African, Arabian and Anatolian plates interlock and fuse with each other. It is basically under the influence of the East Anatolian Fault and the Dead Sea Fault. The East Anatolian Fault starts from Bingöl Karlıova, passes through Gölbaşı and Pazarcık, and reaches the west of Aksu Stream. The Dead Sea Fault joins with the East Anatolian Fault near Türkoğlu and Narlı. The seismic activity of these active faults contribute to the high earthquake hazard of Kahramanmaraş (Sandal & Karademir, 2013).

When the historical and instrumental earthquake records on the East Anatolian Fault are examined; in addition to many smaller earthquakes, two major earthquakes in 1893 and 1513 seem to have affected Kahramanmaraş and its surroundings (Ambraseys, 1989). Apart from the two major earthquakes mentioned above, the absence of a devastating earthquake on the segment of the East Anatolian Fault passing through Kahramanmaraş and its vicinity for a long time along with the development of the city towards the plain indicate that the earthquake hazard of this region is high. In other words, there is a long-term accumulation of energy in these faults, since large earthquakes, especially in the instrumental period, did not occur in this region. Thus, this region is one of the most critical regions defined as seismic gap in terms of seismic hazard in our country. In Figure 4.5, a part of the Eastern Anatolian Fault which passes through Kahramanmaraş city is demonstrated along with the active faults within the borders of Kahramanmaraş. There are very important faults that have the potential to produce earthquakes in and around Kahramanmaraş.

These faults are basically the Eastern Anatolian Fault North branches (Sürgü Fault, Nurhak Fault, Elbistan Fault, Göksun Fault), Eastern Anatolian Fault Southern branches (Gölbaşı-Türkoğlu Segment), Ölüdeniz Fault (Karasu Segment), Kahramanmaraş Fault Zone, Çokak Fault, Aslantaş Fault, Andırın Fault Zone and Engizek Fault Zone. The locations and geometrical features of the mentioned faults are presented in Figure 4.5.

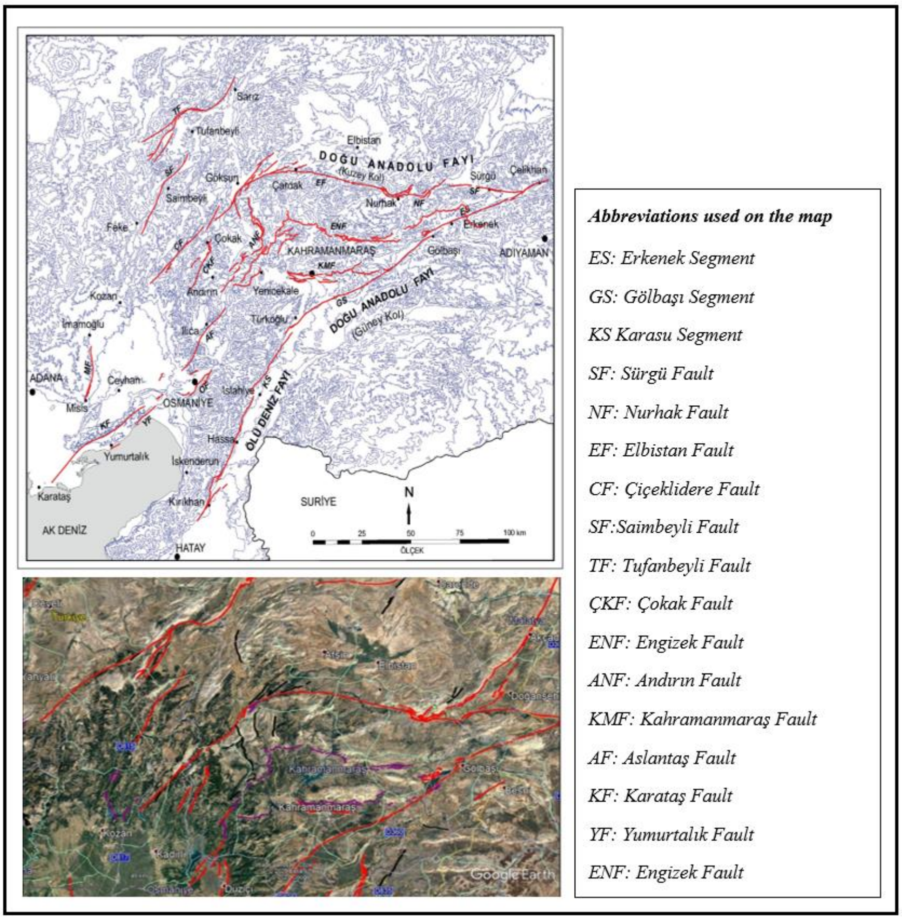


Figure 4.5: *Active Faults in the Kahramanmaraş and its Surrounds*

Source: *(İRAP, 2020), (Mineral Research Exploration, 2020)*

According to the information obtained from the Active Fault Map of Türkiye prepared by the Mineral Research and Exploration Agency, the earthquake risk of Kahramanmaraş increases due to potential ruptures along the active faults which are

Eastern Anatolian Fault Zone No. 2-6, Pazarcık Segment, Kahramanmaraş Fault Zone No. 224, Engizek Fault Zone No. 225, Çardak Fault No. 226, Çokak Fault No. 221 (Yüksel Proje, Dolsar, & Üçer, 2021).

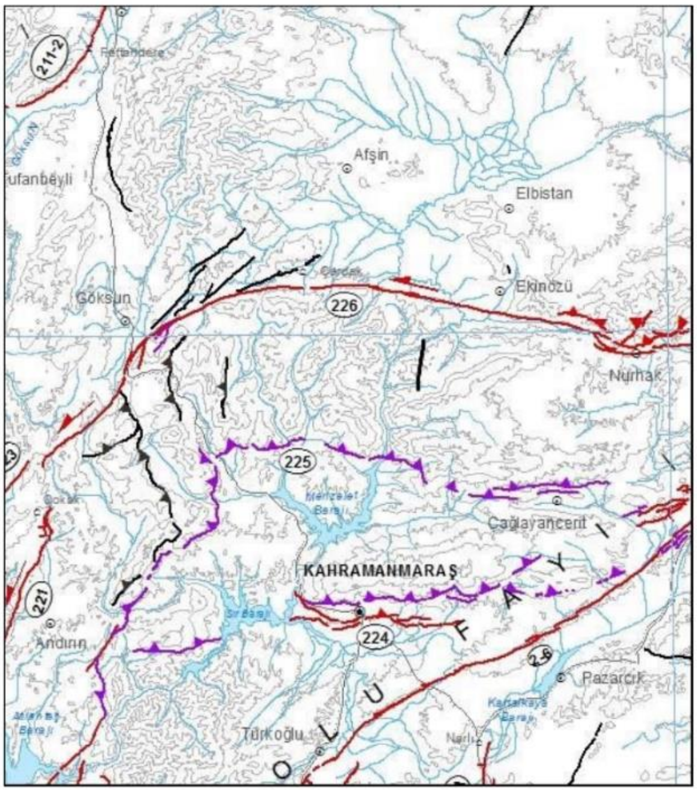


Figure 4.6: *Active Faults in Kahramanmaraş Province*

Source: *(Mineral Research Exploration, 2020)*

East Anatolian Fault: The East Anatolian Fault, which is approximately 550 km long and a left-lateral strike-slip fault, starts from Karlıova in the northeast and passes through Kahramanmaraş (about 15 km from the city center) in the southeast and then extends to the south. It then turns towards Antakya and joins the Dead Sea Fault. The total left-lateral strike slip of the East Anatolian Fault zone formed during the Late Pliocene period varies between 15-27 km (Şaroğlu, Emre, & Kuşçu, 1992); (Arpat & Şaroğlu, 1975). Geological, geomorphological and GPS data reveal that the slip rate on the East Anatolian Fault zone is approximately 8-10 mm/year (Peter, et al., 2000). East Anatolian Fault which extends from Karlıova to Antakya respectively is divided into six geometric segments called Karlıova-Bingöl, Palu-Hazar Lake, Hazar Lake-Sincik, Çelikhan-Erkenek, Gölbaşı-Türkoğlu and Türkoğlu-Antakya as shown in Figure 4.7 (Şaroğlu, Emre, & Kuşçu, 1992). It is also known that many earthquakes have occurred in the historical period along the faults and related segments (Ergin, 1966); (Özmen, 1999); (Soysal, Sipahioğlu, Kolçak, & Altınok, 1981).

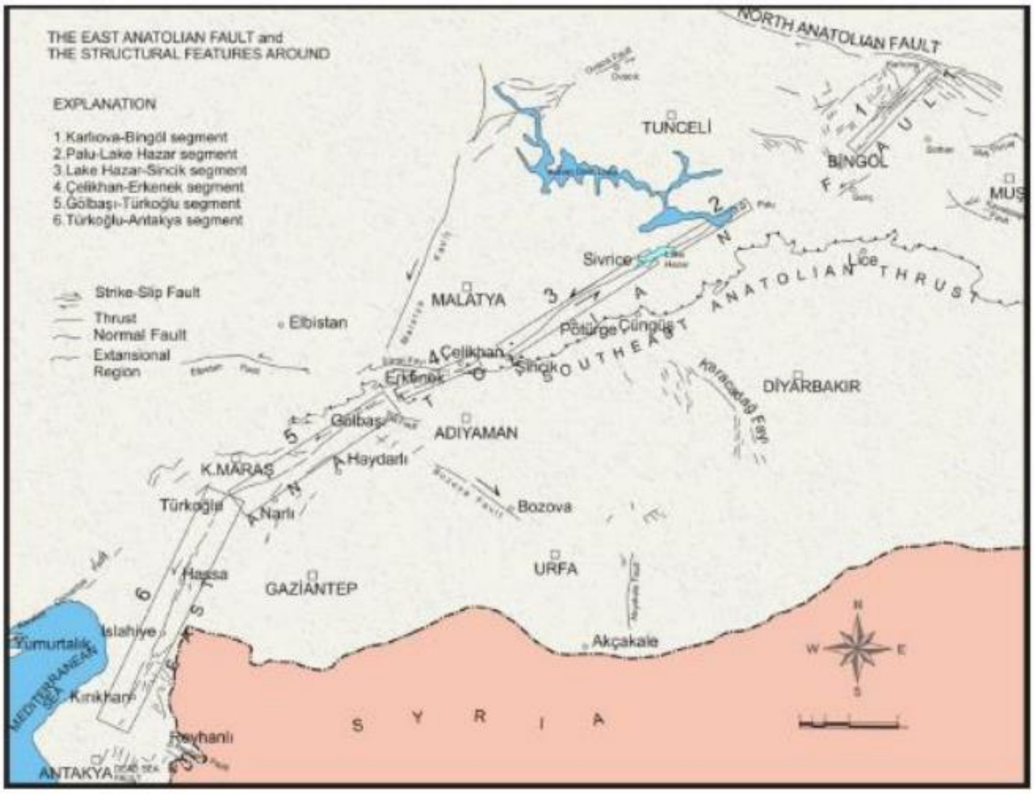


Figure 4.7: *Different Segments of the East Anatolian Fault Zone*

Source: *(Şaroğlu, Emre, & Kuşçu, 1992)*

The Gölbaşı-Türkoğlu fault segment which also covers Kahramanmaraş, is 90 km long. This fault is located in Gölbaşı district of Adıyaman, close to Harmanlı. While this fault continues as a single fault line until around Gölbaşı, it continues by separating into more than one segment after Gölbaşı district. The basic line starts from the west of Harmanlı and extends towards Gölbaşı district (Palutoğlu &

Şaşmaz, 2017). The direction of the fault and the detailed representation of the Gölbaşı-Türkoğlu segment are shown in the below Figure 4.8.

When the situation of the Eastern Anatolian Fault Zone in Türkoğlu District is examined, this fault is observed to have three branches;

- The first fault branch is 22.5 km long from Kuyumcular, Güllühüyük, Station, Ceceli, Akçalı Neighborhoods,

- The second fault branch is 13 km long from Beyoğlu, Şekeroba, Yeşilyurt and Minehüyük Neighborhoods,

- The third fault branch passes through Hacıbebek and Çobantepe Neighborhoods with a length of 6.9 km.

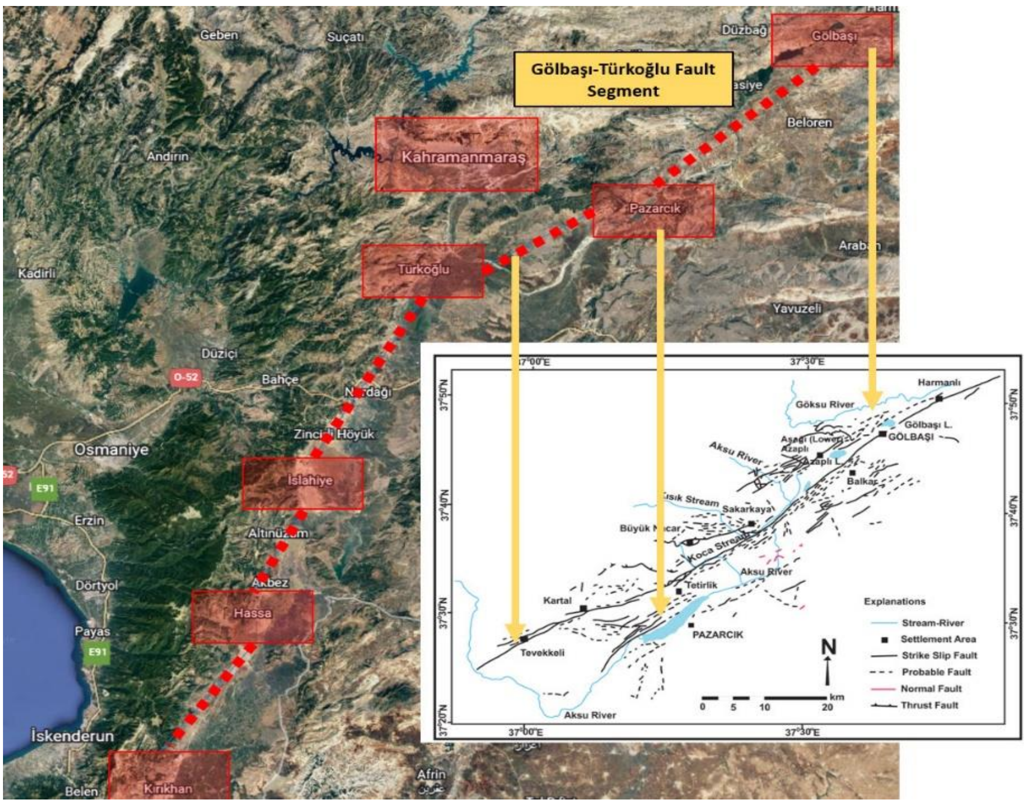


Figure 4.8: *Map of the Gölbaşı-Türkoğlu Segment of the Eastern Anatolian Fault Zone and it's Tectonic*

Source: *(Auther Representation - Google Earth, 2022)*

When historical earthquake records are examined, it is seen that while earthquakes that produced surface ruptures occurred in a large part of the East Anatolian Fault in the 85-year period between 1820 and 1905, there have been no destructive earthquakes on the Gölbaşı-Türkoğlu segment of the fault since 1114 and 1513 (Figure 4.9). However, when the historical records are examined, it is seen that earthquakes with a magnitude greater than M_w=7 occurred in the Gölbaşı-Türkoğlu (Pazarcık) segment. This indicates that the Gölbaşı-Türkoğlu segment may have a seismic gap. In addition to this risk, the existence of Türkoğlu-Antakya (Amanos) segments, which are thought to have produced an earthquake greater than Mw=7 in 1822, increases the probability of producing earthquakes of similar magnitudes today. Therefore, the region is a critical region in terms of large earthquake potential (Tan, Tapirdamaz, & Yörük, 2008).

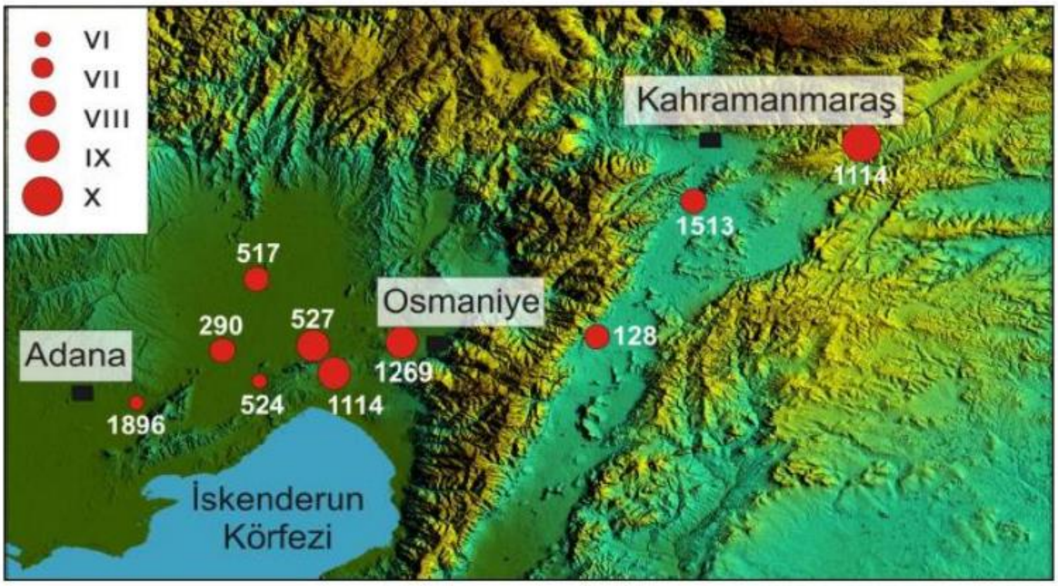


Figure 4.9: *Approximate Locations of Earthquakes in the Historical Earthquake Catalogs in the Study Area and Its Surroundings*

Source: *(Ambraseys, 1989); (Soysal, Sipahioğlu, Kolçak, & Altınok, 1981); (Guidoboni & Comastri, 2005)*

A large number of earthquakes with a magnitude of 5 and above have been recorded on the Eastern Anatolian Fault zone within the last century (Kalafat, et al., 2011); (Tan, Tapirdamaz, & Yörük, 2008). Some of these earthquakes, affecting Malatya with a magnitude of 6.8 in 1905, affecting Bingöl with a magnitude of 6.8 in 1971 and Palu with a magnitude of 5.1 in 1977, are proof that this fault is seismically active. In the instrumental period, on the Eastern Anatolian Fault zone, 9 important earthquakes have occurred until today. Parameters related to these earthquakes are presented in Table 4.2.

Table 4.2: *Data of Significant Earthquakes Occurring in the Instrumental Period on the Eastern Anatolian Fault Zone*

Date	**Location**	**M_s**	**Casualties**	**Number of damaged buildings**
14.07.1964	Malatya	6.0	8	847
26.07.1967	Pülümür (Tunceli)	5.9	97	1.282
22.05.1971	Bingöl	6.8	878	9.111
05.05.1986	Doğanşehir (Malatya)	5.8	7	824
06.06.1986	Doğanşehir (Malatya)	5.6	1	1.174
27.01.2003	Pülümür (Tunceli)	5.8	1	50
01.05.2003	Bingöl	6.4	176	2.500
08.03.2010	Elazığ (Karakoçan)	6.0	42	4.568
24.01.2020	Elazığ (Sivrice)	6.8	41	24.379

Source: *(Ambraseys, 1989); (Soysal, Sipahioğlu, Kolçak, & Altınok, 1981); (Guidoboni & Comastri, 2005)*

The conclusion to be drawn from Table 4.2 is that there was no major earthquake on the Eastern Anatolian Fault zone and around Kahramanmaraş especially during the instrumental period. This seismic gap increases the earthquake risk of the selected region.

North Branch of the Eastern Anatolian Fault: The northern branch of the Eastern Anatolian Fault consists of the Sürgü, Nurhak, Elbistan and Göksun faults (Figure 4.5). The Sürgü Fault is located outside the provincial borders of Kahrammaraş, while the Nurhak, Elbistan and Göksun faults are within the city. The Sürgü Fault is separated as the North Branch of the Eastern Anatolian Fault in the Çelikhan region and it is observed to continue until the Sürgü district. It is a 38 km long left-lateral strike-slip fault.

Kahramanmaraş Fault Zone: Kahramanmaraş Fault Zone is located on the southern skirts of Ahır Mountain. This fault system, which has thrust features, was mapped as a large region in the southern parts of Ahır Mountain (Figure 4.5). The Kahramanmaraş Fault Zone continues in an approximately east-west direction within a 4 km wide zone from north to south by encircling the west of Ahırdağı. The northernmost section of this fault begins in the Kedemen District. It extends from the north of Kahramanmaraş's current settlement to Beşenli village, following the slope failure on the southern slopes of Ahır Mountain. A branch differentiating in Küçüknacar village can be traced from the southern skirts of the Kandil Mountain to the Kısık Stream Valley in the east. It has a total length of 60 km. The 7 km-long fault segment in the middle sections separates from the east-west direction and extends to the south. The southern part borders the Maraş Plain and continues to the east within the Kahramanmaraş settlement center. The total length of the southern segment is about 25 km. The section of this fault passing through the north of the city was mapped as a probable active fault in the Active Fault Map of Türkiye (Yılmaz, Şaroğlu, & Güner, 1987).

4.4 Kahramanmaraş Province Soil Properties

In addition to the tectonics and morphogical features, the local soil conditions affect both the recorded ground motions and the felt intensity of the earthquake at any location. For this reason, the geological and morphological structure of the land and the soil characteristics are also important in addition to the structural features of the building in case of damage during an earthquake. It is particularly known that softer soil deposits gave the potential to amplify the earthquake ground motions resulting in more severe damage levels in the surrounding structures.

Kahramanmaraş is located in a zone where Arabian and Anatolian plates collide with each other, and due to this feature, it has a very complex geodynamic evolution. In the region, rock communities and deformation traces formed in different environments are observed in the period extending from the Paleozoic to the present day. In most of the Kahramanmaraş region, geological units belonging to pre-neogene periods can be seen. Pliocene and post-pliocene units are observed in the part of the study area between Gölbaşı and Türkoğlu. In this region, all units except the Quaternary, which cover particularly large areas, are formed by Miocene and pre-miocene rocks.

Furthermore, it can be said that the weakest soils in Kahramanmaraş region are composed of Quaternary aged alluviums (İRAP, 2020). These types of soils can be widely observed around the Gölbaşı Basin, Türkoğlu, Narlı and Pazarcık. In general, alluvial sediments consisting of fine-grained clay silt and sand-size material around the Gölbaşı Basin are composed of medium-coarse-grained, rounded conglomerates and sands carried by the Aksu River around Pazarcık, Narlı and Türkoğlu.

The alluvial material that forms the great plains south of Türkoğlu contains old marsh sediments and fine-grained sediments (Yönlü, Altunel, Karabacak, & Akyüz, 2012). It is very close to the surface of the groundwater level. Quaternary alluvial ranges throughout the study area are widely observed units, especially in areas bounded by faults, and are widely observed between Gölbaşı and Türkoğlu (Yönlü, 2012).

Kahramanmaraş city center also consists mainly of alluvial type of soil. (İRAP, 2020). Therefore, considering the location of the neighborhoods, population, ground (alluvial or colluvial fill and fault zone) and construction characteristics, it is obvious that a significant part of the population in the city will be adversely affected by a major earthquake (Sandal & Karademir, 2013). The thickness of alluvial soils in the city increases from north to south and from east to west. In the city, which is densely built on alluvial ground, the effect of the earthquake will increase due to the soft soils. Therefore, in a possible earthquake, the ground motions from the earthquake will increase even more. For this reason, the characterization of weak alluvial soils in the wide plain areas bounded by the faults is of great importance in determining the general earthquake hazard.

In addition to this situation, the high groundwater level in alluvial soils increases the risk of liquefaction. Because earthquake waves will be amplified by such soils and transmitted to buildings. This situation, which is defined as ground amplification, means that in case of an earthquake, the city center of Kahramanmaraş will be shaken more severely than the provinces on the rock, and as a result, the damage rate could be higher. We also see that there are dense residential areas on the Maraş Plain in the city. Streams flowing from Ahır Mountain to the bottom of the Maraş Plain have formed small cones of accumulation in the areas where they reach the plain (İRAP, 2020). Cones of debris formed can move in the event of an earthquake and cause slippage. This can lead to landslides triggered by the earthquake. Unfortunately, urban settlement in Kahramanmaraş is mostly located on such grounds.

Past research show that liquefaction may occur in a major earthquake, especially in the southern parts of Kahramanmaraş city center. The liquefaction that may occur in the soils with certain conditions in earthquakes reaching a certain magnitude causes the structures above the ground to not be able to support, and the structures may be severely damaged. Such soils cause problems such as liquefaction, settlement and lateral spreading during earthquakes (Jeoloji Mühendisleri Odası, TMMOB, 2021). Since a significant part of Kahramanmaraş is located in a region that is alluvial and some of it is located in an area that is slightly older but still on weak ground units, it is a city that has experienced negative effects from the ground in earthquakes and still has significant seismic risk.

High bearing capacity soils in the region are observed in a narrow area in the east of Kahramanmaraş (İRAP, 2020). In addition, Ahır Mountain, which forms the northern part of Kahramanmaraş, has a limestone type soil structure. In these places, where the city is shown as solid ground, settlement is at a minimum level due to topographic conditions.

Sandal and Karademir (2013), in their study which is called "The Relationship between Ground Conditions and Earthquake Based on Seismicity in Kahramanmaraş", showed the local site conditions of Kahramanmaraş and its immediate surroundings in Figure 4.10.

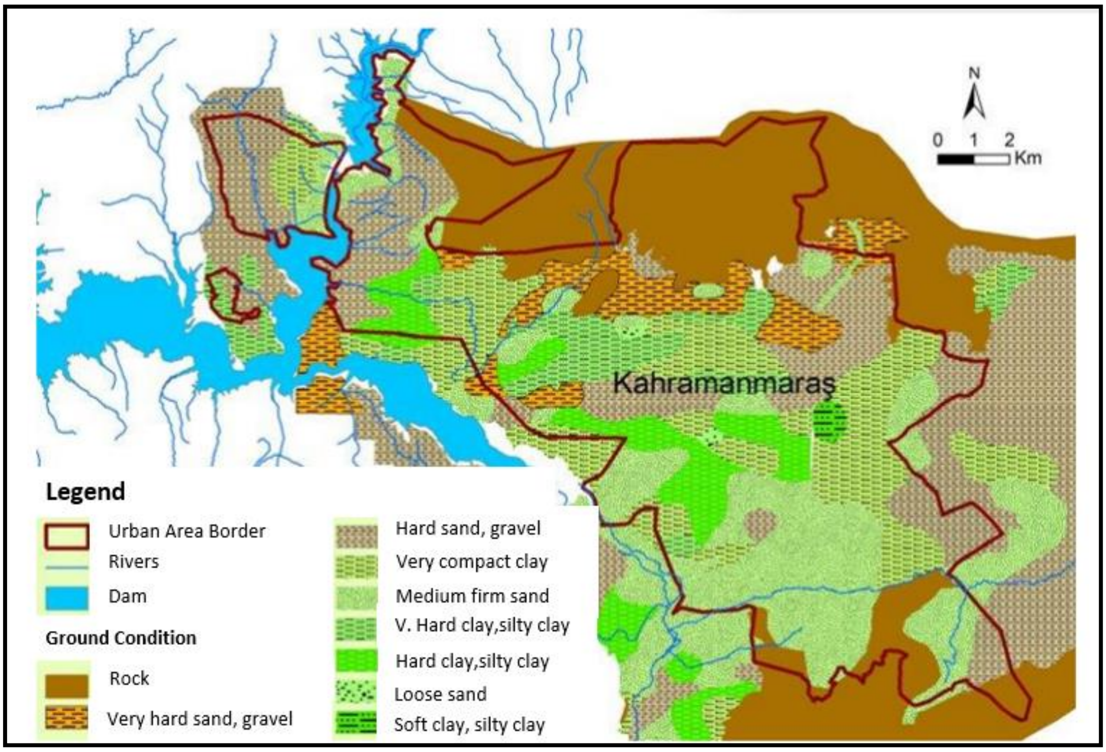


Figure 4.10: *Local Site Conditions of Kahramanmaraş and its Surroundings*

Source: *(Sandal & Karademir, 2013)*

4.5 Kahramanmaraş City Center Development

Kahramanmaraş city center, which was established on the Maraş plain surrounded by rough terrain with very high mountains, consists of Onikisubat and Dulkadiroğlu Districts. A total of 240 neighborhoods and a total population of 671.849 people live in two districts (TUIK, 2021).

The geomorphological structure of the area where the city was basically settled and developed is divided into three main parts: the high mountainous area and the Maraş basin, and the skirt plains and slopes between these two geomorphological structures (Çevre, Şehircilik ve İklim Değişikliği Bakanlığı, 2011).

When we examine the urban development process of Kahramanmaraş, it is possible to say that the most important factor in the formation of the city form as it is today is the topographic structure of Kahramanmaraş (Yüksel Proje, Dolsar, & Üçer, 2021) (Figure 4.11).

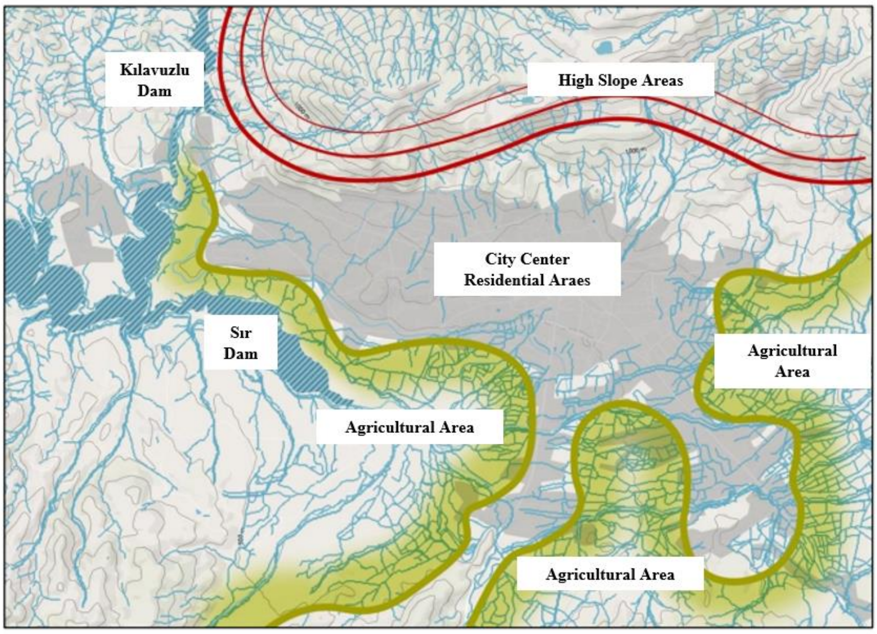


Figure 4.11: *Representation of Natural Thresholds in Kahramanmaraş City Center*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

Due to the natural thresholds limiting urban development, it can be said that the city was settled in the region between the Ahır Mountain in the north and the agricultural lands in the south. The Kılavuzlu Dam, located near the university in the west of the city, and the Sır Dams in the south, stand out as barriers to urban development in the city.

In the east of the city, agricultural lands are located as a threshold as an obstacle to urban development. Although urban development is limited to fertile agricultural lands in the south, in this region (around Adana and Gaziantep roads), it continues with non-residential urban working areas, industrial units, storage areas and developed residential areas with shared parcellation.

When we look at the city center and its surroundings in general, although the city is developing in the east direction, the direction of urban expansion has been realized in the west and south directions (Figure 4.12), (Dünya Bankası, 2020).

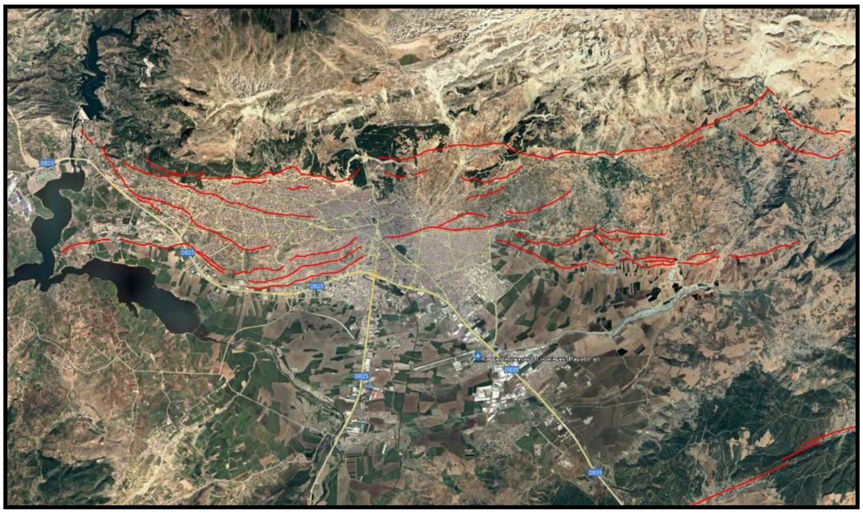


Figure 4.12: *Kahramanmaras City Center Satellite View with Active Faults*

Source: *(Auther Representation - Google Earth, 2022)*

From the 1980s to the present, the city began to expand eastward, but almost all of the urban sprawl took place in the west and south directions (Figure 4.13). It can be said that one of the reasons for this spatial development is the effect of the university. When the urban development of Kahramanmaraş Province is examined in the historical process, it can be said that there is a development in the vicinity of Fevzipaşa, Şehit Evliya, Yusuflar, Ekmekçi, Kurtuluş, İsmetpaşa, İsa Divanlı, Sakarya, Divanlı and Turan neighborhoods, as well as the Ulu Mosque, Kahramanmaraş Castle and the covered market. Neighborhoods are more concentrated in these areas.

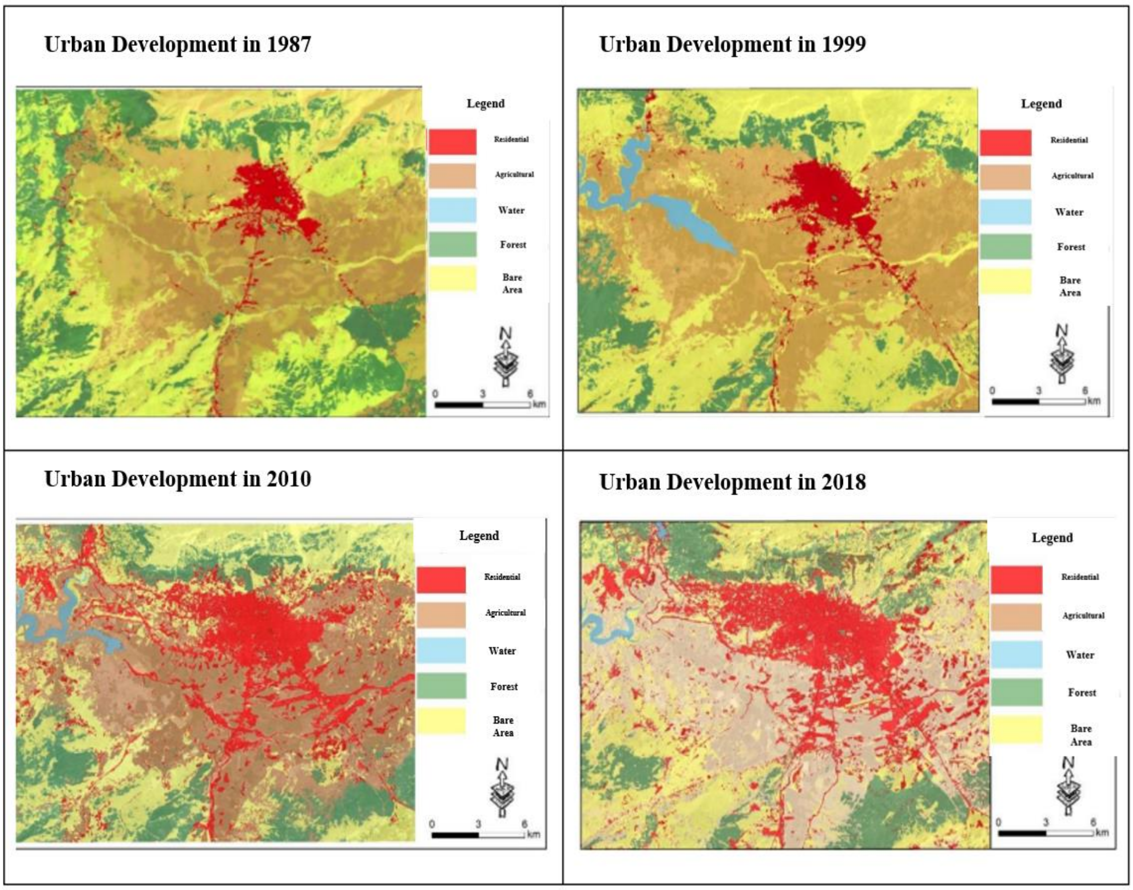


Figure 4.13: *Urban Settlement Area Change in Kahramanmaraş Province Between 1987-2018*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

In addition, the Bahçelievler region has developed as a city center in parallel with the development of the city in the historical process. The part called the old settlement centered in Bahçelievler has developed intensively towards the west. It is possible to observe that the types of buildings existing in the urban area have changed as a result of the rapid urbanization in the city of Kahramanmaraş. It can be said that over time, the number of floors in buildings has increased, the number of houses with gardens has decreased and more mass housing type structures have become more concentrated (Demir, 2007).

The land use change data in Kahramanmaraş urban settlement area between 1987 and 2018 are given in Table 4.3.

Table 4.3: *Change of Land Use in Kahramanmaraş Province between 1987-2018*

	1987	1999	2010	2018
Urban Residential Area	18,02 km^2	25,76 km^2	88,40 km^2	103,92 km^2
Urban Development Direction	East-West	East-Southeast-West	East-West	North-South
Factors Driving Urban Development	Development towards to Adana Gaziantep and Kayseri Roads.	Construction of the Sır Dam, The increase in irrigation areas and agricultural areas with the dam, Increase in field areas in Kale and Fatmali districts.	The inclusion of the Gençosman neighborhood in the east into the city, The widespread use of vineyard houses, which are used as second residences on the skirts of Ahır Mountain, Establishment of Sütçü İmam University in the West The development of Üngüt Neighborhood reaches Kılavuzlu Dam,	Construction of Kılavuzlu Dam, Continuing the construction of secondary housing in the northeast-northwest, Opening the agricultural areas in and around Piri Reis Neighborhood for construction, Establishment of Textile Specialized Organized Sabayi Region on Adana road.

Table 4.3: (Continued)

			Kahramanmaraş Organized Industrial Zone, established near Kavlaklı village, Karacasu District, Osmangazi District, Aksu District, which developed around the established industrial zone, Opening of agricultural areas to settlement by shrinking (Erkenez, Deliçay, Aksu streams are used in agricultural areas and the water surface decreases), The start of agricultural activities in the dam bed with the decrease of the water level of the dam.	

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

Looking at the data obtained from Table 4.4, it is seen that the size of the urban settlement area increased approximately 6 (six) times between 1987 and 2018. The decrease in agricultural areas, in particular, is an indication that urban settlement is advancing towards these areas.

Table 4.4: *Change in Land Use Rates in Kahramanmaraş Province Between 1987-2018*

	Residential Area (km²)	Water Surface (km²)	Agricultural Area (km²)	Forest (km²)	Bare Area (km²)
1987	18,02	1,3	200,1	98,12	189,09
1999	25,76	13,84	216,7	60,02	190,44
2012	88,4	6,64	190,18	72,74	148,78
2018	103,92	3,69	178,91	76,17	144,01

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

The current land use map for 2018 in Kahramanmaraş city center is shown in Figure 4.14.

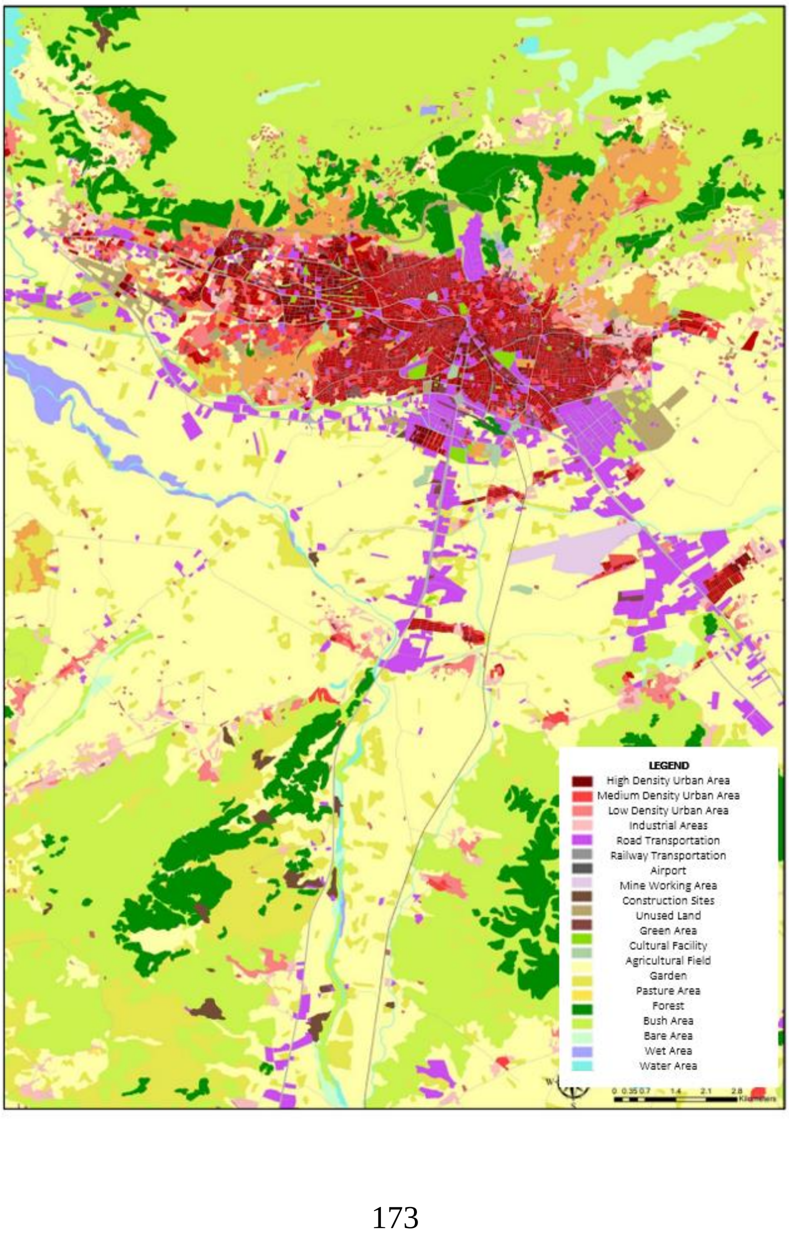


Figure 4.14: *Kahramanmaraş City Center Land Use Decisions (2018)*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

When the satellite images for 2022 are examined, it is seen that the increase in residential areas continues and the bare area ratio continues to decrease. The settlement area image taken for the year 2022 is given in Figure 4.15. In the period from 2018 to 2022, it is seen that the city developed on the east-west axis. The developments contributing to this situation can be shown as developing industrial establishments in the east of the city, mass housing projects in the east and west, and a university campus (Yüksel Proje, Dolsar, & Üçer, 2021).

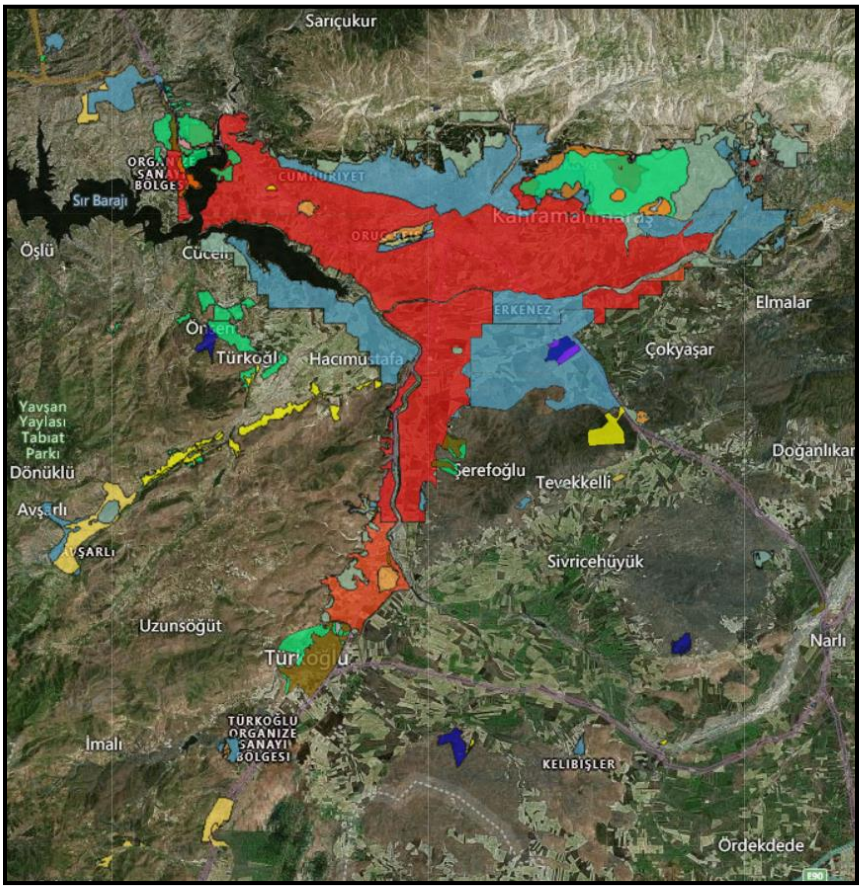


Figure 4.15: *Kahramanmaraş Urban Development Area in 2022*

Source: *(TC. Çevre, Şehircilik ve İklim Değişikliği Bak., 2022)*

Figure 4.16: *Kahramanmaraş City Center (above) and West Side Development Corridor (below)*

4.6 Kahramanmaraş Central Business District (CBD) Development

Central business areas in Kahramanmaraş start from Kahramanmaraş Castle and extend to the main road passing through the south of the province. The approximate size of the current central business area is around 150 hectares. Kahramanmaraş city center main study areas are shown in Figure 4.17.

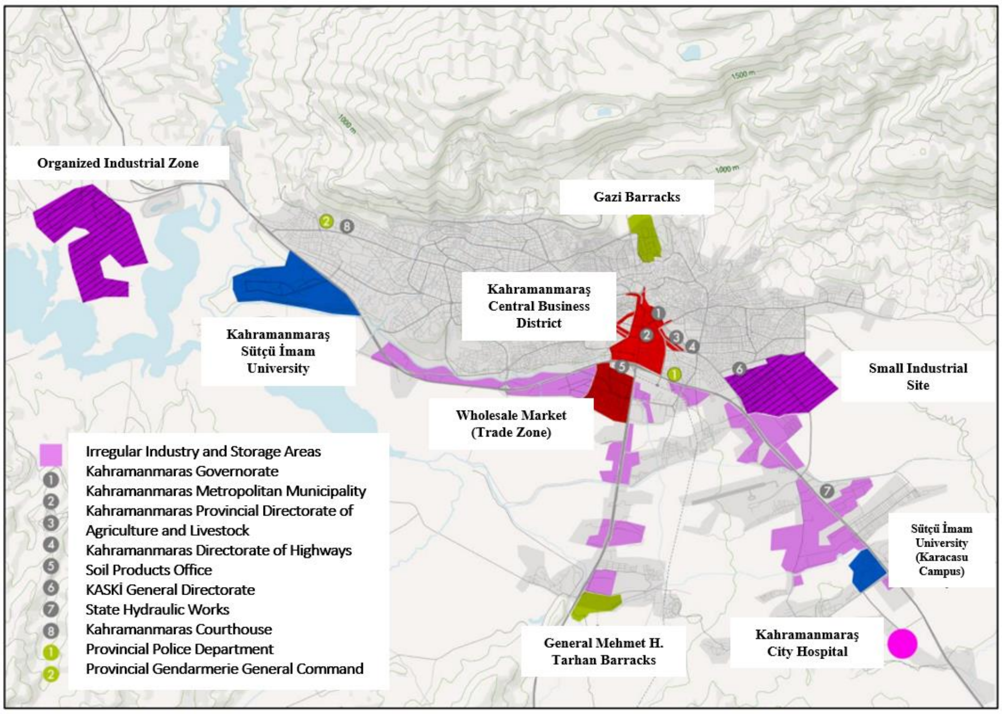


Figure 4.17: *Kahramanmaraş City Center Main Working Areas*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

Commercial units concentrated in the central business area developed along Azerbaycan Boulevard, Trabzon Boulevard and Kuddisi Baba Boulevard, Zübeyde Hanım Boulevard and Atatürk Boulevard in the north. In addition to commercial activities, there are offices and public institutions in the region. There are different public institutions such as the Governor's Office, Courthouse, Municipality Building, Provincial Directorate of Agriculture and Livestock and the 55th Branch of

Highways in the mentioned region. In the south of the region, which is defined as the central business area, the wholesale market and the warehouses of the workplaces dealing with wholesale trade are concentrated. The size of this area is approximately 33 hectares. In the north of the central business area, some public institutions and organizations were gathered. Again, on the west of the same area, there is the Police Department, and further on, the Provincial Gendarmerie Command and the Kahramanmaraş Courthouse.

There is an organized industrial zone in the west of the city and a small industrial site in the east. The organized industrial zone is built on an area of 320 hectares and has been operating since 2003. Approximately 9,000 people are employed in this region. There are production units in 61 parcels of this organized industrial zone, which has 75 parcels in total, and social and administrative units in 14 parcels. When the industrial establishments in the city are examined, there are 2200 workplaces in total in the small industrial site located in the east of the city. This region is established on an area of approximately 270 hectares. With the growth of the city towards the east, the number of existing workplaces in this region is likely to increase. There are irregularly established factories, production sites and warehouses adjacent to the small and large industrial zones in the west and east of the city. These places, which are planned to be brought together by establishing an organized industrial zone, are currently continuing their activities outside this area (Yüksel Proje, Dolsar, & Üçer, 2021).

It is known that small workshop-type industrial buildings are concentrated in the city for handicrafts that were previously developed. In 1957, the old industry in the Menderes District, which has lost its function today, was built. Afterwards, with the changing and developing industrial conditions, large-scale factories started to be built in the east of the city in 1978. It was established in Yavuz Sultan Selim Neighborhood. Currently, it continues to develop along the Gaziantep and Adana road, especially in the southern parts of the city, and Kayseri in the north (Yüksel Proje, Dolsar, & Üçer, 2021).

The main campus of Sütçü İmam University in the city was established in the west of the city. Located on the Gaziantep road, Sütçü İmam University Karacasu Campus is built on an area of approximately 190 hectares (Yüksel Proje, Dolsar, & Üçer, 2021). Kahramanmaraş City Hospital was also established on the same road.

4.7 Kahramanmaraş Province Existing Building Stock

With the rapid urbanization, the phenomenon of migration and the development in mass media, the change in the concept of family by shrinking the family has placed the need for housing, which is the most important concept in the city, at the top of the agenda (Temiz, Binici, Köse, & Kuşat Gürün, 2011). In parallel with industrialization, there has been an intense migration from the surrounding provinces and districts to the city center, and with the migration, an enormous housing construction has been observed in the city center. This internal migration also brought along an infrastructure problem (İRAP, 2020). Generally, the houses around narrow streets display a different texture, sometimes by using the same wall, sometimes by making use of the elevation difference and based on neighborhood relations.

When a distinction is made according to the spatial texture of the city, the part considered as the central business area has a geometrically regular texture and there are offices, administrative units and commercial centers in this area. On the other hand, the traditional center, which forms the historical settlement texture of the city, has an organic texture (Figure 4.18). Reinforced concrete and masonry structures are in the majority in cities and towns. Especially in mountain villages, houses built using stone and earth materials constitute the common type of housing (İRAP, 2020).

In the city as a whole, the construction style consists of 1, 2 and 3 storey buildings in the old settlements. The urban form of Kahramanmaraş has historically been concentrated in the urban area around the neighborhoods of Fevzipaşa, Şehit Evliya, Yusuflar, Ekmekçi, Kurtuluş, İsmetpaşa, İsa Divanlı, Sakarya, Divanlı and Turan, as well as the neighborhoods close to Kahramanmaraş Castle and the covered bazaar. Although the city has expanded to the east since the 1980s, this expansion has been limited. Therefore, almost all of the urban sprawl took place towards the agricultural lands in the west and south (Dünya Bankası, 2020). Divanlı, İsa Divanlı, Duraklı, Turan, Ekmekçi, Yusuflar, Fevzipaşa, Şehit Evliya, Kurtuluş, Dumlupınar, Sakarya, Şeyhadil, Senem Ayşe, Namık Kemal Neighborhoods are located in the place that can be described as a historical settlement consisting of very narrow streets and old buildings.

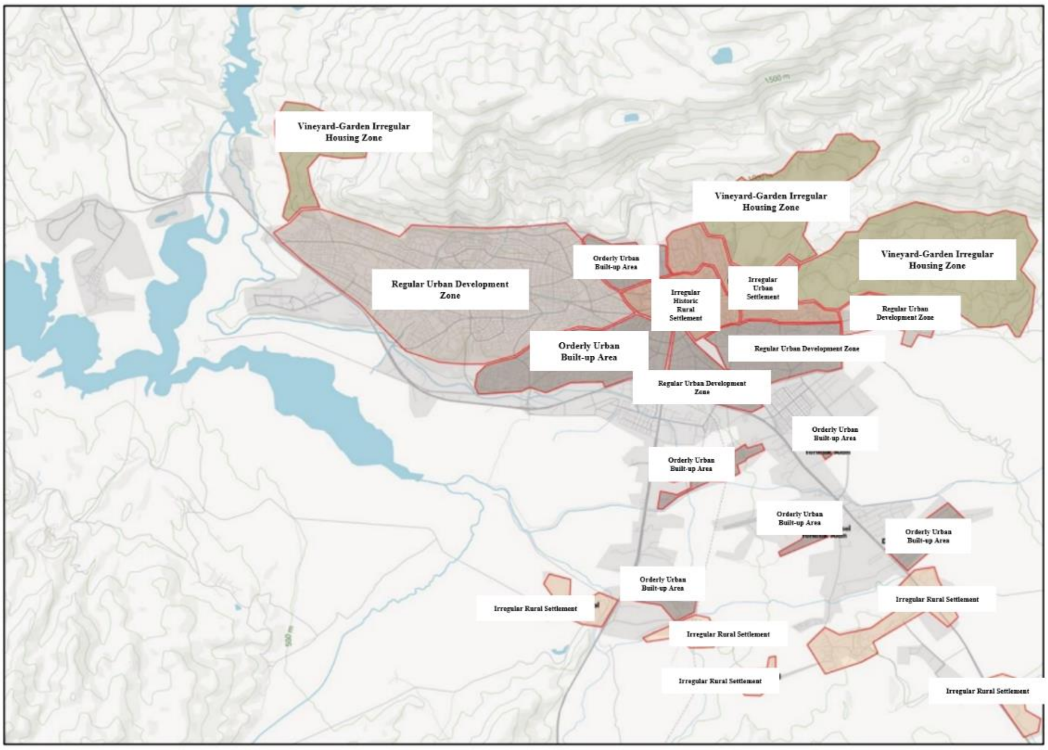


Figure 4.18: *Distribution of Urban Settlement Types in Kahramanmaraş Province Central Districts*

Source*: (Yüksel Proje, Dolsar, & Üçer, 2021)*

Due to the organic texture and street structure of the settlement, these areas are defined as geometrically irregular areas. Shared parcellation areas, which generally consist of masonry-type buildings in the city, constitute the areas of the city that develop in a geometrically regular manner. These regions have a very dense construction texture. Serintepe, Osmangazi, Mağralı, Şehit Evliya, Yörük Selim, Fevzipaşa, Kurtuluş, Divanlı, İsadivanlı, Sakarya, Şeyhadil, Dulkadiroğlu Neighborhoods are where such structures are concentrated. Existing structures are generally built as 1, 2 and 3 storeys (Dünya Bankası, 2020). In Serintepe Neighborhood, where masonry structures are dense, generally 2-3 storey buildings.

Irregular settlement areas, which constitute approximately 6-7% of the existing settled area in the city, are located in the close vicinity of the city center. These are the regions where the pressure of urban transformation is concentrated. Accordingly, in the 1/5.000 scale master development plan approved in 2013, an urban transformation area was declared in the irregular residential area concentrated in the north of the city center. The urban transformation process has had a positive impact on the city, especially in the parts of the irregular housing areas extending to the west. With the transformation, shared parcellation areas have been transformed and higher-rise regular residential areas have emerged.

Urban density differences are observed in the regularly developing regions of Kahramanmaraş. It has been observed that in the north-west region, which can be described as the city periphery, regular construction generally develops as higher-rise (8,9 and 10-storey) sites. Neighborhoods where this kind of development is seen spatially can be counted as Binevler, Haydarbey, Cumhuriyet, Üngüt, Onikişubat, Hürriyet, Akif İnan, Şehit Abdullah Çavuş, Doğukent and İsmetpaşa Neighborhoods, and Trabzon Street in Yenişehir District (Dünya Bankası, 2020).

When the development of the city in the south and southeast directions is examined, it is seen that the development in these directions is gradual. It can be said that in the Şazi Bey, Sümer, Eyüp Sultan neighborhoods and Karacasu region, which are located in the south of the city, there are concentrated parcellation areas that can be described as regular. Along the Kahramanmaraş-Gaziantep highway, it is seen that rural-type settlements developed. Gayberli, Hacı Bayram Veli, Yusuflar and Malikejder neighborhoods in Kahramanmaraş have been declared as risky areas. Serintepe Neighborhood is the one with the most masonry buildings among the central districts. This neighborhood is followed by Karacaoğlan, Duraklı, Namık Kemal and Dumlupınar Districts. The construction style in the province in general consists of 1, 2 and 3 storey buildings in the old settlements.

Second housing development is observed in Dereli, Sarıkaya and Göllü Neighborhoods, which are settled on a sloping land on the skirts of Ahır Mountain in the northeast of the city. This texture, which spreads over a very large area, is in the nature of an irregularly developing vineyard-garden system. In the region, which has a very low building density, there are mostly residential types that can be used for summer purposes. These structures are mostly 2 or 3 storey villas. This type of construction is also seen in the area between Ahır Mountain and Kılavuzlu Dam in the northwest of the city (Dünya Bankası, 2020).

Along with the rapid industrialization on a local scale, immigrants from the surrounding villages, districts and provinces also create unlicensed and unplanned settlements in areas where the land is cheap (Yılmaz M. , 2013). Industrial areas in the city are developing on the ring road (Adana-Gaziantep-Kayseri) routes located in the south of the city. It is located on fertile agricultural lands with high groundwater levels. Since the agricultural areas opened for residential and industrial use in Kahramanmaraş city center are also a 1st degree Earthquake Zone, there is also a risk of life safety in an earthquake that may occur (Temiz, Binici, Köse, & Kuşat Gürün, 2011).

In order to be understandable according to the map obtained in Figure 4.19, the classification was made in 7 groups by demonstrating earthquake zones and the most suitable areas were shown as 7 and the least suitable areas as 1. According to the map obtained in the study, suitable areas are seen densely in the south and north parts of the Kahramanmaraş (Karaağaç, Karaman, & Aktuğ, 2019).

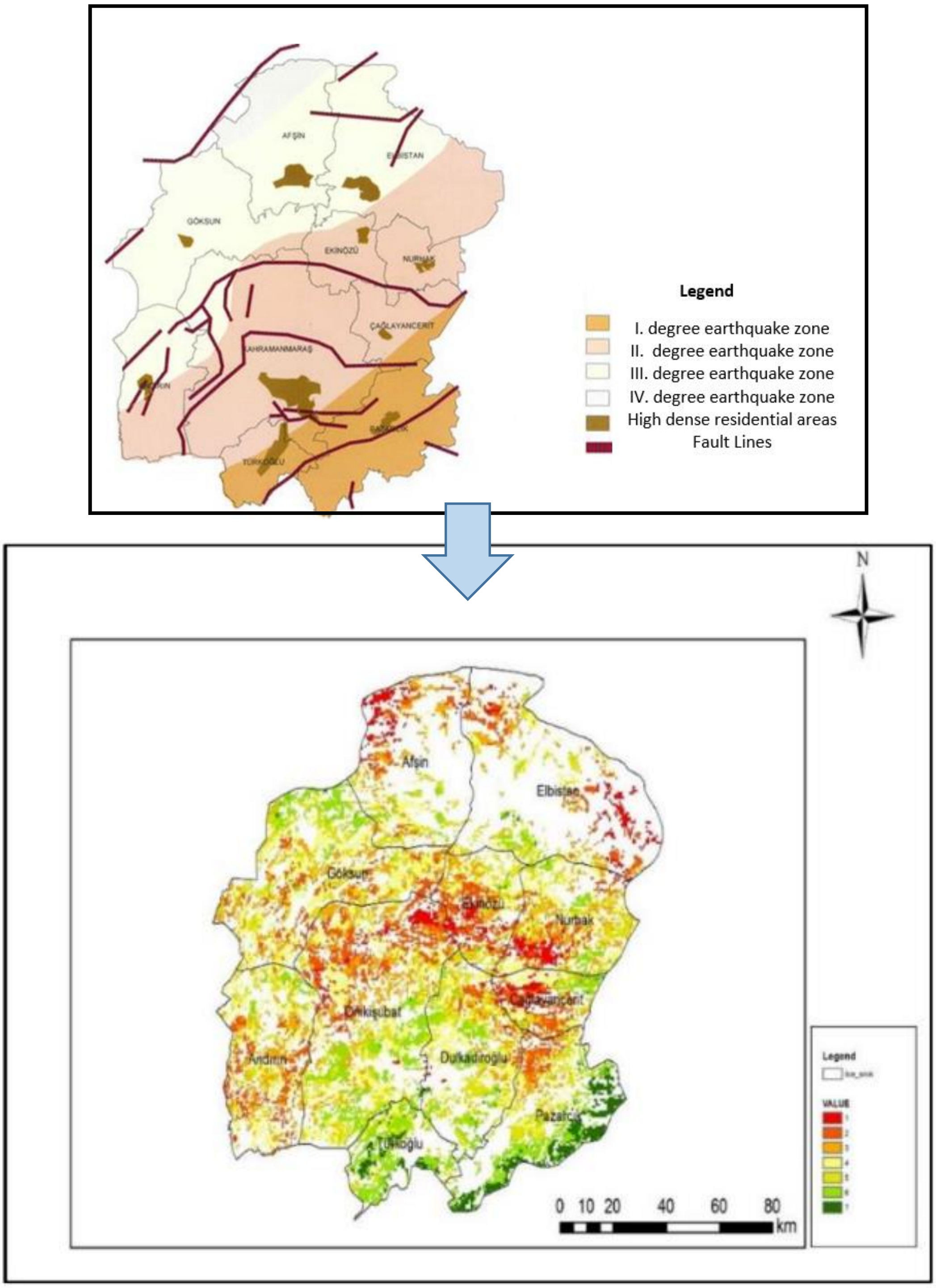


Figure 4.19*: The Most Suitable Settlement Areas for Kahramanmaraş*

Source: *(Karaağaç, Karaman, & Aktuğ, 2019)*

4.8 Rural Settlement of Kahramanmaraş Province Central Districts

There are two districts positioned as the central district in Kahramanmaraş Province. These districts are Onikişubat and Dulkadiroğlu Districts. The population densities of these districts located in the city center are shown in Figure 4.20 and the borders of these districts are shown in Figure 4.21.

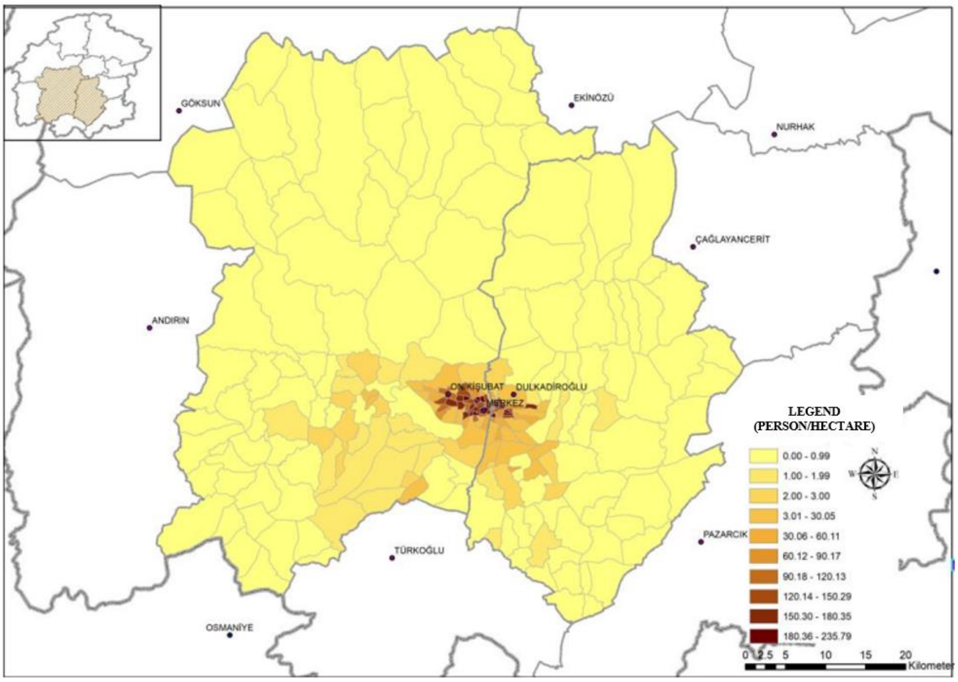


Figure 4.20: *Neighborhood Densities of Onikisubat and Dulkadiroğlu Districts*

Source*: (Yüksel Proje, Dolsar, & Üçer, 2021)*

There are 84 rural neighborhoods in Onikişubat district, which is one of the two central districts of Kahramanmaraş Province. The total rural population of the neighborhoods in the district is 85.368 people. Dönüklü neighborhood of Onikisubat district has the highest rural population with 5.035 people. The total settlement area of the neighborhood is 2.500 hectares. The district is a rural residential area located on a wide plain at the intersection of two valleys (Figure 4.22).

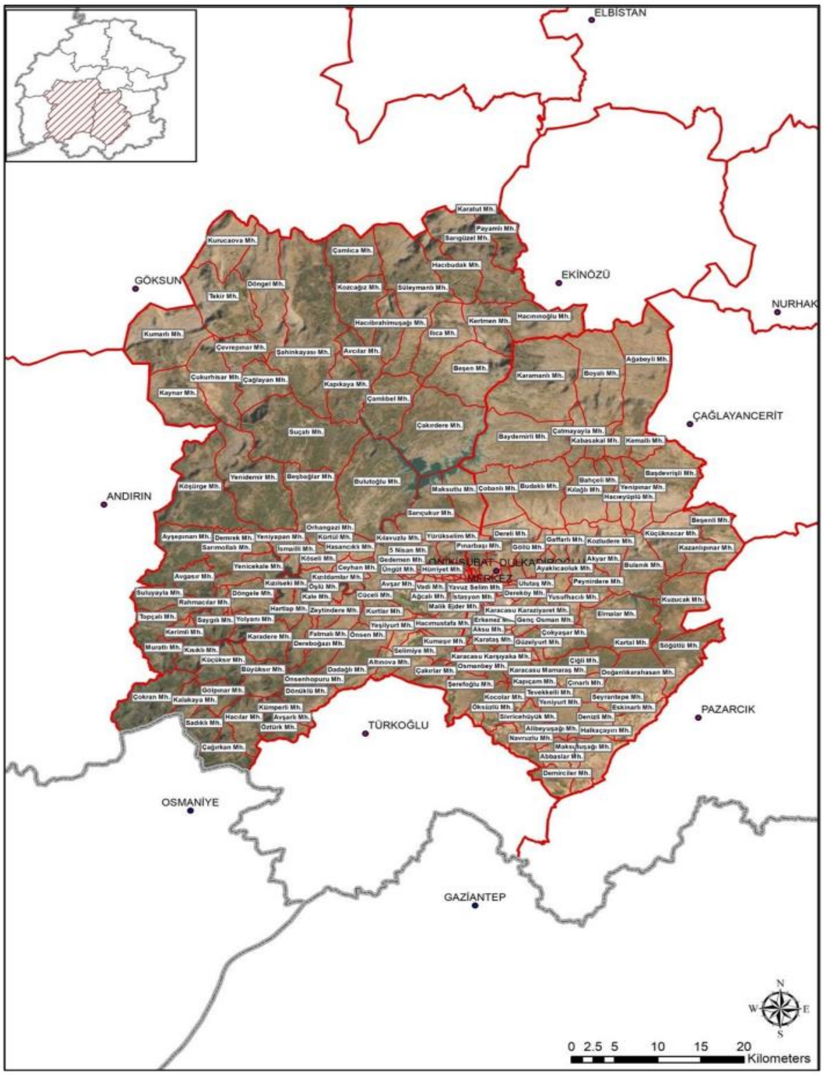


Figure 4.21: *Borders of Onikisubat and Dulkadiroğlu Districts*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

Existing residential areas have developed around agricultural lands with low density. The smallest neighborhood of Onikisubat district is Reyhanlı District. The total population of the rural neighborhood is 71 people and the settlement area is 240 hectares (Yüksel Proje, Dolsar, & Üçer, 2021).

Figure 4.22: *Dönüklü Neighbourhood Satellite Image*

Source: *(Author Representation - Google Earth, 2022)*

The other central district of Kahramanmaraş Province is Dulkadiroğlu district. There are a total of 59 rural neighborhoods in the district. The total rural population of Dulkadiroğlu district is 49.460 people. Elmalı neighborhood of the district has the highest rural population with 4.876 people. The total residential area of the neighborhood is 5.000 hectares. Elmalar District is 20 km from the city center and has fertile agricultural lands (Figure 4.23). The smallest neighborhood of Dulkadiroğlu district is Ekberoğlu District. The total population of the rural neighborhood is 116 people and the settlement area is 700 hectares (Yüksel Proje, Dolsar, & Üçer, 2021).

Figure 4.23: *Elmalı Neighbourhood Satellite Image*

Source: *(Author Representation - Google Earth, 2022)*

4.9 Kahramanmaraş Province Planning History

4.9.1 Kahramanmaraş Territorial Plan (1/100.000)

The main basis of this plan, prepared for 2030, is the Eastern Mediterranean Development Agency Regional Plan and the IX. Development Plans. The aim of the plan is to assign different functions to Kahramanmaraş, which is currently developing as an agricultural province. Within the scope of this plan, in addition to agriculture, the development of the province under the leadership of agricultural products, health, energy, culture, science and technology was presented as a vision. Kahramanmaraş Territorial Plan, which was prepared for the year 2030, is given in Figure 4.24.

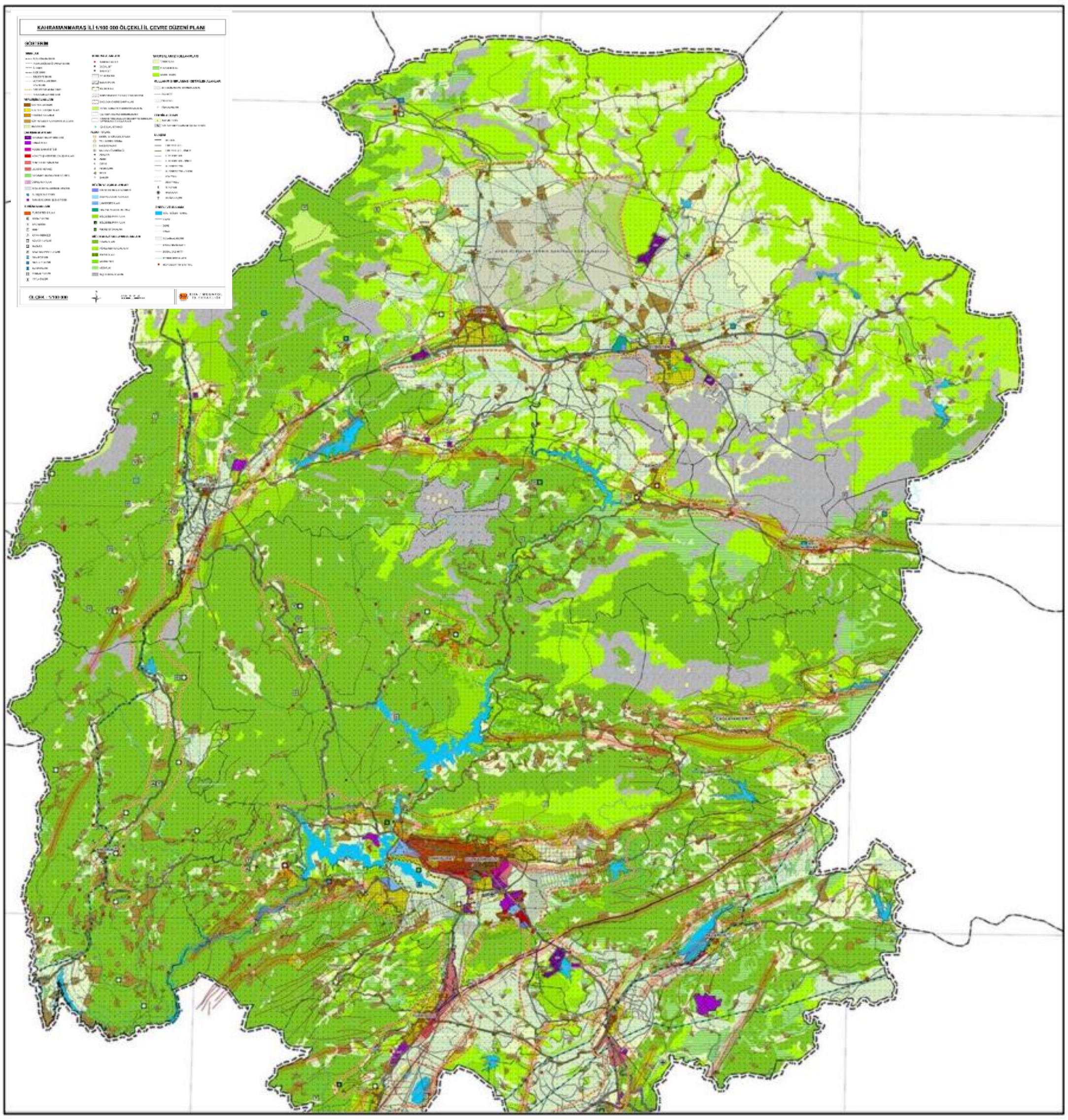


Figure 4.24: *Kahramanmaraş Territorial Plan (1/100.000)*

Source: *(Kahramanmaraş Büyükşehir Belediyesi, 2019)*

4.9.2 Kahramanmaraş Master Development Plan (1/5.000)

The 1/5.000 scale master development plan covers the regions defined as urban areas within the borders of Kahramanmaraş Municipality. In this plan, "1/5.000 scale master development plan decisions will be evaluated at the stage of 1/1.000 scale implementation plan studies, necessary arrangements and renewals can be made in this direction after the studies are concluded." is included in the plan notes section.

4.9.2.1 Kahramanmaraş Center Additional + Revision Development Plan (2013)

The implementation plan (1/1.000 scale) prepared for the city of Kahramanmaraş covers an urban area of approximately 10.000 hectares. The boundaries of the development plan approved according to this plan are approximately 15,4 km in the east-west direction and it is given as approximately 7,5 km in the north-south direction. In this context, Kahramanmaraş has the status of a city that can show developments on a regional scale in the future by examining data such as historical, cultural, natural values, geographical location, social and economic structure . For this reason, the necessity of plan decisions to be taken in order to develop urban identity should be emphasized in urban planning (Table 4.5) (Yüksel Proje, Dolsar, & Üçer, 2021).

Table 4.5: *Kahramanmaraş Center Additional + Revision Development Plan Data*

Scale: 1/1.000
Preparation date: 2013
Target Year: 2030
2010 Population: 1.044.816
2030 Population: 900.000
Existing Planned Housing Area: 1408,92 ha
Development Housing Area: 1473,78 ha
Residential and Development Housing Area: 2252,48 ha
Total Available Space: 6452,24 ha
Total Planned Area: 10095,27 ha
Administrative Facility Areas (existing): 105,71 ha
Administrative Facility Areas: 139,56 ha
Central Business Area: 111,29 ha

Table 4.5: (Continued)

Mixed Use Area: 374,28 ha
Non-Residential Urban Study Area: 627,87 ha
Urban Service Area: 245,02 ha
Strategic Center: 56,09 ha
Industrial Area: 208,84 ha
Small Industrial Area: 166,26 ha

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

4.9.2.2 Kahramanmaraş Dulkadiroğlu District, Şerefoğlu Neighborhood Master Development Plan Research and Plan Explanation Report (2019)- (1/5.000 Scale)

The plan prepared for the Şerefoğlu Neighbourhood of the Dulkadiroğlu district of Kahramanmaraş Province divided the region into two regions, the northern and the southern part. The plan for the northern part of 126.3 hectares and the southern part of 95.3 hectares covers a total area of 221.6 hectares (Yüksel Proje, Dolsar, & Üçer, 2021).

The purpose of the plan has been defined as the creation of public spaces sufficient for the population expected to be formed in the current settlement area in the projection period of the plan, within the framework of the definitions of the zoning plans in the Development Law No. 3194. At the end of the development plan study, it is aimed that the existing physical development in the neighborhood will reach a healthy infrastructure and that the spatial, social, economic and cultural development will be improved. In this way, directing the spatial development and adding a new vision to the neighborhood were presented as the main purpose. In this plan, which will be prepared for the 2040 target year, it is aimed to provide sufficient social, cultural and economic infrastructure for the foreseen population and to create employment opportunities. In the neighborhood, which consists of two different settlements within the plan, the development plan area covers a total area of 168,3 hectares, 99,4 hectares in Uzunkışla settlement and 68,9 hectares in Şerefoğlu Neighbourhood (Table 4.6), (Yüksel Proje, Dolsar, & Üçer, 2021).

Table 4.6: *Kahramanmaraş Dulkadiroğlu District, Şerefoğlu Neighborhood Master Development Plan Data*

Scale: 1/5.000
Preparation date: 2019
Target Year: 2040
2017 Population: 1.164 person
2040 Population: 3.000 person
Existing Planned Housing Area: 22,4 ha
Development Housing Area: 58,1 ha
Residential and Development Housing Area: 80,5 ha
Total Planned Area: 168,3 ha
Residential and Commercial Area: 0,4 ha
Municipal Service Areas: 0,3 ha

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

4.9.2.3 Kahramanmaraş Dulkadiroğlu District, Şerefoğlu Neighborhood Implementation Plan Research and Plan Explanation Report (2019)-(1/1.000 Scale)

In accordance with the 1/5.000 scale master development plan, 1/1.000 scale implementation plan was prepared in order to increase the social, economic and cultural development of the place and to make the place more livable. When the master development plan report prepared for the neighborhood is examined, the phrase "making a livable and accessible plan by providing the necessary standards at the implementation plan stage" is passed. In addition, while preparing the implementation plan of Şerefoğlu Neighborhood, it was aimed to protect the existing texture of the neighborhood and to base the decisions coming from the upper scale plans. The boundary of the planning area is the same as the upper scale (1/5.000 scale) master development plan boundaries and covers an area of 99,4 hectares in Uzunkışla settlement and 68,9 hectares in Şerefoğlu Neighbourhood (Table 4.7), (Yüksel Proje, Dolsar, & Üçer, 2021).

Table 4.7: *Kahramanmaraş Dulkadiroğlu District, Şerefoğlu Neighborhood Implementation Plan Data*

Scale: 1/1.000
Preparation date: 2019
Target Year: 2040
2017 Population: 1.164 person
2040 Population: 3.000 person
Existing Planned Housing Area: 22,4 ha
Development Housing Area: 58,1 ha
Residential and Development Housing Area: 80,5 ha
Total Planned Area: 168,3 ha
Residential and Commercial Area: 0,4 ha
Municipal Service Areas: 0,3 ha

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

4.10 Overall Evaluation of The Case Studies- Problems in Settlement and Construction Decisions in the City

4.10.1 Evaluation of Proposed Plans

The Territorial and Master Development Plans proposed for Kahramanmaraş Province are evaluated below.

4.10.1.1 Kahramanmaraş Territorial Plan Evaluation (1/100.000 Scale)

The obtained Territorial Plan has been prepared in accordance with the 2030 targets. Accordingly, when an evaluation is made for the year 2022, which we are currently in, it is seen that the targets specified in the plan vision have not been achieved. The biggest obstacle to the realization of this target for Kahramanmaraş Province is the lack of initiatives that can transform the agricultural structure. The lack of adequate investments in terms of agricultural industry in the city hinders this development. In support of this situation, the decrease in the agricultural (rural) population in the city can be shown. This decrease in the agricultural sector in the city increased as the transition to the service sector. For this reason, it can be said that the plan produced ended up not serving the purpose.

4.10.1.2 Kahramanmaraş Central Districts Master Development Plan Evaluation (1/5.000 Scale)

It is necessary to examine the Master Development Plan prepared for Kahramanmaraş, together with its annexes, in three separate parts. The first is the Central District Master Development Plan, the second is the Önsen-Kurtlar Master Development Plan, and the third is the Şerefoğlu Neighborhood Master Development Plan (Figure 4.25, Figure 4.26, Figure 4.27).

In the current situation, the development of the center has been with a linear upper form in the east-west direction in accordance with the topography. Although this development seems appropriate in the context of urban infrastructure, mistakes made in detail and practice resulted in the seismic vulnerability of the central district. The residential areas and new development areas that are actively developing on active faults are the biggest proof of this. In addition to this situation, the development along the D825 road, which is included in the Development Plan projections, and which mostly includes non-residential areas, was supported. Accordingly, it was allowed to develop in the east-west and south directions along the road. However, this region is a very rich area in terms of agricultural areas and is not seen as an area suitable for construction in terms of ground. Although one of the objectives of the Master Development Plan is the protection of agricultural lands, it is a contradiction to foresee a development in this direction.

Sufficient area size for the technical infrastructure areas foreseen by the Master Development Plan prepared for the city could not be achieved in practice. In the master development plans developed for the Önsen District and Şerefoğlu Neighborhood, which developed around the city, these regions were specified as the urban sprawl zones of the city and their plans were prepared considering the city center disconnected. It is necessary to consider the developments in these settlements not individually, but by considering the whole city.

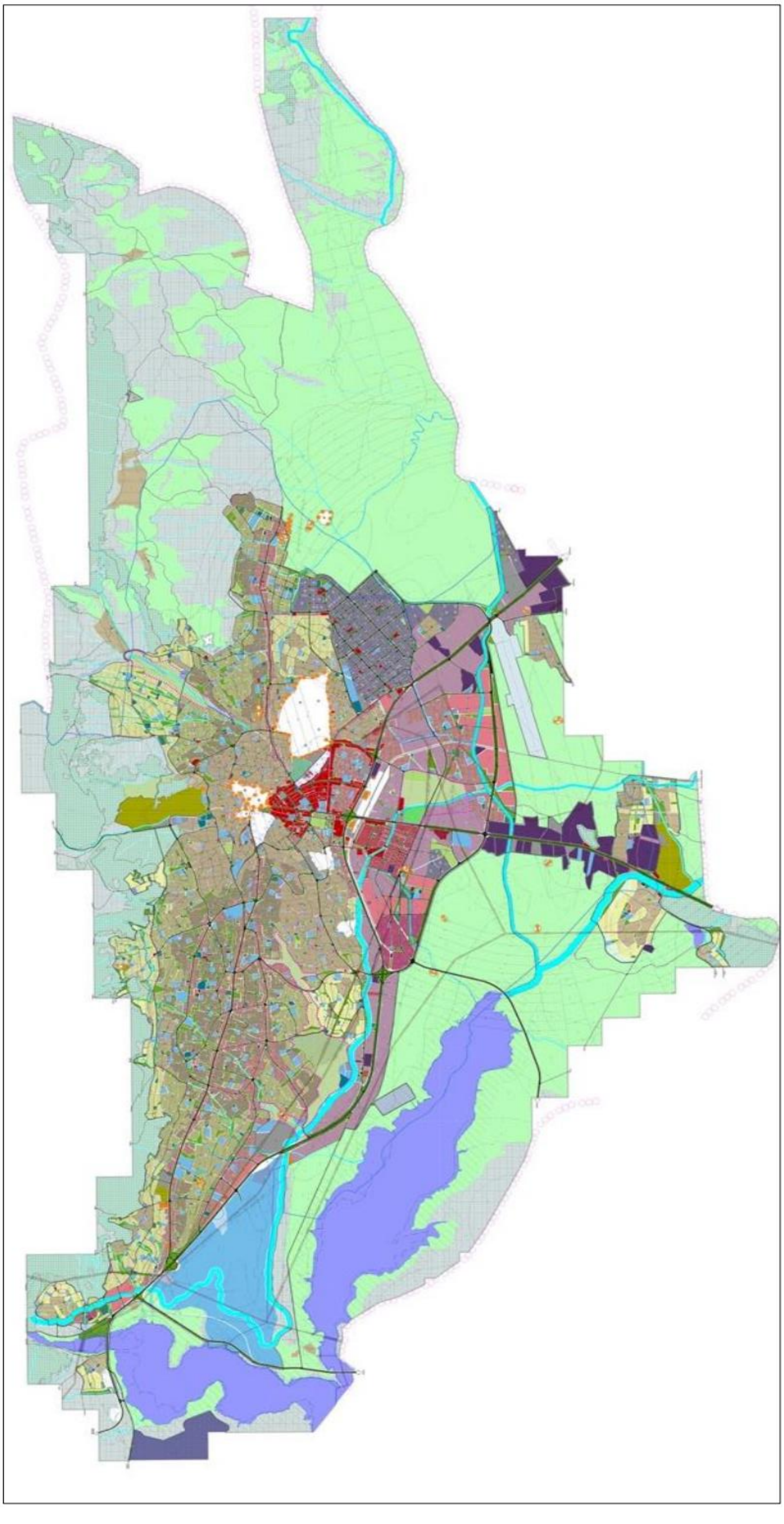


Figure 4.25: *Kahramanmaraş Central Districts Master Development Plan (1/5.000 Scale)*

Source: (Yüksel Proje, Dolsar, & Üçer, 2021)

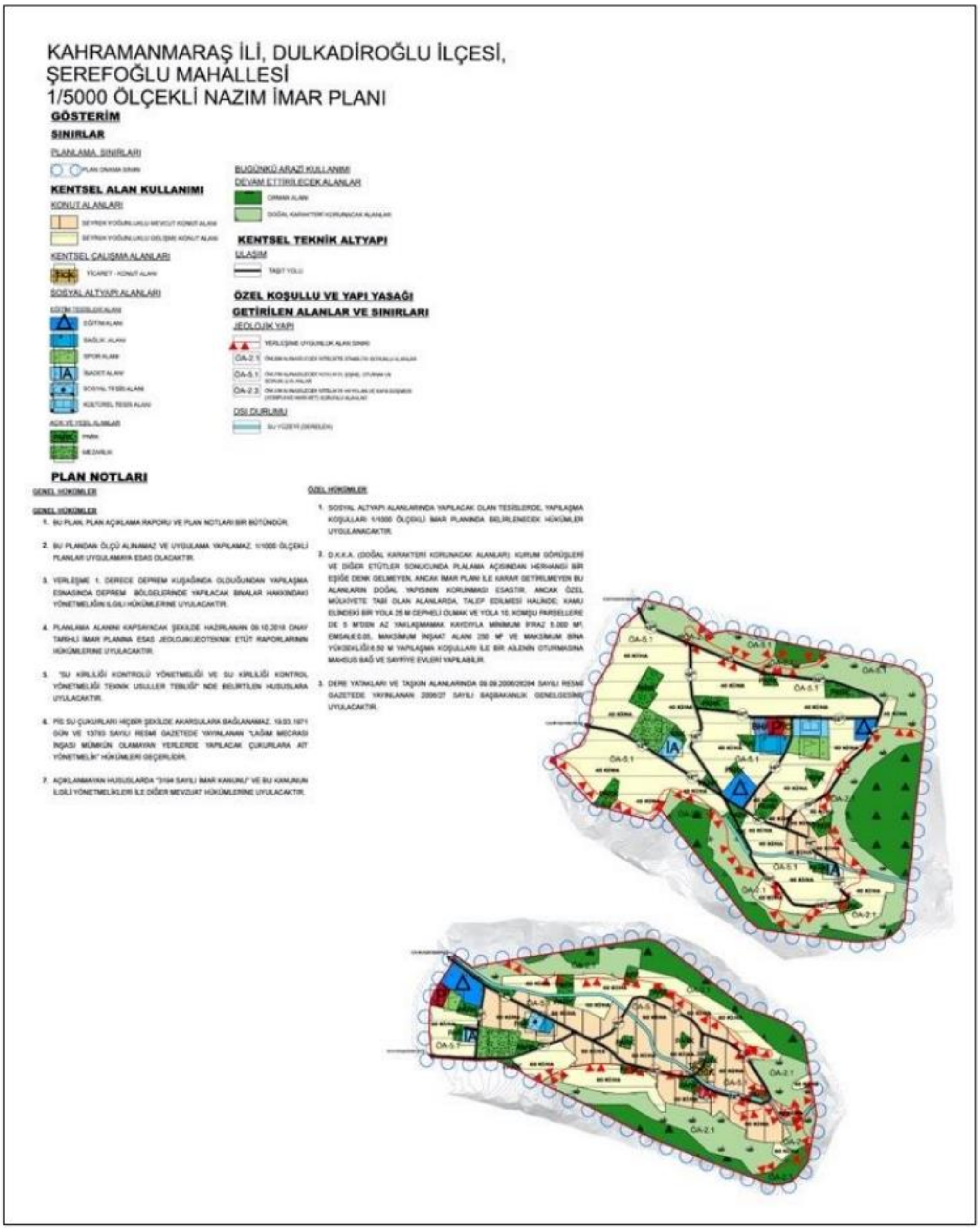


Figure 4.26: *Kahramanmaraş Dulkadiroğlu District, Şerefoğlu Neighborhood Master Development Plan (1/5.000 Scale)*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

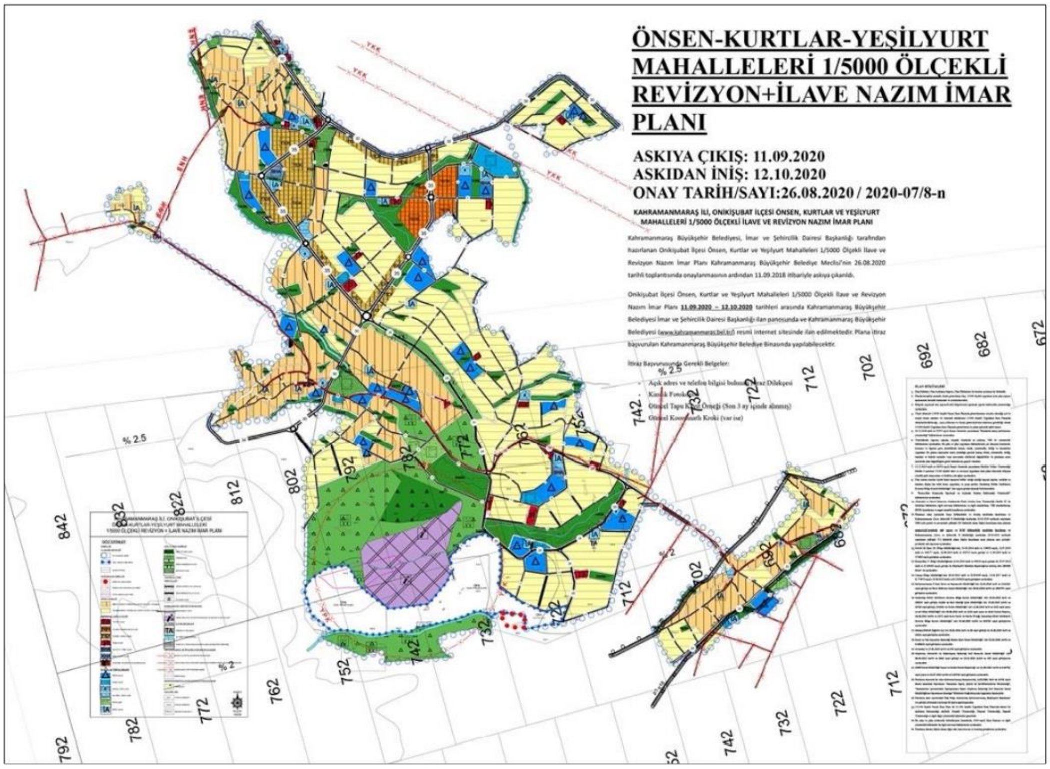


Figure 4.27: *Kahramanmaraş Önsen-Kurtlar-Yeşilyurt Neighborhood Master Zoning Plan (1/5.000 Scale)*

Source: *(Yüksel Proje, Dolsar, & Üçer, 2021)*

When the findings obtained from the evaluation are examined in general, it shows that the practice of the Master Development Plan in Kahramanmaraş districts does not include current developments. In general, when the plan notes are examined, it is seen that the concept of staging is not mentioned at all. However, it is this staging logic that needs to be prepared as the most basic for the city. Accordingly, priority areas can be determined within the urban risky areas. Subsequently, it facilitates the supervision of the development of the urban area and the finding of unforeseen changes in the next Master Development Plan. This tool has not been implemented in the Master Development Plans prepared for the city. Especially for the city center, which is considered to be risky in terms of seismicity, such a study is necessary and will be very useful.

Considering the urban development macroform, it turns out that the plans prepared are prepared to improve the existing ones. Because, considering the geological structure of the existing areas and their suitability for settlement, although they are known to be risky, this may be the only reason why development continues in this region. The fact that plans are prepared with instant decisions or to meet short-term needs reveals this situation. This situation is also observed in Kahramanmaraş city center and its districts. While the Master Development Plans were being prepared, the mistake of incorporating the places that were thought to be "appropriate" and "empty" into the development areas is seen in the city. The fact that this situation is reflected in the plan decisions is a big mistake during the preparation of the plans. In short, Master Development Plans developed for the city could not do more than just include population projections and appropriate urban settlement area usage sizes.

4.10.2 Unregulated and Uncontrolled Construction in the City

Illegal buildings in Kahramanmaraş have an important place in the total building stock. It is observed that illegal constructions in the city are concentrated in the southern, northern and eastern parts of the city, but there is uncontrolled existence in all directions. There are also structures as squatters. Illegal buildings and slums are generally masonry buildings. Figure 4.28 shows the situation of illegal construction in the city. In the city, the concrete of such structures is poured with the traditional method. There is no experimental study on the quality of concrete. It is not allowed to take samples for a voluntary and free quality control study anyway (Temiz, Binici, Köse, & Kuşat Gürün, 2011). Reinforced concrete and masonry structures are in the majority in cities and towns. Especially in mountain villages, houses built using stone and soil materials constitute the common type of housing.

Licensed buildings are generally constructed using reinforced concrete and masonry construction methods. The structures that have been built with traditional formwork until today have started to be built with the tunnel formwork system by some companies in recent years.

While industrial buildings are mostly built with reinforced concrete prefabricated methods, steel, reinforced concrete and masonry structures are also used to a small extent. There are six ready-mixed concrete plants and a factory that produces three prefabricated building elements in the province. Stream bed aggregates are mostly used in buildings, and a small amount of stone chips are used (Temiz, Binici, Köse, & Kuşat Gürün, 2011).

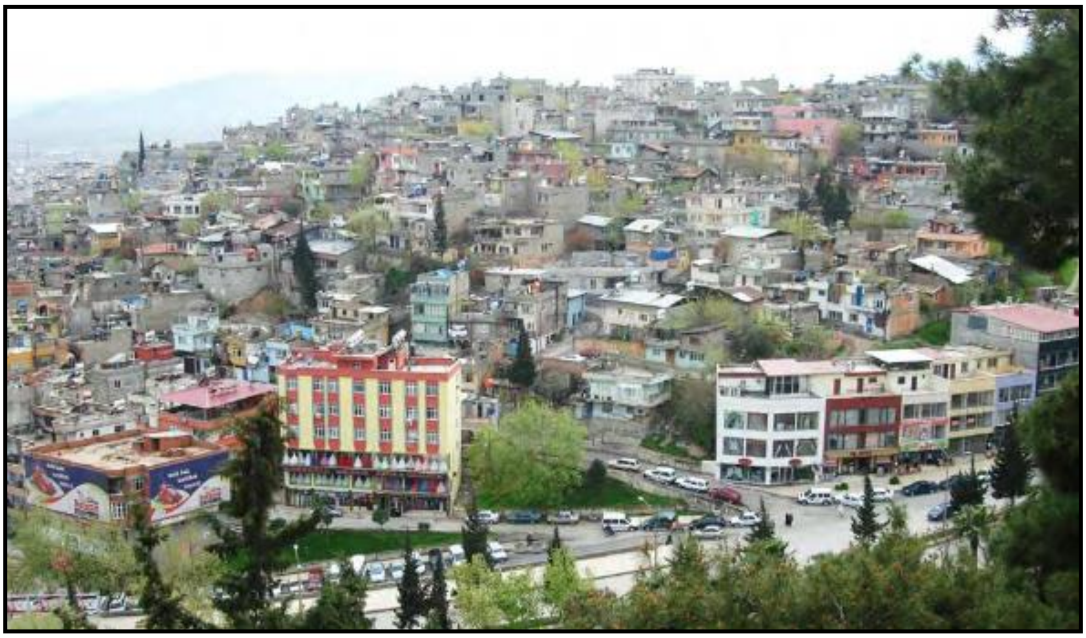


Figure 4.28: *Irregular Construction View in Kahramanmaraş*

4.10.3 Problems in Determinations of Settlement and Industrial Areas

The territorial plan made at the scale of 1/100.000 is a critical plan stage where settlement decisions are made at the provincial scale. At this scale, disaster hazard maps are prepared based on observational geological studies or geological-geotechnical studies. Based on disaster hazard maps, decisions and strategies regarding the spatial distribution of population and activities, infrastructure, and the distribution of residential areas are developed within the framework of basic strategies for disaster prevention and mitigation, and objectives and policies appropriate to this strategy. While preparing the territorial plan in Kahramanmaraş, it is concluded that geological and geotechnical studies were not considered and adequate evaluations were not made. Because when the ground structure of the areas opened to urbanization is examined, it is seen that they are not suitable for urban development. The master development plans prepared by adhering to this plan do not solve the needs of the city because master development plans are the planning stage where basic settlement and usage decisions such as macroform development of the settlement, types of use, densities, transportation, axis, open-green area system and infrastructure are made. Basic strategic decisions such as urban transformation, protection, improvement and renewal regarding settled areas are also made at this stage. It is a major deficiency for the city of Kahramanmaraş that geological geotechnical studies or microzonation studies are not used in the master development plans, depending on the size, development potential and problems of the settlements during the making of these decisions. This situation also lays the wrong ground for the implementation plans to be prepared later. Because, in this region where urban risks are high, wrong planning decisions were taken in the city since the building density, size and height decisions were not based on microzonation, geological-geotechnical studies and settlement suitability maps created as a result of these studies. However, this situation is of great importance in the planning of settled areas in the city where preventive and harm reduction methods are needed.

In the 1/100.000 scale territorial plan prepared for 2030 in Kahramanmaraş, the existing settlements are shown in brown and the suggested areas for urban development are shown in yellow in Figure 4.29. When examined in terms of existing settlements, it seems that the city is located on active faults. It is seen that the new areas to be opened for urban development are also located in risky areas.

The Active Fault Map of Türkiye shows that the active faults pass through the city center of Kahramanmaraş in an East-West direction (Figure 4.30). When the distribution of residential areas in the city is examined, it is seen that there is construction from Ahır Mountain in the north of the city to the Maraş Plain in the South. Kahramanmaraş Fault Zone, located on the southern skirts of Ahır Mountain, consists of different fault segments within a zone extending approximately East-West, within a 4 km wide zone from north to south. Currently, the length of the active faults passing through the Kahramanmaraş settlement center in the East-West direction is approximately 25 km (Jeoloji Mühendisleri Odası, TMMOB, 2021). Considering that the city is developing in the East-West direction, this shows that there is a very serious planning problem.

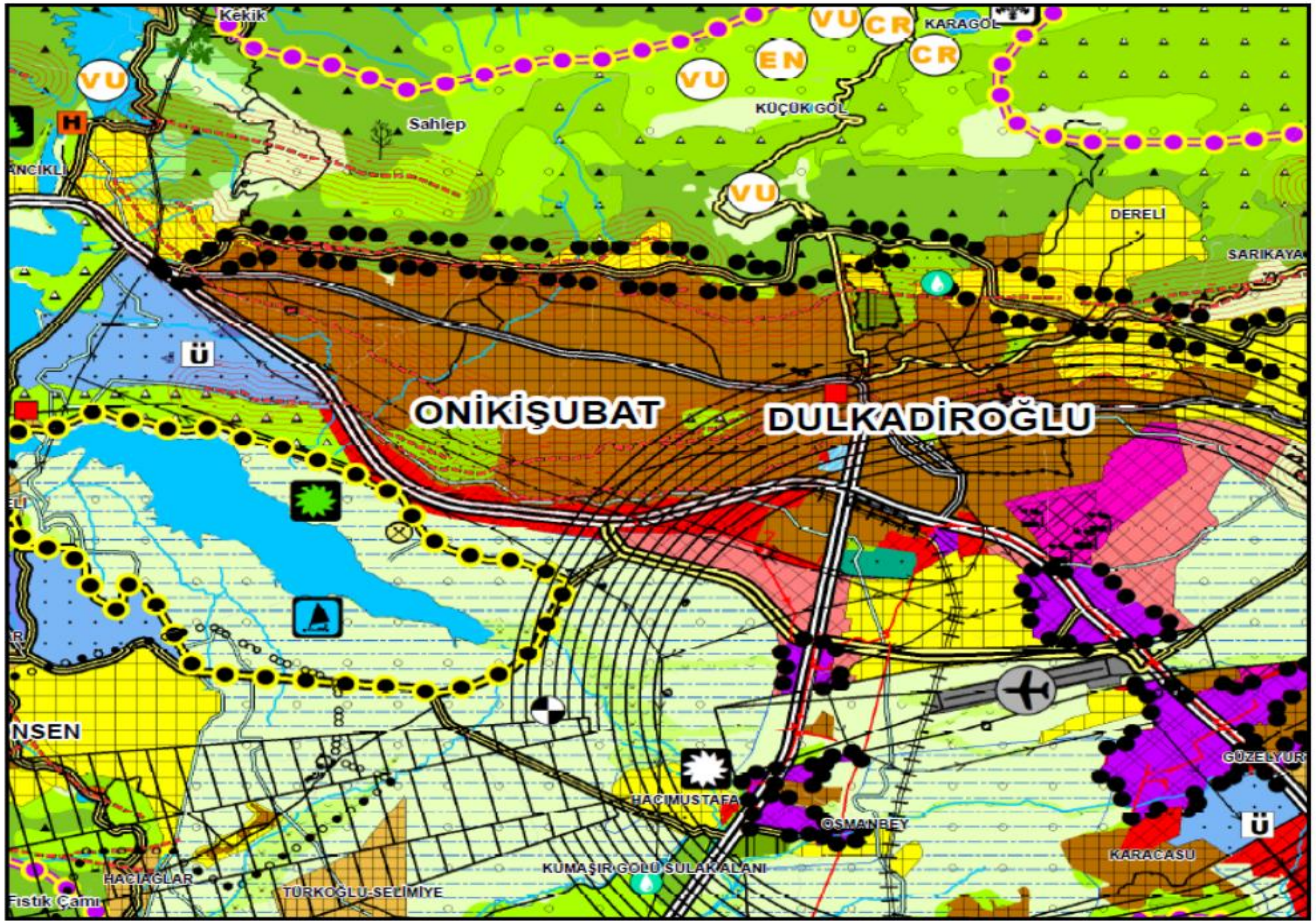


Figure 4.29: *Kahramanmaraş Territorial Plan for 2030*

Source: (Jeoloji Mühendisleri Odası, TMMOB, 2021)

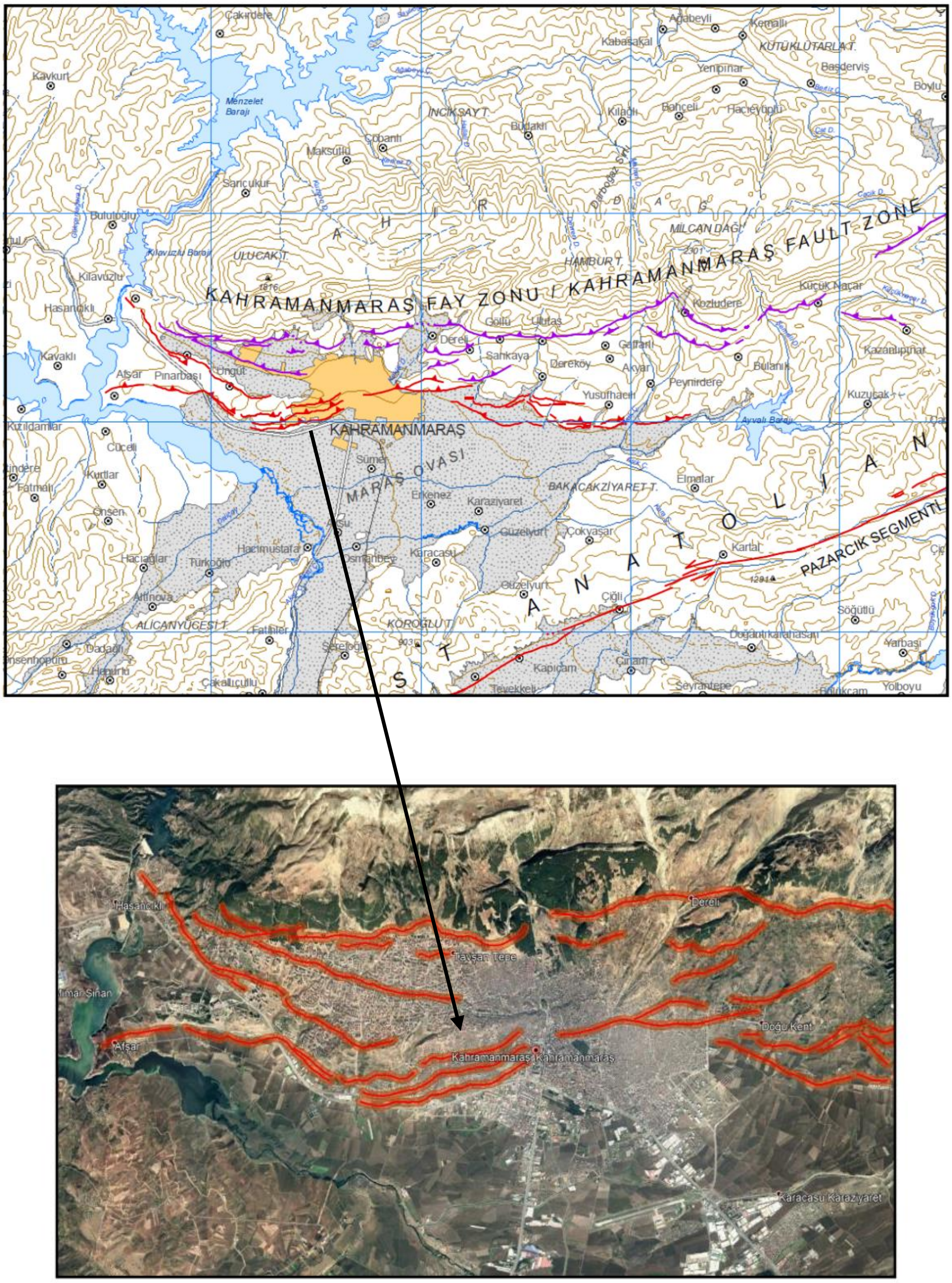


Figure 4.30: *Active Faults Passing through Kahramanmaraş City Center and its Vicinity according to Türkiye Active Fault Map*

Source: *(Jeoloji Mühendisleri Odası, TMMOB, 2021)*

In this context, the Kilavuzlu and Gedemenli districts to the west of the city center, Doğukent and Güneşevler neighborhoods located in the east of the city center, Cancık location in the northern parts of the center, northern parts of Gazipaşa neighborhood, Pınarbaşı neighborhood and Alıçsekisi location in the northeast of the city center pose a great risk due to the active faults in the city.

When we examine the urban settlements on a larger scale, it is observed that there are many settlements on the Gölbaşı-Türkoğlu segment of the Eastern Anatolian Fault Line, which has the potential to cause a major earthquake passes 10-11 km South of the city center. In addition, considering the area of influence of the fault line, we see that most of the urban settlements are located close to this fault line.

Figure 4.31 shows the residential areas within the possible impact area of active faults and also Gölbaşı-Türkoğlu fault segment. As a result, we can say that Pazarcık, Türkoğlu, Çağlayancerit, Dulkadiroğlu and Onikişubat districts are under serious earthquake threat. When we make a detailed current situation risk assessment at the district-neighborhood level in the city, we obtain Table 4.7.

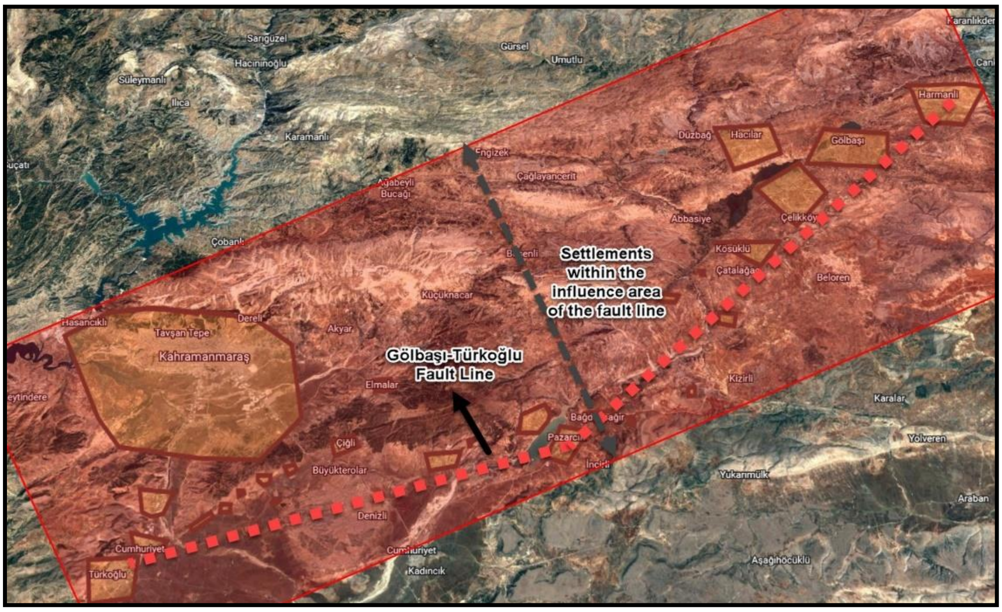


Figure 4.31: *Gölbaşı-Türkoğlu Fault Segment and Near Residential Areas*

Source: *(Auther Representation - Google Earth, 2022)*

We can conclude that the southeastern part of Kahramanmaraş city center, the south part of Onikisubat District, a large part of Dulkadiroğlu District, the western part of Göksun District, all Pazarcık and Türkoğlu districts, and the southeast part of Nurhak District are under the threat of a great earthquake.

Despite active fault information, the area where Kahramanmaraş city center was established is generally a fill (alluvial) ground formed as a result of floods from Ahır Mountain. While the first settlements were on the slopes of Ahır Mountain, they later spread towards the plain. In the settlement opened on the plain, the groundwater is close to the surface. Since the groundwater is close to the surface and the soil type is filling, the bearing capacity of the ground is low (Temiz, Binici, Köse, & Kuşat Gürün, 2011). Unfortunately, there are thousands of residences in the city on fill floors where the risk of being affected by earthquakes is higher in such areas (Sandal & Karademir, 2013). The fact that most of these dwellings are slums, they have masonry properties, and the use of poor quality concrete and insufficient amount of materials (steel, sand, cement, etc.) in the buildings will increase the loss of life and property in a possible earthquake.

When the territorial plan and lower-scale plans of the city of Kahramanmaraş are examined, it is seen that the east-west direction is determined as the urban development area. Due to the topography restricting urban development in the north and south directions, development in the east-west direction was supported. However, when the ground situation of the city and its surroundings is examined, it is seen that the existing settlements where the city is spread are alluvial and sandy soils with very low bearing capacity. Along the Kahramanmaraş-Gaziantep and Kahramanmaraş-Adana ring roads, the area where Aksu and Erkenez Streams pass and its surroundings show a sandy, clayey and silty nature (Jeoloji Mühendisleri Odası, TMMOB, 2021).

In Figure 4.32, where the ground condition and neighborhood densities can be evaluated together, it is seen that the urban density is concentrated on the soils with low bearing capacity (along the east-west axis). The fact that dense residential areas are built in places where the risk of being affected by earthquakes is very high and that they continue to be built for the future is a very high risk factor. Especially in Tekerek, Şehit Abdullah Çavuş, Yirmiikigün, Boğzaiçi and Ağcalı Neighborhoods that are developing in the west of the city, and in Dulkadiroğlu, Namık Kemal and Doğukent Neighborhoods in the east of the city, the heights of the houses are not suitable for the ground structure and adjacent structures are often produced.

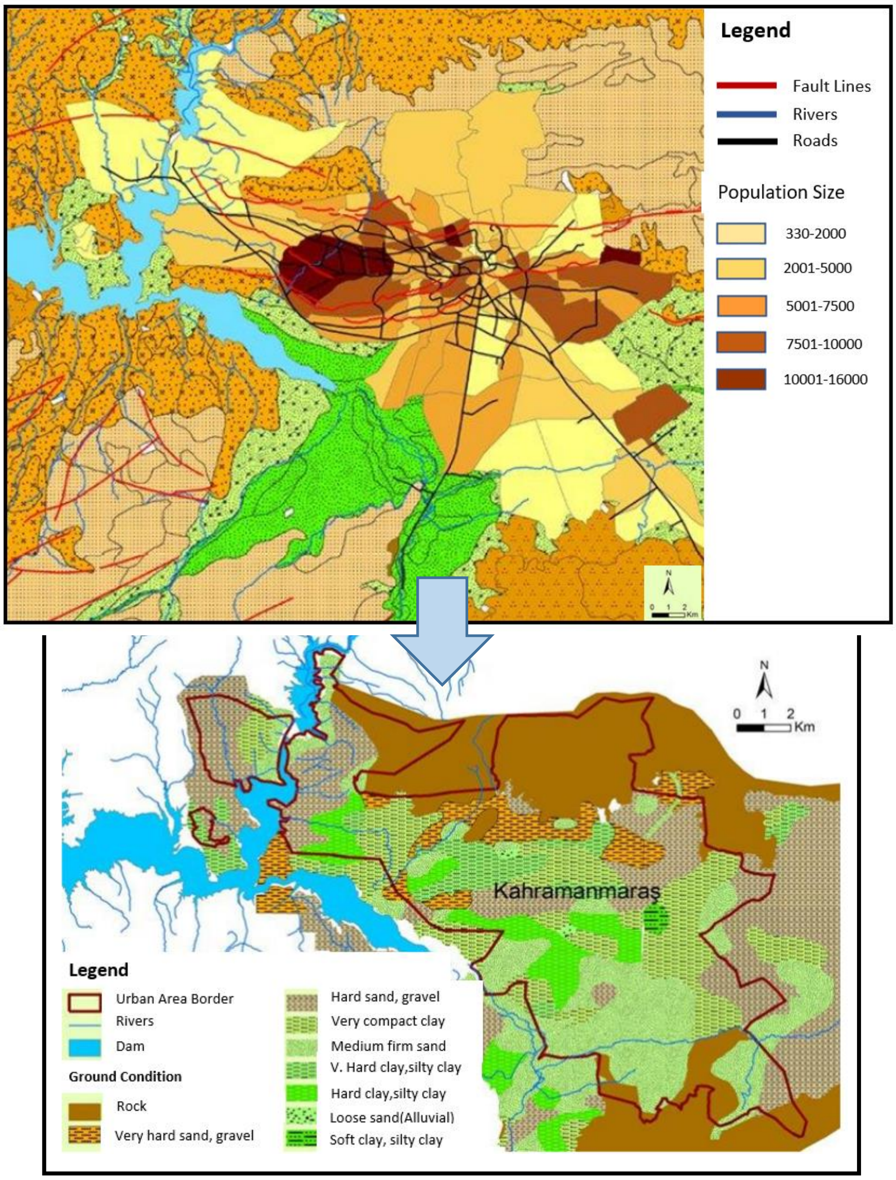


Figure 4.32: *Distribution of Neighborhoods on Soil Types in Kahramanmaraş*

Source: *(Sandal & Karademir, 2013)*

On the other hand, as can be seen in figure 4.32, there are moderately solid soils with higher bearing capacity on the southern slopes of Ahır Mountain, which forms the northern part of the city (Sandal & Karademir, 2013). However, in these areas, it is seen that the urban density is lower due to the more difficult settlement conditions.

In addition to these problems, Kahramanmaraş City and its surroundings consist of absolute agricultural lands with high productivity. There are approximately seven neighborhoods and industrial facilities located in agricultural areas (Yılmaz M. , 2013), (Table 4.8). These agricultural areas, where industrial and residential areas are concentrated, have the characteristics of a first degree earthquake zone. This shows that the ground surveys and reports that should have been done before were not taken into account during the urban planning process.

Table 4.8: *Kahramanmaraş City Earthquake Risk Analysis*

Location	Risk Definition	Reason of the Risk
Pazarcık (including Cengiz Topel, Bağdınısağır, Narlı, Çiğdemtepe, Menderes, Mehmet Emin Arıkoğlu, Şehit Nurettin Ademoğlu and Kartalkaya Dam), **Çağlayancerit (including Soğukpınar, Engezek and Fatih Neighbourhoods) Districts**	Earthquake or Liquefaction	-Being the closest regions to the active fault zone -High liquefaction potential of soil conditions -In the event of a major earthquake, the Kartalkaya Dam be a threatening factor
Türkoğlu District (including Beyoğlu, Ceceli, Minehüyük,Kuyumcular, Çobantepe, Yeşilyurt, Hacı Bebek, Akçalı, Kuyumcular, Güllü Höyük, Fatih, Yeniköy, Kadıoğlu Çiftliği, Yenipınar,	Earthquake or Liquefaction	-Being the closest regions to the active fault zone

Table 4.8: (Continued)

Location	Risk Definition	Reason of the Risk
Hopurlu, Pınar Höyük, Tahtalı Dedeler, İstasyon ve Şekeroba Neighbourhoods)		-High liquefaction potential of soil conditions
Kahramanmaraş City Center (including Bahçelievler Neighbourhood, Yenişehir Neighbourhood, Egemenlik Neighbourhood, Tekke Neighbourhood, South part of the Onikişubat District, Northwest part of the Göksun District)	Earthquake or Liquefaction	-Very close to the active fault zone -Poor building stock, frequent adjoining structures -High liquefaction potential of soil condition, very high-level groundwater -Locating most of the private hospital buildings in these areas
Southeast Part of the Kahramanmaraş City Center (including Sütçü İmam University - Karacasu Campus, Kahramanmaraş Airport, Kahramanmaraş City Hospital and Large Industrial Facilities)	Earthquake or Liquefaction	-Due to the presence of most of the industrial facilities, Necip Fazıl City Hospital, Sütçü İmam University Karacasu Campus, power lines and facilities producing hazardous materials
Dulkadiroğlu District- (including Doğukent, Ulutaş, Gaffarlı, Güneşevler, Aksu, Elmalar, Karacasu Karaziyaret Neighbourhoods)	Earthquake or Liquefaction	-Being close to the active fault zone -Being a landslide risk area -Risk due to being a the newly opening area for development
West part of the Kahramanmaraş City Center (including Tekerek, Şehit Abdullah	Earthquake or Liquefaction	-Being close to the active fault zone -High liquefaction

Table 4.8: (Continued)

Çavuş, Muratlı and Boğaziçi Neighbourhoods)		potential and alluvial soil type -The underground water level is very high, and the risk of landslide is high in the region -It is a region where multi-storey buildings are concentrated and accordingly the population density is high -Concentration of educational buildings in the region

In addition, Türkoğlu and Nurhak district city center, nearly 40 neighborhoods and some facilities such as dams and ponds sit directly on active fault lines or zones. Although the determination of the locations of the active faults and the size of the creeks they can produce are calculated, these data were not used in the development plans prepared and these areas were shown as residential areas in the master and implementation plans.

In Kahramanmaraş, there are settlements in places where the soil is under the risk of liquefaction. Especially in Kahramanmaraş, alluvial soils in the south of the city center are at risk of liquefaction. In Kahramanmaraş city center, there is a very high number of neighborhoods that survive with liquefaction risk. Neighborhoods where settlements are concentrated in these regions without considering the risk of liquefaction is Bahçelievler, Gayberli, Barbaros, Oruç Reis, Yenişehir, Egemenlik, Hacı Bayram Veli, Dulkadiroğlu, Boğaziçi, Tekerek, Şehit Abdullah Çavuş, Dumlupınar and Göksun Neighbourhoods (İRAP, 2020). The building examples in these neighborhoods are shown in Figure 4.33. It is known that ponds are seen in these regions even when it rains heavily. For this reason, the fact that construction is allowed on such soils with a very high risk of swamps and liquefaction puts the district under great threat. However, this is one of the problems that require urgent action for an earthquake-prepared district and city center.

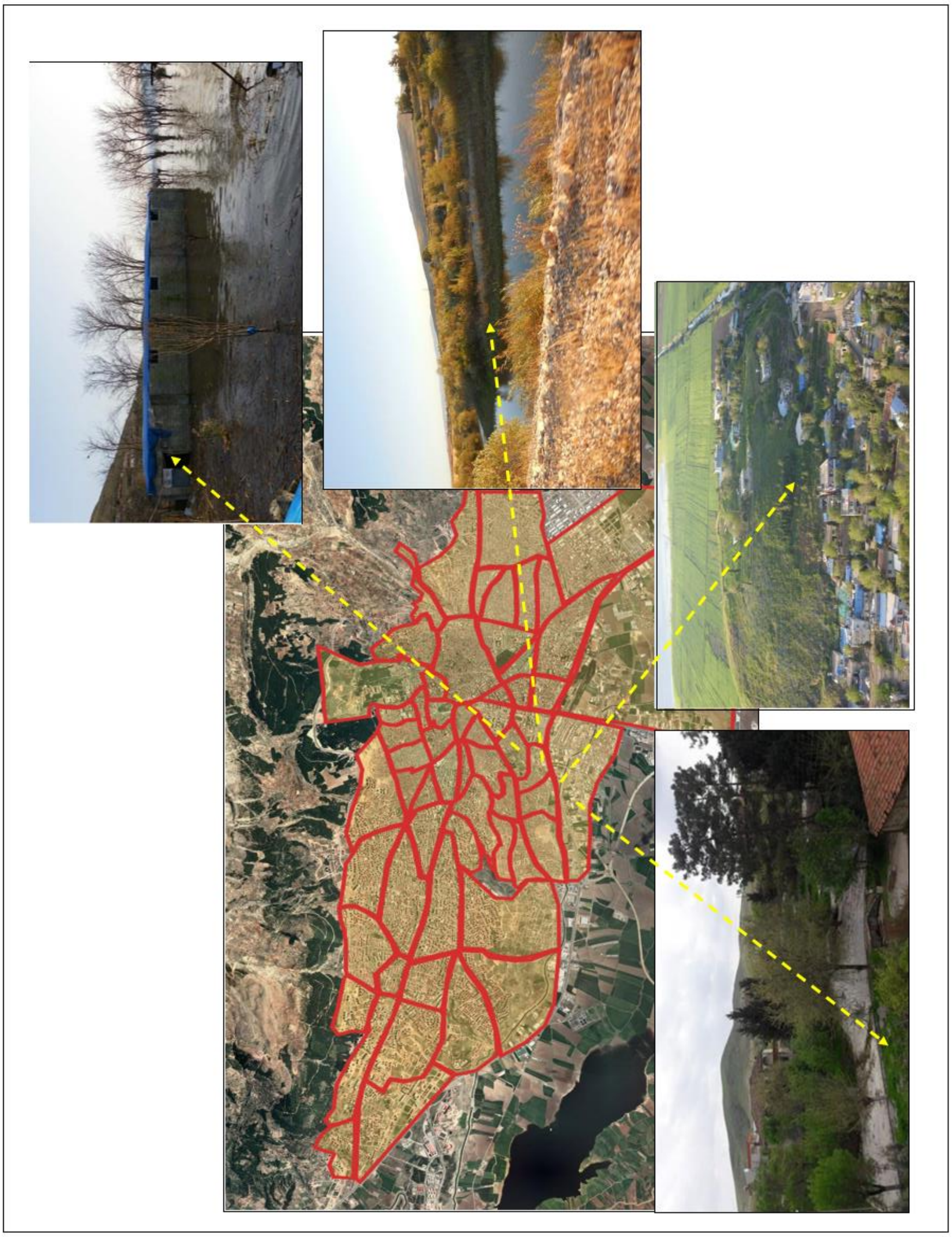


Figure 4.33: *Building Stock Situation on the Liquefaction Risky Soils in Kahramanmaraş City Center*

In addition, during the foundation excavation shown in Figure 4.34, a high flow of water came out during the Pazarcık State Hospital Construction in where is very close to Kahramanmaraş city center. The gas station located opposite this construction site also supplies the utility (vehicle wash) water with the water extracted from its own land (Temiz, Binici, Köse, & Kuşat Gürün, 2011). For this purpose, great difficulties were encountered during the excavation and even during the completion of a part of the foundation, collapse occurred in the ground and caused damage to the foundation. It was opened for settlement by the ground method.

Figure 4.34: *Pazarcık State Hospital Construction Foundation Excavation*

Another problem in Kahramanmaraş city center is that buildings that have not received engineering service are frequently encountered in Bahçelievler, Onikişubat, Tekke, Yenişehir, Egemenlik, Tekerek, Ertuğrul Gazi, Yusuflar, Hacı Bayram Veli, Akçakoyunlu, Şehit Abdullah Çavuş, Muratlı and Boğaziçi which are among the main neighborhoods where the fault line passes. Most of the buildings were not built taking into account the necessary earthquake code rules. The building stock situation in the neighborhoods crossing the fault line is shown in Figure 4.35.

In addition to these problems, it is necessary to mention the building orders in the Kahramanmaraş because there are many separate houses built in attached order in city center (Figure 4.36). In addition, we can also see this type of constructions in Pınarbaşı Neighbourhood, Karamanlı Neighbourhood, Şehit Evliya Neighbourhood, Serintepe Neighbourhood and Yörükselim Neighbourhood which are located at the city center and have not received adequate engineering service. A view from the existing building stock in Serintepe,Karamanlı and Yörükselim Neighbourhoods is also shown in Figure 4.37. The ability of such structures to withstand an earthquake of the type expected in the city is very low because these buildings affect each other's behavior at the time of the shaking, and this form of influence is negative.

Figure 4.35: *Building Stock Situation in Kahramanmaraş Neighbourhoods*

Figure 4.36: *Attached Order Buildings Views in Kahramanmaraş City Center*

Figure 4.37: *Attached Order Buildings Views in Serintepe, Karamanlı and Yörükselim Neighbourhoods*

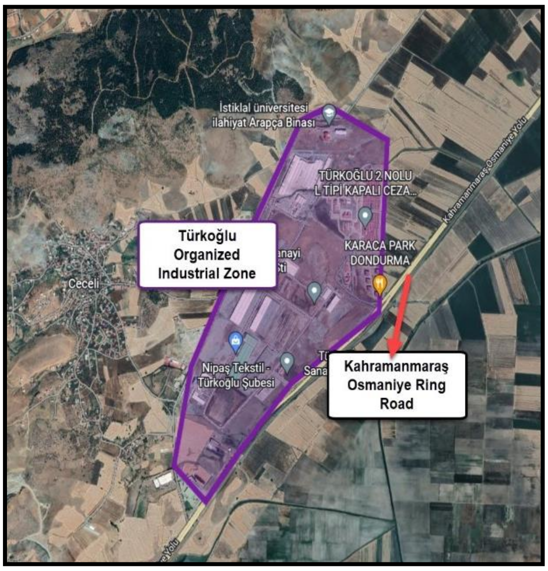
Furthermore, the presence of high-rise buildings is seen especially in Dulkadiroğlu District, in Bahçelievler Neighbourhood, Egemenlik Neighbourhood, Menderes Neighbourhood and Yenişehir Neighbourhood, Ağcalı Neighbourhood in Kahramanmaraş. A view from Kahramanmaraş city center is given in figure 4.38 as an example of this situation. However, it is seen that these structures were built without complying with the distance rules between the buildings. For this reason, it can be said that the probability of buildings colliding during an earthquake is high. This situation will cause greater damage due to the effect of the two buildings on each other during the shaking. The building approach conditions in the new buildings designed with higher floors in the district do not meet the necessary conditions. In the event of a disaster, this situation is likely to magnify the effects of the possible disaster.

When the distribution of industrial areas is examined, it is seen that the industrial establishments located in the south of the Ulu Mosque and Bahçelievler Mosque axis and in the area close to the present city center before 1980 spread over the intercity transportation networks connecting Kahramanmaraş to Adana, Gaziantep and Kayseri on the Maraş plain in the south. Currently, the area is being tried to be completely filled by using intermediate roads. The development of industrial establishments continues along the ring roads (Figure 4.39, Figure 4.40, Figure 4.41).

However, most of these areas are first class lands that need to be protected for agriculture. The fact that most of the industrial facilities are on filled soils (alluvial and colluvial) with low bearing capacity will further increase the impact of a possible earthquake. In addition, they were mostly built with reinforced concrete prefabricated methods (Sandal & Karademir, 2013). Although there are enough inefficient areas to build an industrial structure in Kahramanmaraş, the use of these areas is an indication of a great lack of planning.

Figure 4.38: *Building with Wrong Setback Distances in Kahramanmaraş City Center*

Figure 4.39: *Kahramanmaraş Organized Industrial Zone*



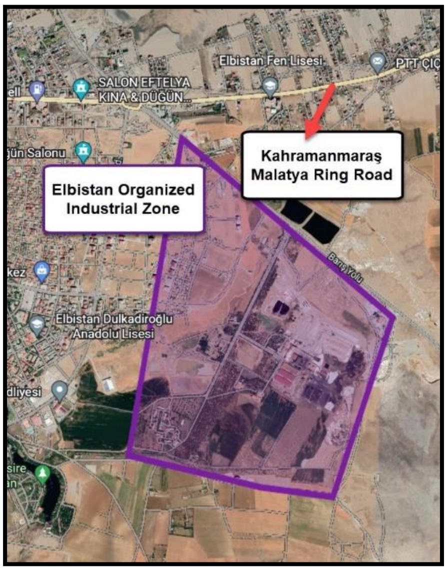


Figure 4.40: *Türkoğlu Organized Industrial Zone (Left) & Elbistan Organized Industrial Zone (Right)*

Figure 4.41: *Industrial Structures around the Osmaniye Ring Road*

4.10.4 Failure to Produce City Plans in Compliance with Needs

It seems that there are problems in the distribution of urban function areas in Kahramanmaraş due to unplanned construction and deficiencies in planning and implementation. The increase in the amount of population and vehicle traffic in the city, which is considered within the scope of the study, has caused the disappearance of the public space feature in the city. This situation, especially in the city center and its surroundings, has led to a decrease in the quality of urban space. The use of the areas defined as urban open spaces for different purposes and the wrong density decisions taken will further increase the effects of the possible disaster.

The historical urban fabric of Kahramanmaraş shows a city formed with dense buildings and narrow streets on a sloping topography (Figure 4.42, Figure 4.43). When the transportation network is examined, the routes of the main transportation roads in the city are in the southeast-northwest direction. While the city was being planned, the city roads, streets and pavements were not made in accordance with the rules stipulated by the standards, or the city's realities were not taken into account when calculating the future population growth and the number of vehicles. It is seen that transportation is difficult in the neighborhoods of Divanlı, İsadivanlı, Duraklı, Turan, Ekmekçi, Yusuflar, Fevzipaşa, Şehit Evliya, Kurtuluş, Dumlupınar, Sakarya, Şeyhadil, Senem Ayşe, Bahçelievler and Namık Kemal Neighborhoods in Kahramanmaraş city center, where the streets are narrow and old buildings are concentrated in Kahramanmaraş (İRAP, 2020). Since the road and pavements are generally inadequate and non-standard, it will cause more buildings to collapse in a possible earthquake.

Figure 4.42: *A Narrow Street View (Duraklı Neighbourhood)*

Source: *(Auther Representation - Google Earth, 2022)*

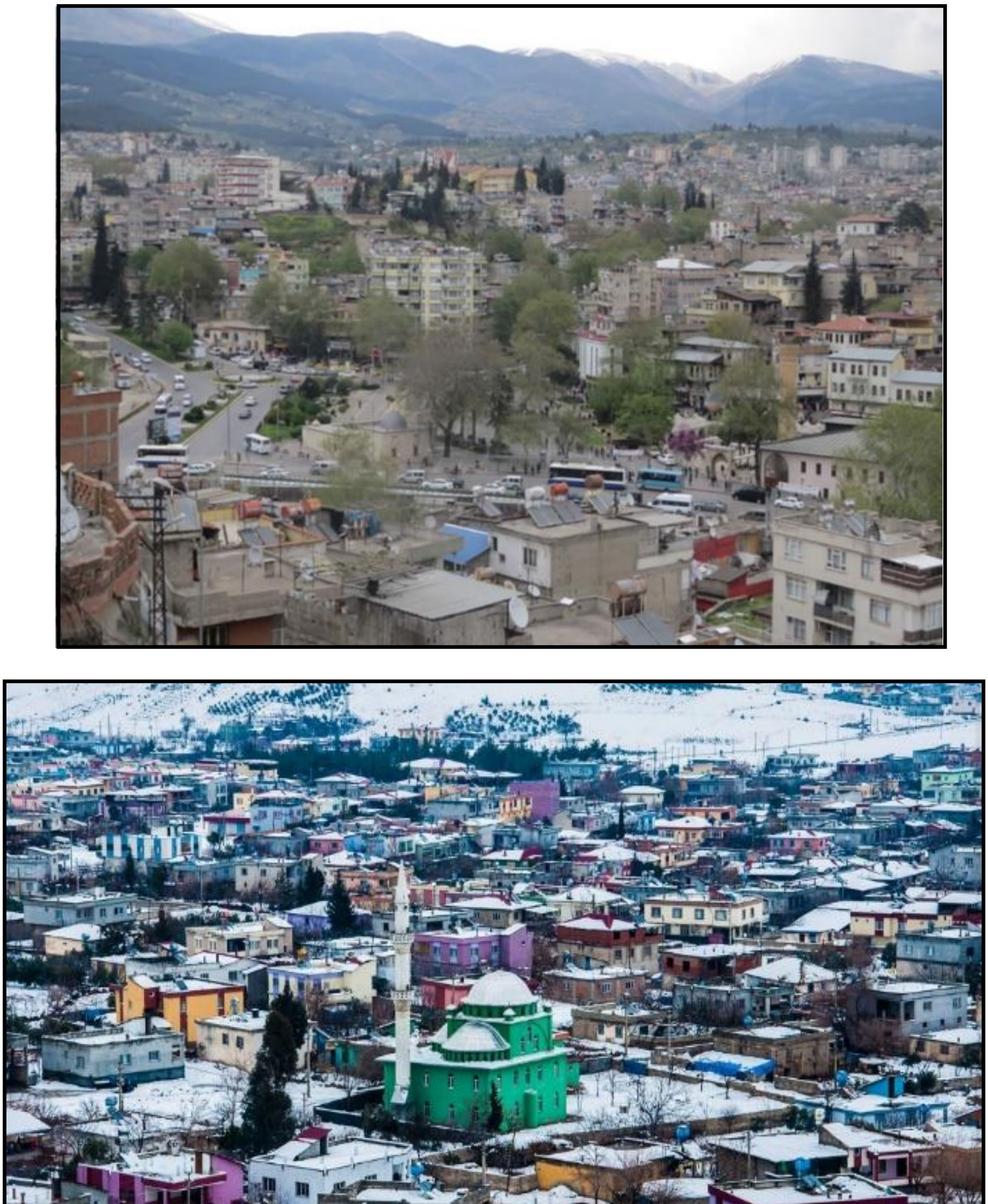


Figure 4.43: *A part of the Region with the Highest Vehicle and Human Density (Tekke Neighbourhood in and Dulkadiroğlu Neigbourhood)*

The sizes of almost all of the open area parcels in the city are below the ideal dimensions (Ekren, 2020). In the event of a disaster, these results show that these areas cannot contribute enough to urban life due to their small surface area and uneven distribution throughout the city. Due to the inadequacy of the avenues and streets and their inability to meet the current need, the road of widening is chosen over time. For this purpose, road demolition and road widening works were carried out on many routes (Figure 4.45).

Figure 4.44: *An Example of Crossover Road Construction*

The first major demolition and road work was carried out around the Kahramanmaraş Castle. In this work carried out in 1981, 270 buildings were demolished and the road to Kale and Şekerdere was opened (Temiz, Binici, Köse, & Kuşat Gürün, 2011) . Even all these demolition and expansion works could not eliminate the mistakes made in the planning in terms of transportation. Especially in the streets on the skirts of Şar Mountain, pedestrian ways and pavements are inadequate and non-standard, it will cause more buildings to collapse in a possible earthquake, and more deaths will be caused as it cannot meet the traffic circulation and open space needs (Kanat & Tıraş, 2019). There is no consistent approach to widening streets, arranging streets and building new roads in the city. For this reason, it is very likely that traffic circulation and open space needs cannot be met in a possible earthquake.

In the study conducted by evaluating the data between 2000-2012 in Kahramanmaraş, the ratio of the existing green areas to the whole city and the population was compared. According to the results obtained, the percentage of green areas actively used increased from 0.1% to 0.5% in 12 years. The percentage of other green areas that can be described as open spaces increased from 4.3% to 4.5% (Table 4.9).

Table 4.9: *Area Uses within the City as a Whole*

	2000	**2006**	**2012**
Active Open Areas	0.1%	0.4%	0.5%
Other Open Areas	4.3%	4.4%	4.5%
Built-up Areas	15.8%	18.9%	27.5%
Other Areas	79.8%	76.3%	67.5%
TOTAL	100%	100%	100%

Source: *(Doygun , Atmaca, & Zengin , 2015)*

Although there seems to be an increase in the percentage of green areas for the whole city, these rates are at a negligible level next to the rate of construction in the city as a whole. Because between these years, the rate of construction increased from 15.8% to 27.5% (Doygun, Atmaca, & Zengin, 2015). Figure 4.45 is quoted to explain how urban open space usage developed in and around Kahramanmaraş between the years 2000-2012.

Figure 4.45: *Distribution of Open Space Uses by Years*

Source: *(Doygun , Atmaca, & Zengin , 2015)*

When the active green space rates per capita are analyzed in the same study, it is seen that there is a gradual increase (Table 4.10). However, this situation is still insufficient when we look at the growth rate of the urban population. In addition to this situation, the increasing population in Kahramanmaraş city center causes the contribution of green areas to urban life to be minimal. In other words, although the increase in the amount of active green space provided in the city is shown as a positive development, the uncontrolled increase in population in parallel with this situation causes the contribution of the areas to the city to not be at the desired level. For this reason, the inadequacy of existing open spaces has become a problem encountered in the city.

Table 4.10: *The Amount of Active Green Space per Capita*

	2000	**2006**	**2012**
Total (m^2)	131.207	410.202	548.054
Population	326.198	371.463	443.575
Per Capita (m^2)	0.4	1.1	1.24

Source: *(Doygun , Atmaca, & Zengin , 2015)*

In this context, the problems of open space and access to open space, especially in the city center, in this region where disaster risk is so high, is a great negative for the city. However, an accessible open space system that will be created by spreading all over the city can be used as urban gathering areas and safe zones in case of earthquakes.

Considering the urban fabric of Kahramanmaraş city center, it can be concluded that sufficient open spaces are not provided for the district. It is clear that no measures have been taken to provide open spaces in a district that lives with such an earthquake risk. It is seen that the necessary road standards were not complied with, especially in the areas that can be described as rural areas and also in the district center, and the urban fabric was interfered with indiscriminately. This has led to urban growth without infrastructure facilities. It is possible to encounter this problem throughout the district. The uses caused by this situation are shown in Figure 4.46.

Figure 4.46: *Insufficient Open Space and Insufficient Infrastructure in Kahramanmaraş City Center*

4.10.5 Project Deficiencies Occuring in the Construction Production Process

When the construction in Kahramanmaraş is examined, it is concluded that some of the existing housing stock is quite old. Among these buildings, there are also buildings that were constructed illegally and that did not receive adequate engineering service. These structures are types of structures that can be evaluated as weak in terms of earthquake performance. In addition, they are structures that do not comply with the building regulations required by the period. It is also common to encounter buildings built without the necessary project documents in the city.

Whether or not there is illegal construction in the city, it is observed that the projects are prepared without local soil properties of many buildings, sufficient care is not taken in making the ground load bearing calculations, the dimensions of the structural members are out of standard, and the structural plans of the buildings are designed to cause some structural irregularities like projections in plans, weak and soft storey problems, discontinuity of vertical structural members and the problematic configurations of connection details between main structural members (Sandal & Karademir, 2013).

In Kahramanmaraş, preparing a project without knowing the local soil properties sufficiently, sacrificing strength in the building for aesthetics, customer requests coming to the forefront of standards and rules, problems based on negligence in architectural drawings and static calculations, and failure to fulfill the requirements of the necessary regulations can be the main factors causing building design issues.

Based on these deficiencies, following observations are made in Kahramanmaraş:

- Moving to the building project stage without calculating the ground bearing capacity correctly is among the main problems encountered in the construction process in the city (Figure 47),

- The construction of high-rise buildings on soils with high liquefaction potential and on filled soils has been identified as a serious problem encountered in the whole city (Figure 48),
- The dimensions of the loading members are not in accordance with the conditions stipulated by the codes (Figure 4.49),

Figure 4.47: *High Rise Settlements on Infill Ground*

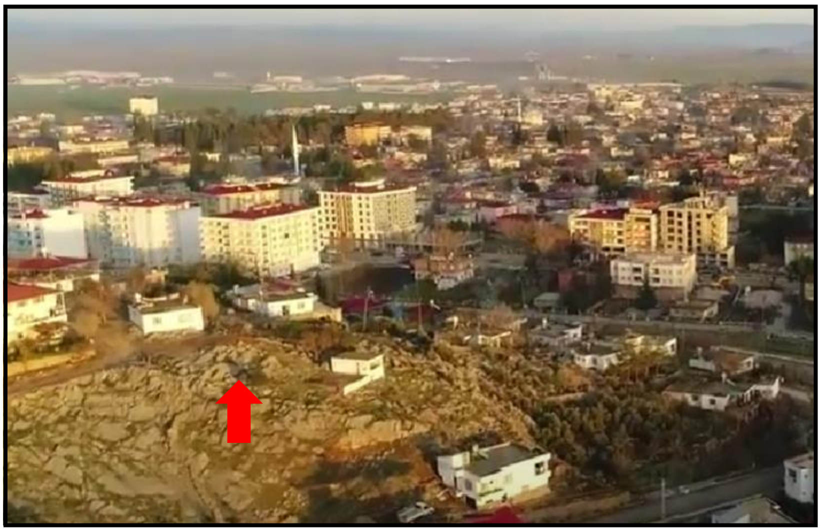


Figure 4.48: *Constructions on Infill Ground*

- Anti-symmetrical design of buildings and floor (plan) discontinuities (excessive and unbalanced overhangs, excessive openings) are observed in the whole city,
- Formation of short column, soft storey and weak storey irregularities (Figure 4.50) are the most basic project design mistakes that are observed in Kahramanmaraş.

Figure 4.49: *Insufficient Column Cross-Sectional Area*

Figure 4.50: *Private Administration Business Center Building with Various Seismic Design Faults*

- Mostly bricks, mud, briquettes and stones are used in masonry structures. As a result of combining the materials with mortar, it does not create a continuous environment in terms of the load bearing system. This kind of defective building construction processes are encountered throughout the whole city. Particular examples from the city center are shown in Figure 4.51.

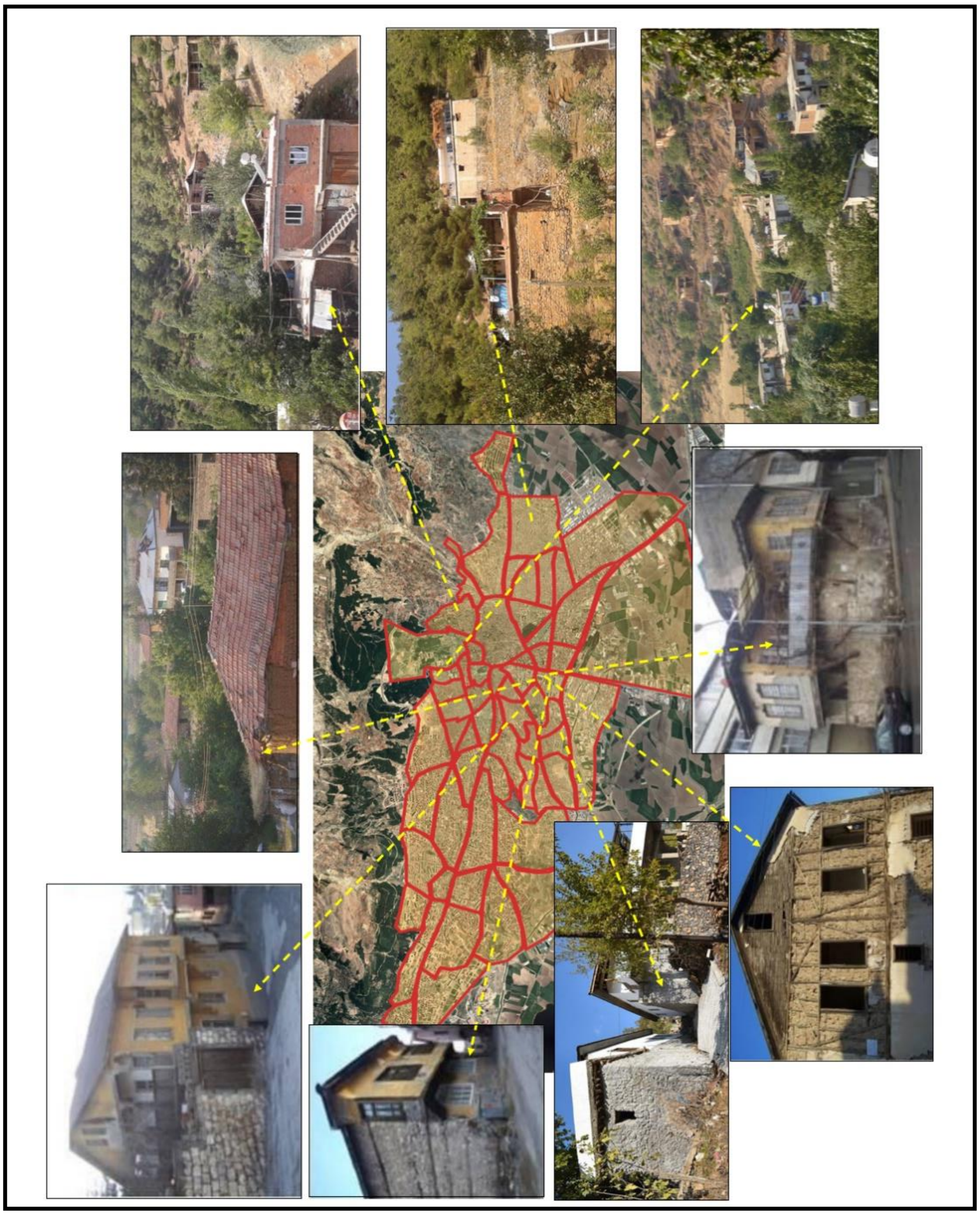


Figure 4.51: *Masonry Structures Examples from City Center and Surroundings*

4.10.6 Implementation Mistakes and Inadequacies in the Construction Production and Audit Process

The labor force in Kahramanmaraş generally consists of people who have not received enough training in their profession and have been trained in a master-apprentice relationship. This situation, which is observed throughout the city, creates some negativities in the construction process. In particular, the use of construction methods that have not changed from the past to the present reduces the quality of the work. The fact that the people working in the sector are not adequately trained in their profession may lead to irreversible situations in cases where adequate inspections are not made. For example, some of such situations are observed in the city; using traditional methods during concrete pouring, fitting loose reinforcements and putting deliberately insufficient number of links and ties for structure. All this will further increase the effect of a potentially devastating earthquake.

Visuals of some of the situations determined as a construction site application problems in the city are given. In this context, Figure 4.52 shows the segregation status of the column concrete obtained as a result of incorrect concrete casting methods during a field application. This situation disrupts the homogeneous structure in the concrete and reduces the concrete strength. It can even cause the formation of plastic hinges in the event of an earthquake. In the future, corrosion of the reinforcements will appear as an expected situation.

Figure 4.52: *The Building with the Concrete Pouring Work*

In addition, in Figure 4.53, the building areas are preserved by pouring the foundation and ground floor column and wall concretes and Figure 4.54 shows an image where some of the strip foundation beams are poured with concrete and the foundation is left as it is. Such building construction processes are inconvenient in terms of corrosion of the reinforcements and concrete in the building. It is necessary to prevent such practices, which are frequently observed in the city.

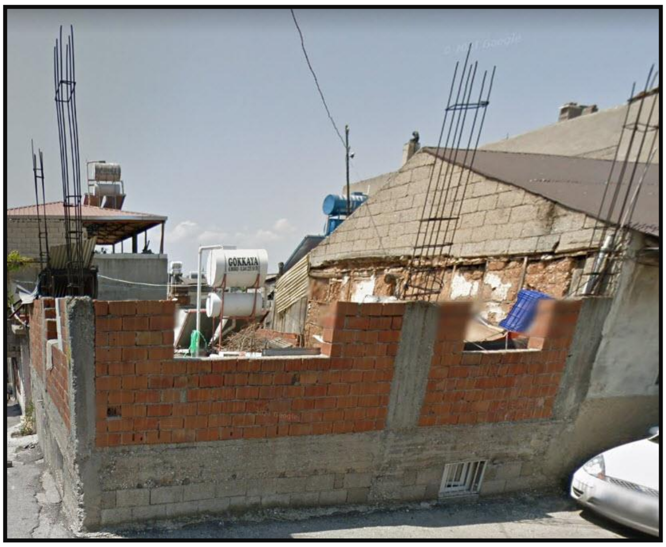


Figure 4.53: *Unfinished Construction Site Examples*

Figure 4.54: *Unfinished Foundation Construction*

Lastly in Figure 4.55, the detail of the column-beam junction with the links outside and the aggregates separated is seen. This causes a reduction in the existing reinforcement cross-sectional area. As a result of this decrease, the lateral translation capacity of the structural members decreases. The bonding forces between the reinforcement and the concrete section decrease, resulting in loss of load transfer. In addition, the volume of corroded steel reinforcement expands due to corrosion residues as a result of corrosion of the steel. The pressure that occurs at this time can cause cracks on the concrete. This may reduce the strength of the concrete and cause it to lose its function. This problem, which is frequently encountered in Kahramanmaraş, adversely affects the behavior of reinforced concrete structures under the earthquake loads. As a result, it significantly reduces the structural strength and earthquake performance of buildings.

Figure 4.55: *Open Reinforcements and Corroded Concrete*

One of the application mistakes that occur in the Kahramanmaraş city during the construction implementation process is the unconscious preparation and casting of concrete. Approximately 40% of the concrete preparation and casting work in Kahramanmaraş center is done with the traditional method (Temiz, Binici, Köse, & Kuşat Gürün, 2011). Especially the use of low-strength concrete and reinforcement and poor quality materials will inevitably increase the loss of life and property in an earthquake. This situation poses a significant risk in Kahramanmaraş, where most of the settlements are under the risk of earthquakes. In the city, the quality of concrete and reinforcement used must be tied to a certain standard in order to determine the strength of the entire load-bearing system.

Finally, one of the main shortcomings is that the required building audits are not carried out in the necessary order and frequency during the construction implementation process in the city. However, the technical staff of the municipality is obliged to make regular checks during the construction implementation phase, starting from the foundation construction. Inadequate inspections or ignoring the conditions that should not be possible may cause strength losses in buildings during an earthquake. Such situations have the potential to lead to irreversible situations in terms of earthquake hazard in the city.

4.11 Concluding Remarks

In line with the data obtained when the seismicity analysis of the city center and its surroundings was made, a detailed analysis of the information was made in this section. Accordingly, the results summarized below were evaluated spatially in Chapter 5. The problems obtained depending on the data obtained can be summarized as follows;

- It is known that Kahramanmaraş has increased both in terms of population and spatial growth from past to present. When the current situation is examined due to the fact that the city is on the Eastern Anatolian Fault zone, the seismicity criterion is the first factor to be considered in the selection of the urban settlement area. Because this situation deeply affects both the existing settlements and the settlements to be planned in the future in the lands opened for development. When the urban development area in the province is examined, it is possible to see that it spreads from the skirts of Ahır Mountain starting in the north to the plain in the south. However, this area can be characterized as an area with a high earthquake potential. Considering that there is a seismic energy accumulation of approximately 200 years, the risk of this region is multiplied. In addition to this situation, the fact that the city center and its surroundings are located on alluvial soils with lower bearing capacity of large industrial establishments and the high risk of liquefaction due to this is another problem that occurs in the city. Because the effect of the earthquake on this type of ground will be more. Especially in the city, such settlements, which are agricultural areas, should be prevented and their use as agricultural land should be ensured. For this reason, it is necessary to carry out detailed ground surveys in the built-up areas and to carry out the necessary evacuation procedures for the places within the urban development area. For the new development areas to be selected based on these studies, it should be ensured that these areas are determined by considering the existing risks.

- In the city center of Kahramanmaraş and on the plain that opens to the south, the presence of illegal or slum-like structures in the existing built-up areas poses a great risk in case of a possible earthquake. Construction on such agricultural areas should be prevented and the existing ones should be made suitable for a possible disaster gradually.

- When the existing building stock in Kahramanmaraş is examined, it is seen that there are many buildings below certain standards in terms of building resistance against an expected earthquake. In particular, the fact that the buildings were built without considering the current earthquake code principles, the mistakes made in the survey and project design process of the buildings, the negativities encountered in the field applications during the construction process (poor material, insufficient workmanship, etc.) significantly reduce the seismic resistance of the building. In addition, during the project and construction inspection process Experiencing malfunctions and condoning mistakes further increases the risk of structures.

- In order to minimize the loss of life and property in a disaster, the necessity of creating open spaces throughout the city and developing transportation plans in this way has not been adequately considered throughout the city of Kahramanmaraş. In this context, it is necessary to re-evaluate the transportation system and the open supply system and ensure its integration into the existing plans.

CHAPTER 5

CONCLUSION AND LEARNING OUTCOMES

5.1 Summary

The conclusion of the research brings together the data obtained in the context of the research objective described in the introduction to this thesis. To remind you, the aim of the study was to find the gaps between the planning decisions taken in the analysis phase of the city and regional planning processes,development plans and the construction practices to have seismically resilient cities. Then, the city of Kahramanmaraş was investigated and evaluated in terms of seismic resilience.

According to this aim, the gaps obtained in Turkey and Kahramanmaraş in the process of seismic resilient urban planning and construction will be presented as a summary. In this context, the intertwined close relationship between uran planning and construction process will be discussed in the research findings part.

Then, in the recommendations part, based on the results of the theoretical study, the results of the field study will be analyzed and brought together. How to solve the problematic points of the urban seismic resilient city findings for Kahramanmaraş district will be explained in detail in the suggestions section. Finally, after presenting the research results and the suggestions developed, some ideas were tried to be given for possible future studies.

5.1.1 Research Findings

It has been observed that important steps have been taken and various structuring has been carried out after the 1999 earthquake in terms of creating a seismically resilient urban texture in our country. However, these positive steps have not yet been fully reflected in the urban planning discipline. In the construction process, the seismic resilience criteria, which are perceived as only building quality improvement, remain only conceptual and do not constitute a methodical approach, increasing the formation of urban risk.

1) The main gaps in the urban location selection and settlement decisions process in Turkey can be listed as follows:
   - Although obligatory after the 1999 earthquakes, insufficiently prepared geological and geotechnical reports are the first gaps observed in this process. In this context, the number of earthquake hazard maps for specific regions and microzonation studies developed to guide the planning is very few. There is no clarity in the development legislation regarding the use of geologic data in the process of preparing higher-scale plans (the regional plan and the territorial plan). This is an important gap in high-scale planning that makes it difficult to identify risk factors based on earthquakes. For this reason we can say that these reports do not adequately guide the urban planning process.
   - As a second gap is that geological and geotechnical reports are not prepared independently from the development plan preparation processes because the prepared reports can be easily changed due political pressures. Therefore, wrong plan decisions are developed for wrong regions.
   - As a thid gap, it is possible to say that the measures taken against earthquake hazard in our country have been developed at the building level. In other words, seismic risks are not defined at the urban level. In this process, the development of urban risk reduction strategies without the participation of the local community and local governments causes the plans to be inadequate.
   - As a fourth gap, it is seen that the measures taken against the risks and the improvement strategies do not support each other from the upper scale to the lower scale. The main criterion is that the plans of different scales are compatible with each other.That means, upper-scale plans should set the principles of urban development by establishing a base for lower-scale plans. Unfortunately, we often cannot talk about this harmony in the risk-based planning phase in our country.

- The last observed gap at this stage is the inadequacy of the control mechanisms in the preparation and implementation of the plans. Insufficient controls of the implemented plans and subsequent illegal changes cause inadequancies in the process.For this reason, the process should proceed in a controlled manner not only in the analysis phase but also in the implementation phase.

If such gaps that we experience in our country are not resolved during the planning stage, the construction process will also be adversely affected by this situation. Because these two processes are the continuation of each other and should be evaluated as a whole of intertwined relations.

2) The main gaps encountered during the construction decision making process in Turkey can be listed as follows:
   - When we consider the effects of earthquakes in our country in terms of construction, the first gap is the buildings that are not sufficiently designed and constructed in accordance with earthquake resistant design principles. If we look at the experienced earthquakes in our country, the majority of the losses occurred due to structural defects. In order to prevent such damages, the dynamic behavior of the structure should be decided according to the related code principles. However, in our country earthquake codes are not taken into account sufficiently in the design process. For this reason, vulnerable building stock occurs against earthquakes.
   - Another reason for the poor performance of buildings during earthquakes in our country is the lack of building audits. Since, the audits made without complying with the standards for field applications is another main gap in the construction process from the past to the present. Poor workmanship or use of poor quality materials due to lack of building audits make the building stock vulnerable to earthquakes.
   - Lastly, in addition to the building audits that were not made during the construction stage of the buildings, the absence of a building use audits after the construction of the buildings is another gap identified in this

process because we know that mistakes made during the use of buildings can leave structures vulnerable to earthquake effects. Such as cutting columns, demolition of walls, enlarging the total area of the building, adding extra storey to the building are frequently encountered problems in our country. Therefore, building inspections that need to be implemented in order to prevent such illegal constructions are defined as another gap in the system.

3) Evaluation of Kahramanmaraş city in terms of seismic resilience:

Like most settlements of our country, the city of Kahramanmaraş is located on an active fault and living under the threat of earthquake. It is one of the region where active faults pass under the buildings in the city center as well as having weak ground and therefore being severely shaken in a possible earthquake. For this reason, it is expected that the city will be damaged in a possible earthquake greater than M_w=6.5 due to both the severe shaking caused by the earthquake and the danger of surface faulting. The fact that one of the important seismic gaps in Türkiye with earthquake expectation is in the region clearly shows the importance and urgency of the work that needs to be done throughout the city.

Although it is stated in the plan notes of the territorial plan prepared for 2030 that places that are as far from the fault line as possible and that can be considered as hard in terms of ground should be selected for lower-scale plans, the planning was made by ignoring this situation. Again, in the plan notes section of the same plan, it was emphasized that considering the current earthquake risk, detailed geological and geotechnical studies should be carried out in construction activities and construction decisions should be made accordingly. However, the data obtained show that the necessary studies are not done or are done incompletely and the settlement decisions are not taken considering the earthquake risk.

When the territorial plan prepared for 2030 is examined, it can be concluded that the existing and new places to be opened for urban development are risky places in terms of earthquakes. There is a large part of the settlement directly on the fault line and the region to be affected by this fault line.In addition, currently, a large part of the population and industrial facilities in the city are located on the alluvial filling ground, where the bearing capacity is lower. This means that the effect of an earthquake will be seen more. In other words, soils with weak engineering properties increase the amplitude of earthquake waves and transfer them to the buildings above them. In this case, the wisest approach is to make the structures comply with the rules in a way to meet the earthquake shaking. Because if a structure is built in accordance with the necessary earthquake regulations according to the expected ground shaking, it will not cause loss of life. However, as a before experience in Kahramanmaraş, it is seen that many buildings were heavily damaged or collapsed due to defects or deficiencies at the site and project design processes of the buildings, material and workmanship faulties during the construction of the building and arised from the insufficient audit.

One of the most important elements of reducing earthquake damage is the readiness of structures for a possible earthquake. When the earthquake exceeds a certain magnitude, it shows its effect on the earth and causes the collapse of structures or severe damage depending on its size. There have been earthquakes of this magnitude in the past of Kahramanmaraş. Therefore, there is a possibility that it will happen in the future as well. In this context, the most basic precaution that can be taken for structures that will be damaged in an earthquake is to precisely determine the locations of the active faults, to evacuate the areas on these faults over time, to reduce the density of structures and population (use as green areas, open areas or etc.), these areas in the future. It is to impose a building limitation for the building and to make the development plans in accordance with the ground conditions and the danger of surface faulting. In Kahramanmaraş and its surroundings, this study needs to be carried out urgently and put into action.

Some recommendations developed as a solution to all these problems are given under the heading 5.1.2.

5.1.2 Recommendations

Suggestions developed for Kahramanmaraş to survive a possible earthquake in the future with minimum damage are grouped under two headings, considering the current development areas and new development areas.

- Accordingly, considering the relationship between site selection and construction decisions, the following conclusions have been reached for new development areas:

1-	Although it is known that paleoseismology studies have been carried out on some faults in Kahramanmaraş Province, the exact determination of the places where the faults pass and the earthquake characteristics by conducting necessary research on the fault lines/zones where paleoseismology is not performed throughout the city or where different researchers have reached different results.
2-	Although it is known that microzonation studies have been carried out in Kahramanmaraş city center, microzonation studies are carried out in all settlements in the city for the detailed identification of urban risks, especially in newly developed settlements and ensuring the participation of different professional groups (geological engineers, geophysical engineers, city planners, civil engineers..) in the preparation phase of these studies.
3-	Determination of the location and characteristics of active faults clearly for the whole region with data input from different disciplines and paleo seismological studies based on geological engineering studies.
4-	Preparation of the Earthquake Master Plan in the light of the information to be obtained from the above study results and information to be obtained from other disciplines like city planners, civil engineers and architectures, and developing a control mechanism to ensure that these plans, prepared on the basis of region, city, and neighborhood, are implemented or monitored as they are.
5-	Determining the development and settlement strategies of the city by taking into account the Earthquake Master Plan, and within this framework, the active fault lines should be processed on the territorial maps and the areas within the conservation band of the active fault zones should be included in the 1st degree natural threshold values.
6-	Completing building inventory for the whole province on a GIS based basis in accordance with applied standards (social structure, number of independent units, building type, number of floors, construction permit date, basement floor use, construction year, tenant/homeowner status, renovation), especially in Onikişubat (city center), Dulkadiroğlu, Pazarcık and Türkoğlu Districts) and establishing city information systems to be integrated with the local disaster information system, ensuring the integration of existing information with the new system.

7-	Preventing illegal or squatter areas in the city, and gradually redesigning existing structures to fit the new order in a way that does not disrupt the urban fabric and completing the observational studies on masonry and adobe buildings in rural neighborhoods immediately.
8-	Transition to an effective building and project control system with the cooperation of the local administration in the building production process and later (audits are carried out by different disciplines as both qualitatively and quantitatively manner), ensuring the use of standard materials determined by the regulation and not allowing the use of those who do not meet the rules stipulated by the specifications.
9-	Ensuring participation at all levels which are local administrations, senior administrations, non-governmental organizations and the public are involved in every stage of the preparation of the plans and developing a transparent planning approach and strengthening inter-agency cooperation and coordination. - Taking decisions together with relevant institutions in the processes of approval of geological-geotechnical reports and announcement of risky areas. - Receiving support and consultancy services from universities and professional chambers for the preliminary examination and technical examination of the site selection, soil investigation and geological geotechnical survey reports. - Preparing risk maps on the basis of neighborhoods with the participation of the public and evaluating the disaster risks specific to the neighborhood. - Submission of provincial hazard and risk maps to the use and information of institutions and the public. - Organizing workshops, meetings, etc. to establish mechanisms that will enable non-governmental organizations, the private sector, volunteers and vulnerable groups to participate in disaster risk reduction activities. - Ensuring the effective use of the appropriation allocated for investments within the scope of disaster and emergency situations in disaster risk reduction activities. - Working with insurance sector representatives to raise public awareness on the importance of compulsory earthquake insurance. - Conducting joint training and awareness activities with related professional disciplines on earthquake regulation and related legislation for architects, engineers and contractors.

	- Establishment of a specialization committee by inviting stakeholders from different sectors and organizing meetings and regular exchange of ideas between them about disaster risk reduction strategies. - - Sharing the geoscientific data in the digital environment between the stakeholders through a common access system and thus strengthening the data sharing.
10-	Creating a culture of disaster risk reduction. - Carrying out activities aimed at raising awareness and reducing the risk of earthquakes with the participation of the public in homes, schools and workplaces. - Organizing activities, conducting campaigns and disseminating these activities (social media, etc.) by considering the needs of different groups in order to disseminate information in the field of disaster risks and disaster risk reduction. - Informing public officials, private sector, non-governmental organizations, volunteers and all citizens, primarily vulnerable groups, on disaster risk reduction and providing disaster awareness trainings and exercises for all vulnerable groups. - Establishment of disaster research/implementation centers. - Arranging the areas converted into assembly areas so that they can be used in a disaster, taking into account the vulnerable individuals, and introducing these areas to all segments of the public and demonstrating their accessibility.

- Accordingly, considering the relationship between site selection and construction decisions, the following conclusions have been reached for existing residential areas:

1-	Establishment of "Soil Investigation Branch Offices" in the Metropolitan and Country Municipalities. - Updating the liquefaction maps by determining the liquefaction potential of Kahramanmaraş and its surroundings, especially in the region where the schools (Sümbüllü and Ağcalı Streams surroundings) located in the south of Tekerek Road, around the Kahramanmaraş Sütçü İmam University junction. - Since Bahçelievler, Gayberli, Barbaros, Oruç Reis, Yenişehir, Egemenlik, Hacı Bayram Veli, Dulkadiroğlu, Boğaziçi, Tekerek,

	Şehit Abdullah Çavuş, Dumlupınar and Göksun neighborhoods are areas with a high risk of liquefaction, the necessary studies should be carried out one by one for the existing structures in these areas and it is planned according to risk groups and gradually moved to more durable places in terms of ground.
2-	Reviewing the master and implementation plans after these changes in the territorial plan, renewing the active fault lines by incorporating them into the development plans, and re-evaluating the existing urban development areas by taking these results into account and not allowing construction in potentially risky areas until the current development plan is updated. - Closing the areas determined as unsuitable areas in the geological-geotechnical survey reports based on the development plan in the city center to settlement, proposing them to be declared as risky areas and specifying them in the urban transformation strategy document. - Revising the spatial plans of Ulutaş, Gaffarlı, Kozludere, Güneşevler, Doğukent, Elmalar, Karacasu Karaziyaret Neighborhoods in Dulkadiroğlu Neighbourhood which are unsuitable areas for settlement due to being an disaster exposed areas. - Revising the spatial plans of Bahçelievler, Yenişehir, Egemenlik, Tekke and South part of the Onikişubat, Northwest part of the Göksun Neighbourhood in Kahramanmaraş city center which are unsuitable areas for settlement due to being an disaster exposed areas. - Revising the spatial plans of Tekerek, Şehit Abdullah Çavuş, Muratlı and Boğaziçi Neighbourhoods which are located west part of the in Kahramanmaraş city center which are unsuitable areas for settlement due to being an disaster exposed areas. - Revising the location selection of Sütçü İmam University - Karacasu Campus, Kahramanmaraş Airport and Kahramanmaraş City Hospital which are located on an unsuitable areas for settlement due to being an disaster exposed areas. - Taking into account detailed ground study results and priorities for earthquake resistant building design for new constructions in the south of Tekerek Road, around the university junction (around Sümbüllü and Ağcalı Streams) and South of Doğukent Road. - Taking as a basis that the construction on the filled ground with high agricultural potential but low bearing capacity should be kept to a minimum (if possible not done) and if it is necessary, the floor height does not exceed the carrying capacity.
3-	After the development plans are approved by the relevant municipalities and defined as an urban development area in the landuse plan, determining the

	strengths of the existing structures by considering the Earthquake Master Plan again for the places opened to the existing urban settlement and gradually renovating or moving them, starting from the most risky place. - Prioritizing and relocation of urban settlements in Kahramanmaraş city center neigbourhoods which are Bahçelievler, Onikişubat, Tekke, Yenişehir, Egemenlik, Tekerek, Ertuğrul Gazi, Yusuflar, Hacı Bayram Veli, Akçakoyunlu, Şehit Abdullah Çavuş, Muratlı and Boğaziçi by taking into account their earthquake resistance, in the light of earthquake master plan and risk analysis studies and carrying out retrofitting and transformation works. - Prioritizing and relocation of urban settlements in Pazarcık (including Cengiz Topel, Mehmet Emin Arıkoğlu , Bağdınısağır, Narlı, Çiğdemtepe, Menderes, Şehit Nurettin Ademoğlu and Mehmet Emin Arıkoğlu Neighbourhoods) and Çağlayancerit (Soğukpınar, Engezek and Fatih Neighbourhoods) by taking into account their earthquake resistance, in the light of earthquake master plan and risk analysis studies and carrying out retrofitting and transformation works. - Prioritization and relocation of urban settlements in city center in Dulkadiroğlu district (Aksu, Elmalar, Karacasu, Karaziyaret neighborhoods) and Muratlı Neighborhood in Onikişubat District by taking into account their earthquake resistance, in the light of earthquake master plan and risk analysis studies and carrying out retrofitting and transformation works. - Prioritizing and relocation of urban settlements in Türkoğlu district, Beyoğlu, Hacı Bebek, Cumhuriyet, Çobantepe, Minehüyük, Kuyumcular, Ceceli, Yeşilyurt, Akçalı, Yenipınar, Güllü Höyük, Kıllı, İstasyon and Şekeroba Neighborhoods by taking into account their earthquake resistance, in the light of earthquake master plan and risk analysis studies and carrying out retrofitting and transformation works.
4-	Shifting the industrial establishments located on the ring roads, on the filled soils with high agricultural potential in the South and West of the city, towards the organized industrial zones to be established on the slope lands in the South and Southeast direction with a lower agricultural potential.
5-	In order to reduce the impact of a possible earthquake in the city that cause loss of life and property, roads, intersections and open areas (especially Batı Park, Madalyalı Junction, Derepazarı, Şekerdere, Ulucami, Kıbrıs Square, Azerbaycan Boulevard and Trabzon Street where pedestrian and vehicle traffic are intense) should be designed in accordance with the needs of the disaster preparedness city. It is thought that it should be restructured and alternative routes to be used in case of emergency should be developed.
6-	Securing critical infrastructures

	- Making risk analysis of pipelines passing through settlements and taking necessary precautions. - Reviewing the earthquake risk analysis studies of all the dams in the region and determining the dam flood areas and including them in the emergency plans. - Carrying out the necessary retrofitting and transformation works of Private / Public Hospitals located in Bahçelievler and Eski Maraş Neighborhoods in city center and Pazarcık State Hospital in Pazarcık, Türkoğlu Central Health Center and Türkoğlu Community Health Center in Türkoğlu District, Narlı Health Center in Narlı Town. - Retrofitting or rebuilding educational institutions prioritized by the Ministry of National Education according to earthquake risk analysis results. - Prioritizing, retrofitting and transforming public buildings in the light of earthquake resistance inventory and risk analysis studies.

5.2 Limitations of the Research

Based on the urban seismic resilience concept, this study tried to explain how the process should work from the planning stage to the construction stage. This process description is not based on any analysis method or application. The main point taken as a basis is the results caused by the major earthquakes in the past in Türkiye. Policies and strategies developed to avoid these results were evaluated under the urban seismic resilient city concept.

Although the study explains the relationship between seismic resilience and urbanization issues, as well as how the seismic resistant urban policies developed affect the sfet-sensitive urbanization process, it has certain bindings. Ideas developed by considering Turkish conditions, political situations and legislation are not binding for every country in the world.

The details of the necessary Implementation Plans from the Kahramanmaraş Province Metropolitan Municipality determined for the study could not be reached and the data could not be obtained by the authorized institutions. For this reason, the smaller-scale examinations were made by obtaining from the official websites and news of the relevant Ministry, relevant Governorship and Municipality institutions. For the data that could not be obtained in any way, satellite images were examined in detail and tried to be digitized.

5.3 Recommendations for Further Studies

The study has developed a perspective for the planning and construction processes of urban seismic resilience. Kahramanmaraş city was chosen as a case study. The relationship between urbanization and seismic resilience can be compared with different examples in the world to form a basis for future studies. In this way, the subject of urbanization within different mechanisms can be further developed by considering the principles of seismic resilience. Secondly, the suggestions developed as a result of the case study can be used in the seismic evaluation of a different region. Considering the existence of similar risks for the provinces close to the region, the method followed may be similar for these cities. Again, if more detailed implementation plans are obtained for the Kahramanmaraş, the study can be expanded by adding more dimensions. In this way, the analyzes made with the results will be a guide for the applications to be made in the process of creating seismically resilient cities.

5.4 Epilogue

Last but not least, during the stage of one-month final corrections of the thesis, on February 6, 2023, two devastating earthquakes with a magnitude of M_w =7.7 in Kahramanmaraş province Pazarcık and M_w =7.6 magnitude centered in Elbistan occurred. The M_w =7.7 magnitude earthquake occurred at a depth of 8.6 km, while the M_w =7.6 magnitude earthquake occurred at 7 km depth. As can be seen in Figure 5.1, a large number of aftershocks have occurred from the main shocks. According to the intensity map produced using the Earthquake Preliminary Damage Estimation System (AFAD-RED), the intensity of the earthquake in the settlement area closest to the epicenter of the M_w =7.7 earthquake was calculated as MMI XI, and the intensity of the M_w =7.6 earthquake was calculated as MMI X.While the M_w = 7.7 magnitude Pazarcık earthquake coincides with the Narlı Segment at the northern end of the left lateral strike-slip Dead Sea Fault Zone, the M_w =7.6 magnitude Elbistan earthquake coincides with the Çardak Fault, which is a branch of the Eastern Anatolian Fault.

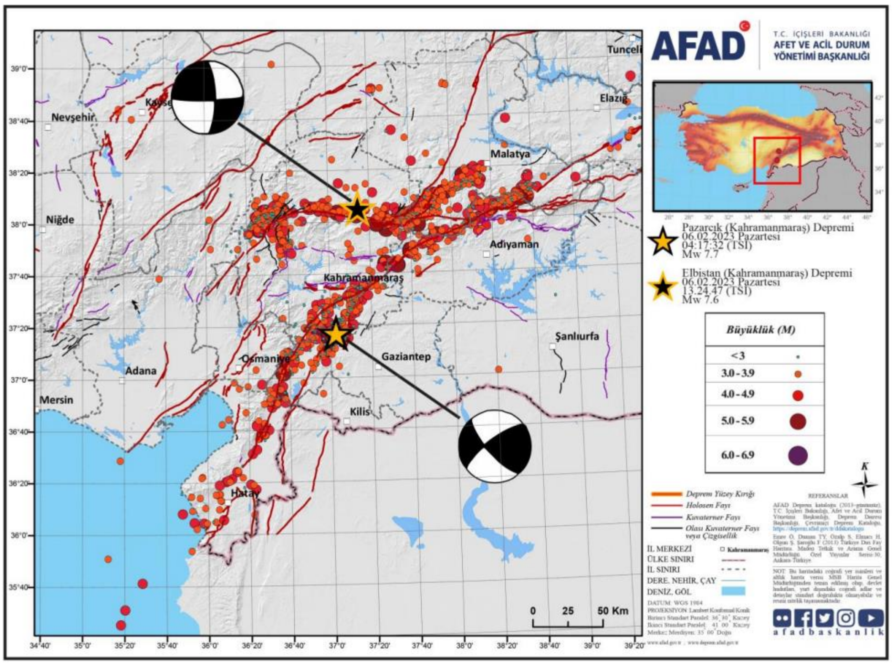


Figure 5.1: *06.02.2023 Pazarcık Mw =7.7 and Elbistan Mw =7.6 Earthquakes and Aftershock Activities*

Source: *(Disaster and Emergency Management Presidency, 2023)*

Preliminary data from strong ground motion stations show that earthquakes affect a very large region. Both earthquakes mostly affected the cities of Kahramanmaraş, Gaziantep, Hatay, Adıyaman, Elazığ, Adana, Şanlıurfa, Diyarbakır, Malatya, Osmaniye and Kilis with residents of over 15 million. The events caused significant shaking and damage. As of 18.02.2023, the total number of causalities exceeded 40.000, and 110.000 were injured. More than 100.000 buildings collapsed or were heavily damaged.

According to the comments of experts from all over the world on these earthquakes, this event has been rated as the most important seismic activity that has affected the region for over 500 years. Initial observations showed that the leading causes of this tragedy were high peak ground acceleration and spectral acceleration values exceeding the predicted design values and irregularities in structures.

Unfortunately, these earthquakes that occur are where words fail. I wish we were not so late. I am very sad…

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