Istanbul Seismic Risk Mitigation and
Emergency Preparedness Project
**ISMEP**

# Urban Planning and Construction for Disaster Mitigation

## TRAINING BOOK FOR LOCAL DESICION MAKERS

**TRAINING BOOK FOR LOCAL DECISION MAKERS**

TRAININGS ON SAFE CITY SAFE LIFE

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Istanbul

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# Urban Planning and Construction for Disaster Mitigation


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## Introduction

### Aim

The aim of this training program is to give information to the participants on natural hazards and their impacts on urban land, strategies on disaster preparedness, their role and responsibilities and to provide necessary skills on disaster mitigation. The program, moreover, shows to the participants how they can be involved to the disaster mitigation activities and their responsibilities.

### Scope

This training guideline focuses on urban planning and construction in the frame of disaster mitigation with; natural hazards and their impacts on settlements, strategies on disaster preparedness, structural and urban risks and activities to reduce probable risks. In this context, participatory techniques will be applied using the experiences and environment of participants to examine the possible method and techniques that can be used for.

### Motivation

The motivation of this program is the need of disaster mitigation planning due to a collective method which can support long term social and physical rehabilitation against natural hazards. It is crucial that cities are planned disaster resilient and sustainable, especially in Turkey where devastating hazards occur frequently. Disaster preparedness should be provided not only at urban scale but also at building scale. Technical staff have very important roles to achieve this process so called "Safe City, Safe Life". Briefly, related issues are required to be informed and disseminated. This training program, therefore, aims to contribute necessary information for local decision makers.

### Definitions

Disaster mitigation strategies on urban planning stress sustainable development, livable and safe cities. This approach is based on, in one hand, the reduction of probable urban risks which are likely to cause deaths and losses and on the other hand, integration of policies and strategies with public ownership. Disaster mitigation on urban planning gives responsibilities to all stakeholders of the community. These responsibilities can be either collective or individual. Cities have chance to be prepared against disasters by means of participatory disaster mitigation planning.

### Target Group

The target groups of this training program are local decision makers, local technical staff and community representatives who are the key stakeholders in disaster mitigation on urban planning and construction process. This training guideline is prepared for local decision makers.

## Main Objectives of the Guideline

This training program which focuses on disaster mitigation at both urban and building scale, aims to give information to local decision makers, local technical staff and community about situation which they will face with and how to deal with. These are as follows:

1 **Enlighten the role of urban planning in urban risk reduction**

Existence of un-planned settlements causes great losses during natural hazards and it worsens the way of dealing with disasters. Urban planning tools are effective to reduce or eliminate probable risks. This training program aims to eliminate or reduce risks in urban areas, to evaluate current state at urban and structural scale and to develop and how to apply necessary strategies and techniques.

2 **Enlighten concepts of disaster and participatory planning set in Turkish legal framework**

Development regulations and planning practices in Turkey include disaster and participatory planning concepts. This training program relies on disaster mitigation strategies with participation in order to show how these concepts can be implemented in the planning practice.

3 **Provide synergy among participants**

Participatory planning requires developed decision making, applied and monitored by all stakeholders. This training program aims to activate target groups to disaster mitigation with a perspective of participatory planning which focuses on "producing ideas together".

4 **Improve participatory decision making and using relevant skills**

In order to have concrete success in collective decision making, the integrative process and related methods and techniques should be provided. This training program targets learning by doing actions that participants develop skills which would help them to enhance their new knowledge due to case studies and to apply and to disseminate what they have learned.

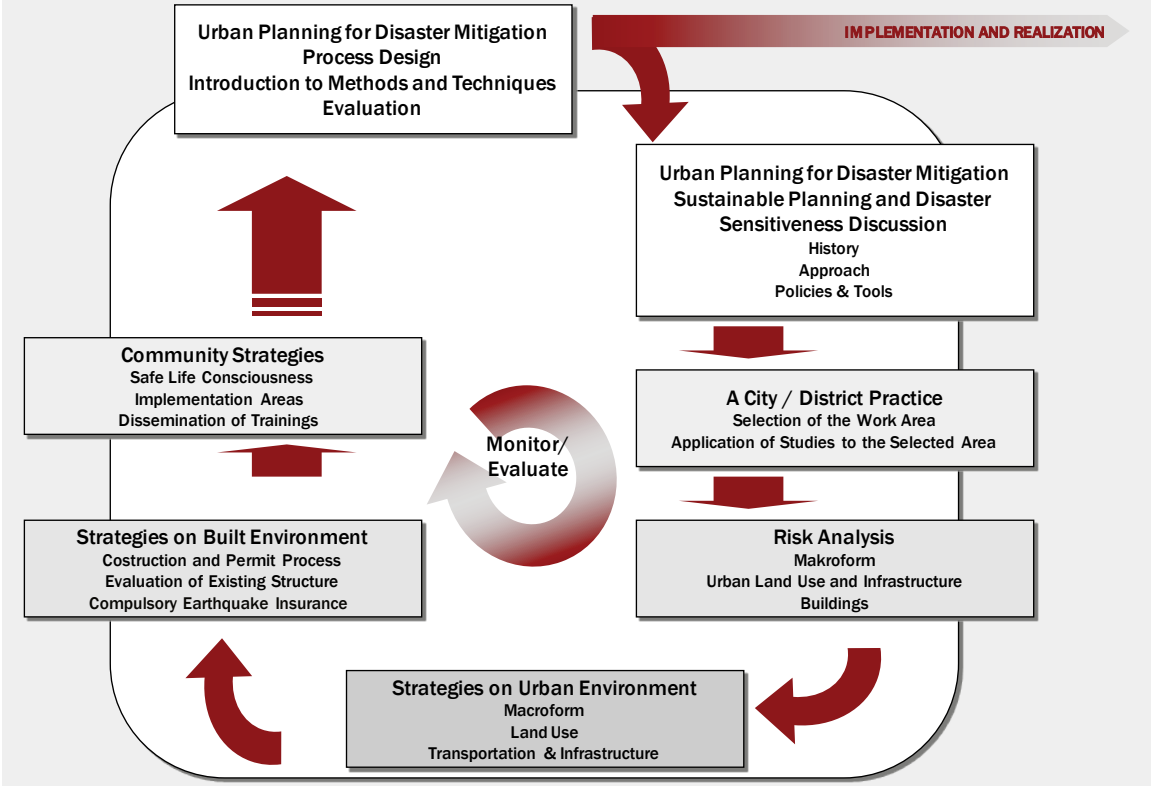
## Knowledge and Skills

The objectives that participants would achieve are; to evaluate of disaster mitigation and to develop planning principles; to produce strategies and policies; to query urban planning discipline in the frame of disaster mitigation; to learn about and to implement participatory techniques. Beside theoretical information, participants will practice discussion methods. On the other hand, the training program will help to increase their risk perception on building environment and land uses.

## Content of the Program

The main aim of the training program is to examine main principles of urban planning process for disaster mitigation using some relevant methods and techniques (Figure 1). First of all, disaster mitigation will be discussed in the context of sustainable development and subsequently, the role of urban planning will be considered in mitigation and/or reducing risks. This stage will be followed by the process of urban planning for disaster mitigation. In this case, participants will evaluate their own living environment. In the frame of the case study, participants will analyze risks and develop strategies on urban, building and community scales. At the last stage, mitigation strategies on urban risk reduction, methods and techniques will be summarized and evaluation of the training program will be done.

**FIGURE 1.** STEPS OF TRAINING PROGRAM ON SAFE CITY SAFE LIFE



## Part 1 – Importance of Urban Planning for Disaster Mitigation

In this section, disaster mitigation will be discussed in the sustainable planning perspective and in this context, the importance of sustainability; main motivations and its history will be given. The role of urban planning will be examined in the frame of risk reduction to achieve sustainable livelihoods and to enhance community awareness according to the hierarchical feature of planning practice.

### Disaster Mitigation in the Perspective of Sustainable Planning

*Concept of Sustainability and its Background*: In the Brundtland Report[1], sustainability is defined as a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

**SUSTAINABLE DEVELOPMENT**

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

The concept of sustainability and the urgent need to achieve sustainability were first discussed in 1970's at the World Summit of the United Nations because of the negative impacts of urban development on natural environment. In 1992, at the Rio Declaration to attend sustainability the strategies on international dialogue and cooperation were declared. Again in 1992, the Conference of Environment and Development by the UN emphasized on environmental, economic and social dimensions of sustainability and presented Local Agenda 21 to enhance livability, equity, citizenship, implementation and governorship. In 2002 in Johannesburg, World Sustainable Development Summit focused on natural deterioration and climate change with natural disasters which can be seen as the consequences of this environmental change.

*Importance of sustainability*: This was the first time in 2008 that urban population over-passed rural population. This leads to call this era as "urban millennium". It has been projected that urban population will go to increase especially in the metropolises of developing and less developed countries (UNFPA, 2008).

However, water resources, agricultural land are facing with a serious threat coming from urbanization which causes overdevelopment, natural environmental deterioration, over capacity usages. On the other hand, this development style breeds natural disasters. Therefore, planning for disaster mitigation is crucial in the perspective of sustainable planning.

In order to eliminate risks coming from natural hazards, it is important to protect natural integrity and functioning and to plan urban areas according to ecological units. In this extend carrying capacity of ecosystems, urban areas and their needs should be noted carefully.

[1] Brundtland, G. (1989) Our Common Future, World Commission on Environment and Development, Oxford University Press.

## Importance of Urban Planning for Disaster Mitigation

**COMPLEMENTARY DISASTER MANAGEMENT**

Complementary disaster management system covers four stages of emergency planning (preparedness, mitigation, response, recovery) and forms a cycle. This system requires a comprehensive framework for disaster management system.


More than half of world population is living in urbanized areas. Metropolitan areas of most developing countries are composed of un-planned areas and un-healty conditions. When natural hazards hit dense settlements of those countries, the consequences are usually disastrous.

Disaster management covers to organize any kind of resources in prevention of mass damages, to analyze hazards and risks, to make decisions and to evaluate. In order to achieve this system, a comprehensive disaster management system should be required. Disaster Management comprehends 4 basic sequential phases (preparedness, mitigation, response, recovery). The nature of disaster management system requires a comprehensive planning approach as well.

1 *Preparedness:* To define duties and responsibilities and to organize resources in emergency periods.

2 *Mitigation:* To reduce or to remove risks in long period which are likely to cause losses in human life and assets due to hazardous event.

3 *Response:* To search and rescue aftermath of a disaster.

4 *Recovery:* To recover infrastructural, physical and social environmental problems occurred after disasters to get better living conditions.

According to the development pattern of settlements (existance of un-planned areas) "**risks**" are likely related with built-up area, community and economy. However, it is possible to eliminate such risks due to mitigation strategies in disaster management. Therefore, tools of **urban planning** play an important role in reducing negative disaster impacts.

This training program focuses on how to mitigate disasters due to urban planning tools.

## Disaster Mitigation Strategies in Sustainable Urban Planning

With the basic aims such as improve the quality of life and to leave livable settlements for future generations, urban planning should be managed in taking into consideration of mitigation strategies against natural hazards[2]-[3]. This should be achieved with the participation of people from all age, gender and social status which would feed equity principle in the community.

[2] Tezer, A. ve Türkoğlu, H. (2008) Afet Zararlarını Azaltmanın Temel İlkeleri, T.C. İçişleri Bakanlığı ve JICA, Miktad Kadıoğlu ve Emin Özdamar (Editörler), JICA Türkiye Ofisi Yayın No: 2, Mart 2008, Ankara
3 FEMA (2000), Planning for a Sustainable Future,Project Impact, FEMA No:364

Disaster mitigation strategies in the perspective of sustainable urban planning are[4]: **1)** To protect and to integrate with natural environment with taking into account ecological thresholds; **2)** To reduce over use of land and resources; **3)** To enhance an integrated planning approach achieving environmental, social and economic objectives; **4)** To allocate resources, opportunities and environmental risks equally and in equity principle; **5)** To reduce natural disaster vulnerability.

1 *To protect and to integrate with natural environment with taking into account ecological thresholds*: These settlements are which developed with taking into consideration of ecological thresholds and naturally sensitive areas like water basins and shores which are protected with regard to protection-use balance. In several disasters, the main reasons are related not to take account natural environmental thresholds and ecosystems at regional scale. The relationship of these areas and settlements, land use decisions, and their compatibility are very crucial to achieve "sustainable settlements". Therefore, in one hand, risks related with natural environment can be controlled and on the other hand biological diversity is protected. It is possible to decrease the impacts of disaster using natural control mechanisms of environment.

| SETTLEMENTS NOT INTEGRATED WITH NATURAL ENVIRONMENT | RISKS |
|---|---|
| • To capture water drainage system in underground canals<br>• To dry wet lands which feed surface and underground water<br>• Expanded and dense structuring | • Deterioration of water resources<br>• Deterioration of natural balance of water cleaning provided by natural control mechanisms<br>• Increase of floods according to the non permeable surface |

2 *To reduce over use of land and resources*: The urge of sustainability is strongly related to the "limits of natural environment" and misuse of resources by human beings. In this perspective, urban planning should follow adequate land use policy which considers limits of sensitive natural environment and effective use of resources. Instead of expanded settlements, attending sustainability and compact settlements are favorable. From this point of view, avoiding to settling near natural hazardous areas, urban plans would have rational decisions on urban land use policy.

| DEVELOPMENT CONSUMING LAND AND RESOURCES | SUSTAINABLE DEVELOPMENT |
|---|---|
| • Low density expanded areas at the periphery of cities.<br>• Expanded development | • Re-use of vacant areas or deteriorated areas for new development<br>• Compact development |

[4] Beatley, T. (1998), The Vision of Sustainable Communities in Cooperating with Nature: Confronting Natural Hazards with Land-use Planning for Sustainable Communities, (Editor: Raymond J. Burby), Natural Hazards and Disasters Series, A Joseph Henry Press Book.

3 *To enhance an integrated planning approach achieving environmental, social and economic objectives*: Disaster mitigation due to natural hazards in urban areas requires a long term and comprehensive perspective. In this extend, residential activities, economic activities, accessibility to public facilities and safety gain great importance. Furthermore, land use policies should drive safety in urban areas, sustainable regeneration programs should be enhanced and risks on economic and social structures should be taken into account. For instance, the Marmara Earthquake (1999) caused devastation at community and economic scale of the entire country because it occurred in the most industrialized zone of Turkey. Therefore, from the point of view of natural hazards, sustainable economic development covers resilience of economic system against natural hazards.

4 *To allocate resources, opportunities and environmental risks equally and in equity*: In the settlements which are faced with natural disasters, afterwards it may be some problems on property rights in the recovery process.[5] Limitation of property rights and expropriation of heavily damaged or collapsed building due to natural hazards and property rights transfer, which is not widen in Turkey, are key issues to handle in order to allocate resources in equal way. Since government supports vicitims in any case, however, it causes not to take precautions, diminish risk perception and increase acceptability of risks. Therefore, individuals, within this kind of system, prefer not to take necessary precautions to mitigate risks instead, they prefer to invest on daily and short term solutions. Despite necessary knowledge is acquired by the community, this kind of applications drives people to be less aware on natural disasters.[6] These are the main obstacles in front of allocation of resources, awareness programs and dissemination activities on mitigation. Governmental policies, in this extent, should drive community to be more aware on natural environmental sustainability and natural hazards with long term strategies.

5 *To reduce natural disaster vulnerability*: Sustainable development policies can not eliminate all risks by themselves; however, they balance risks in the point of social and economic development. Some of the settlements had been developed in a vulnerable way according to their historical background. Therefore, it is not too realistic to evacuate all those areas to eliminate risks. On the other hand, settlements can be strong against natural disasters by land use control, transportation/infrastructural planning, urban regeneration and renovation.

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[5] Balamir, M. (2002a) Painful Steps of Progress from Crisis Planning to Contingency Planning: Changes for Disaster Preparedness in Turkey, Journal of Contingencies and Crisis Management, Vol. 10, No.1, pp.39-49.

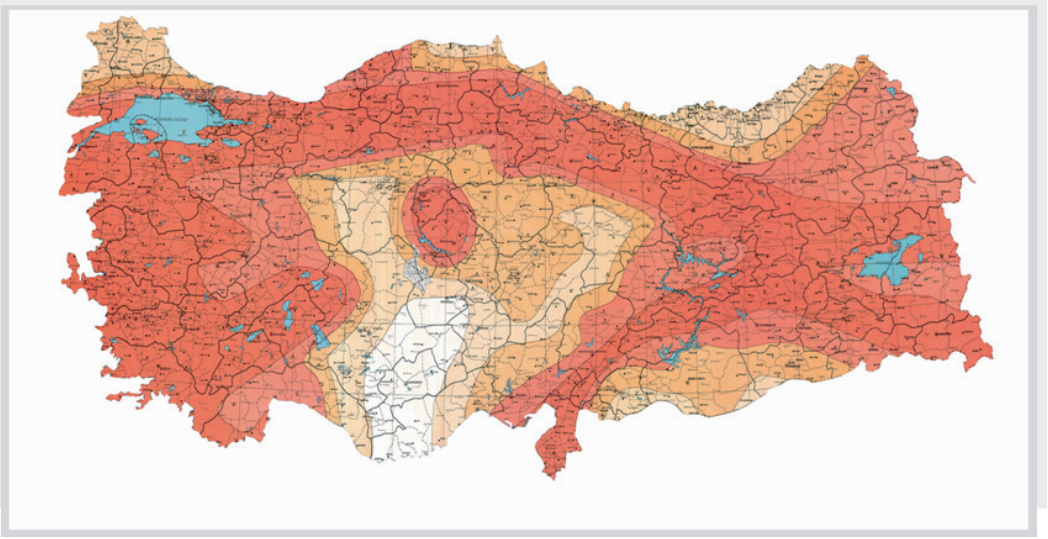
[6] Burby, R. J., (1998), "Policies for Sustainable Land Use", in Cooperating with Nature: Confronting Natural Hazards with Land-use Planning for Sustainable Communities, (Editor: Raymond J. Burby), Natural Hazards and Disasters Series, A Joseph Henry Press Book.

## Part 2 – Urban Planning for Disaster Mitigation

While rapid urbanization which lets development of unplanned and unhealthy settlements in one hand and on the other hand the increase of population density in hazard prone areas, they all urge a strong requirement in disaster focused policies at both local and central level in Turkey. Once looking at the earthquake hazard map for Turkey, we can see that large territories with dense urban settlements are under the threath of serious earthquake hazard where we unfortunately are likely to face social and economic losses (Figure 2).

The primate city of Turkey, Istanbul, is under the pressure of negative urban impacts and earthquake threat at the same time. As Istanbul is more than a simple city which carries an important global role, the risks are bigger.

**FIGURE 2** EARTHQUAKE HAZARD MAP OF TURKEY (BİB, AİGM)



**Content:** Urban planning as a tool for disaster mitigation is crucial to sustain community and economic existence and welfare for livable cities. In this section, only the components of disasters are mentioned to define and to understand natural hazards[7]. The aim of this section, therefore, is to indicate devastating impacts of hazards on human settlements.

Urban planning focuses on all environmental aspects of a settlement regarding to regulations and municipal structure to achieve mitigation strategies. Regulations refer all legal statements concerning the region, city or an area. Municipalitiy administration structure covers political authority and opportunities. Population is defined as demographic and socio-economic aspects of community. Cultural and historical values refer concrete and abstract values of a community. Urban environment comprehends physical built-up environment and infrastructure. Table below shows components of settlements.

[7] *Mikrobölgeleme ve Hasar Görebilirlik Çalışmaları Metodoloji El* Kitabı, (2006) ABS Consulting, UCER-ALTER, MEER Projesi (Marmara depremi acil yeniden yapılanma projesi)

| Settlement Profile | Settlement Components | Explanation |
|---|---|---|
| **REGULATIONS AND IMPLEMENTATION TOOLS** | • **Regulations on Urban Planning** (*development and land use decisions*)<br>• **Development Law** *(to standardize development system)*<br>• **Environmental Law** (*to protect natural resources)*<br>• **Development Plans** (*future development of cities*)<br>• **Emergency Plans** (*to reduce losses in human life and economy)*<br>• **Mitigation Plans** (*to reduce losses)* | Regulations to be implemented at regional ad urban scales. Mitigation plans comprehend urban planning, development plans, emergency plans and environmental law which are mentioned in zoning code. |
| **ADMINISTRATIVE STRUCTURE OF MUNICIPALITY** | • **Authorized area** (*urban and rural areas inner boundaries*)<br>• **Opportunities** (*technology/equipment, financial resources, human resources)* | Related with authorized area and opportunities of municipalities. |
| **POPULATION** | • **Total Population** (*population, density, location, economic and social characteristics)*<br>• **Income** (s*ocio-economic aspect of community*)<br>• **Housing** (*location of residential areas and their typology*) | Related with demographic, social and economic aspects of population and living standards. |
| **NATURAL ENVIRONMENT** | • **Location** (*geographical location)*<br>• **Topography** (*morphology, slopes and physical structure*)<br>• **Climate** (*weather conditions*)<br>• **Forestry** (*flora and fauna)*<br>• **Geology** (*physical structure and condition of soil*)<br>• **Batimetry** (*physical and morphological structures under water*)<br>• **Water Basin** (*water resources and rivers*) | Natural environmental systems which cover water basins, natural pattern, flora, fauna, open and green areas. Topography, climate and geology are also important in these systems. |
| **CULTURAL / HISTORICAL ASSETS** | • **Cultural** (*concrete and abstract values*)<br>• **Historical** (*historical assets*) | Values presenting historical and cultural assets of a community. |
| **URBANIZED AREAS** | • **Building Inventory** (*structure, vulnerability and occupation*)<br>• **Open Spaces** (*open and green areas for public use*)<br>• **Transportation** (*docks/ports, airports, railways, roads etc.)*<br>• **Infrastructure** (*electric, natural gas, oil, telecommunication, water, swerage, dams, channels etc.)* | Built-up areas comprehend all structural and infrastructural systems. Open spaces and infrastructural systems are crucial aftermath of a disaster to survive. |

**Consistency of strategies in planning hierarchy:** Regarding to urban and demographic dynamics and development scenarios of a city, coherent strategies and policies should be developed and integrated from the scale of regional plans through strategic plans, development plans and implementation[8]:

**CONSISTENCY of STRATEGIES in PLANNING HIERARCHY**

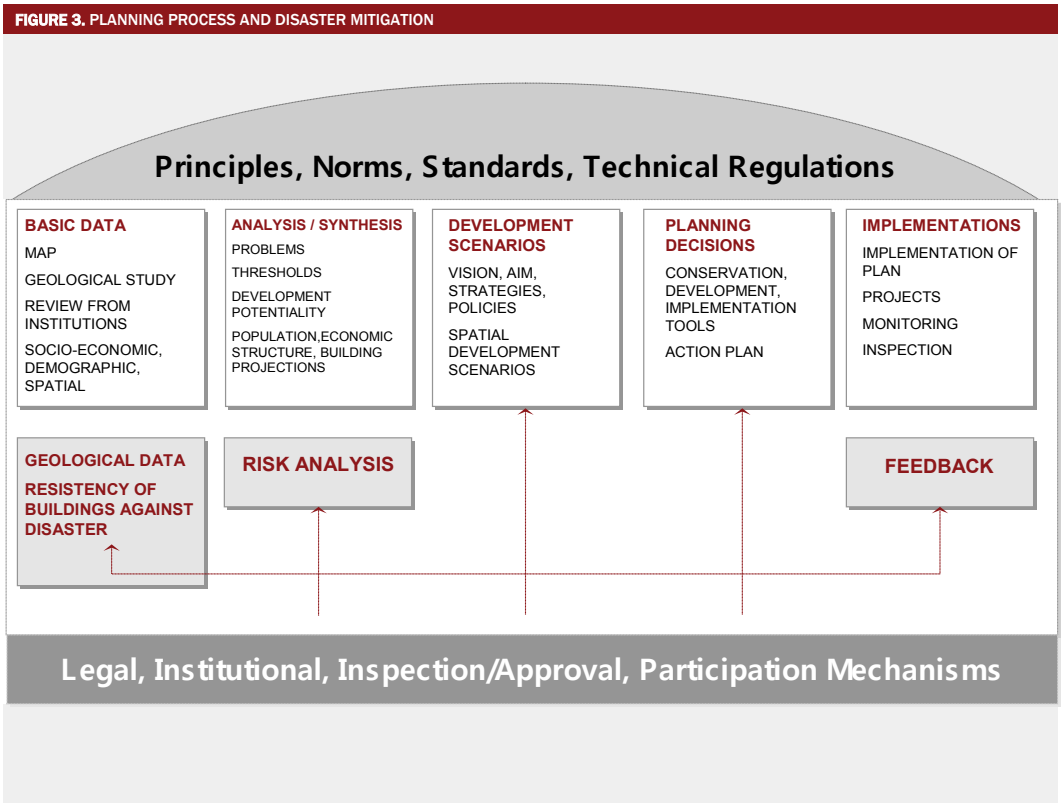
"For instance, relocation of critical facilities and investments at national level through hazard free zones and implementation of regional plans which note available safer zones for new urban development have important roles in reducing natural risks and mitigation activities"

- Socio-economic plans drive physical development at national scale;
- Decisions on locations take natural hazards as constraints at national and regional level;
- Plans with different scales are compatible;
- Policies are produced to ease interactions between environment and community.

**Planning process and disaster mitigation:** Planning process is defined as a comprehensive implementation process respecting to rules, norms, standards and techniques and consisting of legal, institutional, consultancy/approval and participatory mechanisms. However, planning process and implementation of every community should be compatible according to their own dynamics. Planning process is described in 5 main stages. (Figure 3): 1) Data; 2) Analysis/Synthesis; 3) Development Scenarios; 4) Planning Decisions; 5) Implementations. The first stage refers to gather data and to map at environmental, physical, demographic and economic scale. In the second stages, date gathered are analyzed and evaluated. In the third stage, referring to the output of the second stage, vision, aim, main objectives, strategies, policies and spatial development scenarios are developed. In the forth stage, conservation, development and implementation tools are described and action plans developed. The last stage is described as implementation, monitoring and inspection of plans.

[8] Tezer, A. ve Türkoğlu, H. (2008) Afet Zararlarını Azaltmanın Temel İlkeleri, T.C. İçişleri Bakanlığı ve JICA, Miktad Kadıoğlu ve Emin Özdamar (Editörler), JICA Türkiye Ofisi Yayın No: 2, Mart 2008, Ankara.

**FIGURE 3.** PLANNING PROCESS AND DISASTER MITIGATION




In order to mitigate disasters and to develop plans respecting mitigation principles, the findings and important remarks coming form **Risk Analysis** should be considered in each planning phase. The primary data on this process is obviously data on ground conditions which can affect the intensity of shaking and the other one is about the building inventory. All kind of analysis should be evaluated at urban scale to drive future settlements. Another important point in this process is that feedbacks at every level which eases monitoring.

**URBAN MANAGEMENT AND PARTICIPATORY PLANNING**

**In participatory approach, groups of interest ae not just be informed but also they are involved in decision making process. Participation enables all groups of interest to claim their rights and on the other hand it enables economize of resources caused by one way feedbacks. Moreover, participation improves democracy, strength and community learning during decision making process.**

**Participatory approach:** There is no unique process in disaster mitigation planning. However, the common point of best practices is practicing participatory planning.[9]

Participation in local administration and planning emphasizes democratic participation of groups of interest into decision making process, anticipates development of collective intelligence, takes differentiation among participants as the potential of creative ideas and provides collective production of ideas and taking action for individual and community learning. In participatory approaches, knowledge should be developed through action. Otherwise, the process may be faced with a threath of dissappearence. Collective development of ideas should go through collective actions. Participatory approach, comparing with the traditional approaches, has some

[9] *Mikrobölgeleme ve Hasar Görebilirlik Çalışmaları Metodoloji El* Kitabı, (2006) ABS Consulting, UCER-ALTER, MEER Projesi (Marmara depremi acil yeniden yapılanma projesi)

benefits such as: effective decision making, contribution to democratization, commitment, supporting to individual and community learning and shifting decisions through actions.[10]

1 *Effective Decision Making*: This is the process where all groups of interest participate in decision making and therefore it would prevent some disadvantageous decisions to certain group of interest.

2 *Democratization*: This is the democratization of decision making on settlement issues with all groups of interest. Participatory planning process requires open dialogue and equality of all groups on the issues.

3 *Commitment:* This stage enable decision makers and other groups of interest to come together and therefore decision makers are up to commit about issues.

4 *Learning*: Participatory planning process provides comprehensive learning environment. It is based on gathering people from different interest, skills and level of knowledge and specialists to develop collective ideas, collective discussions and exchanges.

5 *Being Action Oriented*: At the last stage of decision making process where all shareholders contribute in, action plans are produced. Abstract concepts are easy to vanish. This process enables decisions to be action oriented. Action plans comprehend the steps of projects, implementation mechanisms of institutions, timing and budget. It is crucial that decision making mechanisms cover implementation, monitoring and evaluation stages. In this extent, decisions should be shifted through actions.

**Legal Regulations:** Municipality Law (No: 5393) (2005), gives duty to special provincial administration, municipalities and villages to: provide competency in local services, cooperate public services, protect public interest, provide local needs and develop disaster preparedness/ emergency plans. In this law, it is mentioned about "Urban Regeneration". This implementation tool has a strong potential on disaster mitigation and enhancing public interest perspective. Urban regeneration should be reviewed with social improvement, economic development, natural preservation and democratic organizations.[11] In the regeneration areas, besides physical changes, according to the special features of the area, different social and economic policies can be implemented. This process should provide employment, support community strongness, physical recovery and safer construction.

Metropolitan Municipality Law (No: 5216) (2004), entitles metropolitan municipalities to physical planning and management of infrastructural systems; Disaster Law (No: 7269) entitles governorships and district administration on education, health, transportation, environment and energy. In the Development Law

[10] Ataöv, A. (2007). Planlamada sosyal bilmcinin değişen rolü: Toplumdan biri olmak", Mimarlık Fakültesi Dergisi (Journal of the Faculty of Architecture), 24(1), 139-152.

[11] Ataöv, A. & Osmay, S. (2007). Türkiye'de kentsel dönüşüme yöntemsel bir yaklaşım. *ODTÜ Mimarlık Fakültesi*, 24 (2), 57-82.

(No: 3194), local municipalities are entitled to make plans however mitigation activities are not mentioned.[12]

In the local administrative regulations, there are principles on disaster mitigation strategies and participatory planning process. Metropolitan Municipality Law (5216), Municipality Law (5393) and Special Provincial Administration Law (5301) indicate that local administrations should provide participation in developing their spatial and institutional strategic plans. Despite it is not clear how to participate in decision making process, it is still obligatory for local administration to provide participation in making plans. In the article 76 of the Municipality Law indicates that during the development of visions and strategies for cities, it is required a collaboration with City Council (which was found according to Local Agenda 21). Therefore, Local Agenda 21 which was related by the initiatives of local governance before 2005 has been legally interfered in local administration by the Municipality Law.

**COOPERATION AMONG LOCAL ADMINISTRATION, PRIVATE SECTOR AND COMMUNITY**

It is assumed that only government is responsible to provide necessary founding from the budget. However, this is not a right assumption.

The main duty of Local Governments on mitigation activities is to prepare development plans, building control, to take precautions to ensure security and their implementations.

Private Sector should correspond decisions taken in plans, to provide mitigation in their own enterprise.

Community should be involved and support mitigation activities.

**Cooperations:** Once discussion financial and technical resources in mitigation activities, it is assumed that only government is responsible to provide necessary founding from the budget. However, this is not a right assumption. The main duty of *Local Governments* on mitigation activities is to prepare development plans, building control, to take precautions to ensure security and their implementations. Public awareness campaigns are also in the responsibility of local governments to reduce possible risks on human life and community belongings.

Mitigation activities are crucial to prevent investment to receive damages. Hence, *Private Sector* should correspond to decisions taken in plans, to provide mitigation in their own enterprise and to contribute and participate into public awareness activities conducted by local governments. Moreover, community should be involved and support mitigation activities. Therefore, mitigation strategies on planning should reach through every level of *Community* since raising awareness is the key component to mitigate risks.

[12] Balamir, M. (2001) Recent Changes in Turkish Disaster Policy: A Strategical Reorientation?, P.R. Kleindorfer (ed.) Mitigation and Financial of Seismic Risk in Turkey, *NATO Science Series*, Kluwer Academic Publishers, pp. 207-234.

## Part 3 – Risk Analysis

Risk analysis is based on analyses and evaluation of natural hazards threating settlement and of its vulnerability level. In this section, after general information on hazard analysis, vulnerability analysis and risk analysis are given; a method will be introduced on the impacts of natural disasters on settlements done by municipality.

The primary stage of risk analysis covers the special features of natural threats (probability, intensity, return period etc.) and exposure of settlements such as built environment and demography (Figure 4). Storage of data on digital database would ease necessary baseline for risk analysis. Data can be gathered from different institutions. For instance, while demographic data can be obtained by Turkish Statistical Institute, data about urban land can be obtained from the database of relevant municipalities. Data about the outer parts of municipalties can be acquired from governorship of the relevant province. Building information, historical buildings, building ages and buiding types can be provided either from site analyses or by Provincial Directorate of Cultural and Tourism Ministry. It is also possible to compare building information from municipality with present state. Ownership information can be obtained from Property Directorate.

Hazard, vulnerability and risk analyses can be performed using to various methods. The most common of them is **Geographical Information Systems** used by several institutions which enable accurate results, mapping and evaluation. This method eases in combination of vector data with attributes in a single database and therefore in questioning data relations. For instance, it is possible to overlay information about hazards of a specific site with information on settlement covering data on buildings. As precise as data are, it is possible to produce detailed evaluation.

**FIGURE 4** RISK ANALYSIS PROCESS AND HIERARCHY

| | INFORMATION | 1st LEVEL ANALYSIS | 2nd LEVEL ANALYSIS |
|---|---|---|---|
| REGION | DEMOGRAPHIC DATA<br>DATA OF EMERGENCY SERVICES<br>REGIONAL LAND USE DECISIONS | PRODUCING HAZARD MAPS<br>SUPERPOSING REGIONAL LAND USE, HAZARDOUS USES,EMERGENCY SERVICES AND INFRASTRUCTURAL HAZARD MAPS | VULNERABILITY AND RISK ANALYSIS AT REGIONAL SCALE PRODUCED BY GIS SYSTEMS |
| URBAN / BUILDING | DEMOGRAPHIC DATA<br>DATA OF EMERGENCY SERVICES<br>URBAN LAND USE DECISIONS<br>STRUCTURAL DATA | PRODUCING HAZARD MAPS<br>SUPERPOSING REGIONAL LAND USE, HAZARDOUS USES,EMERGENCY SERVICES AND INFRASTRUCTURAL HAZARD MAPS<br>ANALYSE OF URBAN PATTERN<br>SCARCITY OF OPEN SPACES<br>STRUCTURAL RISKS | VULNERABILITY AND RISK ANALYSIS AT URBAN SCALE PRODUCED BY GIS SYSTEMS |

**Hazard Analysis,** is a method which reveals potential natural threats (such as earthquake, flood, landslide, avalanche) according to their return periods, magnitudes and intensities with their spatial distribution on a certain region. For example, in the case of earthquakes, it is possible to produce hazard maps using historical data, return periods and likely affected zones. In earthquake hazard analysis three main methods are used to identify potential threats: analysis based on observations, probabilistic and deterministic approaches. These methods can be used separately and as well as all combined.

Analysis based on observation is the traditional way to analyze seismic hazards using historical data and site observation. These analyses, even today, have significant contribution in understanding impacts of previous seismic events occurred in a certain region to estimate probable future impacts. Probabilistic approach studies return periods as well as seismic sources. The main focus of this analysis is to consider all possible seismic activities in a certain period of time which illustrate probability. Deterministic approach focuses on cause and effect relations. It reveals worst case scenarios. The primary advantage of this approach is that it is relatively simpler than probabilistic approach and it can give clues to provide maximum safety conditions.

Regional (macro) hazard maps are produced either for a particular hazard or as an integrated hazard map which includes all aspects of various hazard sources. Urban hazard maps show more specifically hazardous locations which are indicated roughly on regional hazard maps. Micro hazard maps are the results of microzoning studies. In the microzoning maps, seismic hazard source is related with ground conditions where therefore, hazard prone areas are indicated. Besides these maps show direct impacts of a probable earthquake, they show secondary impacts of earthquakes such as landslide, liquefaction and inundation.

**Vulnerability** which is used for natural, built-up and socio-economic environment can be defined as the fragility of an object against to any kind of threat (or danger) which might increase risks. Hereby, vulnerability is related with potential losses. The studies examining urban earthquake risks, vulnerability is defined with building stocks and their features, demography and economic aspects of the settlement. Vulnerability, on the other hand, can be defined as the exposure of objects or elements independently from danger.

Physical vulnerability points out the fragility of built up environment. As well as the quality of upper structure and infrastructure of a settlement, occupation and usage of these objects plays an important role to identify their vulnerability. Environmental vulnerability indicates how natural environment is susceptible against various threats. For instance, forest areas, water resources and underground water are more sensitive than the other natural resources. Furthermore, very special fauna and flora which are not common on the entire earth are declared as sensitive areas as well. Another component of vulnerability is called as socio-demographic vulnerability. Living standard, social networks, beliefs, age, gender and race of a community are evaluated in the frame of socio-demographic vulnerability. These characteristics affect risk perception and participation to disaster mitigation activities. Economic vulnerability, on the other hand, describes the fragility of the economic asset or activities of a given region. For instance, if the main economic activity of a region serves to entire

country (or international trade), in the case of any damaged, they might be big losses and it might require big investments to recover.

In urbanized areas, vulnerability components cited above are strongly related with probable losses and when they meet with natural or technological hazards, chain losses might be occurred. After an earthquake, there are also some facilities which are slightly affected or not affected at all. However, due to damages on infrastructure or transportation, these facilities may not function. This situation is called as systemic vulnerability.

Regional vulnerability analysis focuses on present situation of a region; it examines and compares planning decisions in the context of vulnerability and risks. Urban vulnerability analysis covers landuse, population density, transportation, infrastructures, critical facilities such as schools and hospitals and hazardous land uses. Urban pattern is the best indicator to illustrate general characteristics of settlements. Building density, building form (attached or detached), view formed at vertical, proportion of covered-uncovered land and architectural reflections of cities help differing them from each other and make them "unique". Characteristics or urban pattern is an important issue to indicate the resilience of the city during crises and emergencies such as earthquakes.

Administrative buildings and/or areas have crucial role in the case of any emergency to response and to organize and coordinate team aftermath of any hazard. Emergency management units have crucial roles in distribution necessary services and aids, providing security and daily living comforts for the victims to response the impacts of hazards. On the other hand, buildings or areas stocking hazardous materials are important to notice to prevent collateral hazards triggered by a natural hazard.

The land use pattern is connected to each other by infrastructural and transportation facilities which are very critical after the earthquake occurrence. Shortage in electricity, sewerage system, clean water and natural gas may cause difficulties on daily life in one hand and on the other hand it can be reason of more serious problems such as epidemics. Communication and transportation are critical as well so they provide connections by the means of information and commuting respectively. Micro scale vulnerability analysis refers to vulnerability analyses on land use and building scale.

Risk analysis defines probable losses on elements that are effected by a hazard. Seismic risk analysis: (1) earthquake and their impacts such as landslide, liquefaction and inundation; (2) vulnerability that defines community's safety of life due to buildings,roads and bridges which form urban areas; (3) sensitivity that defines building quality and (4) a type of variables of settled area that defines density (Logario,1990).[13]

The studies that go to the front in regional (macro) scale are estimates of economic losses. Economical structure is one of the elements that is affected mostly in an

[13] Logario, H.J., 1990. Earthquakes: An Architect's Guide to Non-structural Seismic Hazards. New York: John Wiley and Sons.

eartquake and seeing these effects in a long period of time. There might be effects on economy with the losses in disaster and lamenesses after the disaster.

Risk analysis at urban scale is the evaluation of all elements of community that faces with the disaster. In these analysis, superposing the hazards and elements that faces hazards is the most used and practical method. By that, mostly necessary areas that must be rehabilitated in the city are defined.

Risk analysis in micro scale defines probable losses which are according to the superposing of land use and hazard maps and structural vulnerability conditions of the area.

**Example:** Istanbul Metropolitan Municipality and Japan International Cooperation Agency (JICA) developed 4 different earthquake scenarios for Istanbul. At the first stage of this study, referring historical earthquakes and scientific findings, different fault models were produced (Figure 5). Subsequently, in order to evaluate urban risks, urban, building and demographic information were gathered and therefore risky zones were indicated (Figure 6).

In 2003, in order to implement the results of JICA Project, the Metropolitan Municipality of Istanbul signed a memorandum of agreement with the Bogazici, Istanbul Technical, Middle East Technical and Yildiz Technical Universities to develop a comprehensive earthquake risk mitigation master plan. The Earthquake Master Plan for Istanbul was established to make an overall assessment of the current situation; seismic assessment and rehabilitation of existing buildings; address urban planning legal and financial issues; ensure that social and educational issues and risk and disaster management issues. The plan acknowledges that organizations at the local level have an important part to play in the network of disaster management. The area of educational and social issues proposes various earthquake preparedness programs, with an emphasis on community education and social networking stating that for earthquake disaster mitigation and preparedness, public education and awareness campaigns and community organizations are very important.

There are several theories and approaches to estimate how disaster can affect settlements. In this hand book, risk analysis, engineering applications, macroform, urban pattern, land use, hazardous uses and historical, cultural and conservation areas will be given as an example for mitigation activities.[14]

[14] Mikrobölgeleme ve Hasar Görebilirlik Çalışmaları Metodoloji El Kitabı (2006) ABS Consulting, UCER-ALTER, MEER Projesi (Marmara depremi acil yeniden yapılanma projesi)

**FIGURE 5** FAULT LINE MODELS (IBB) JICA, 2002

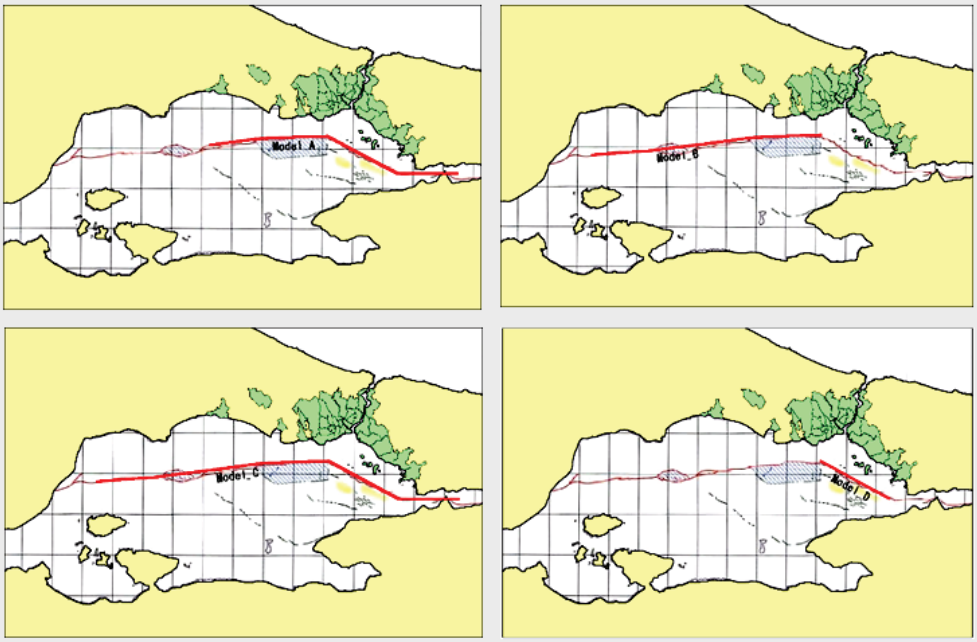
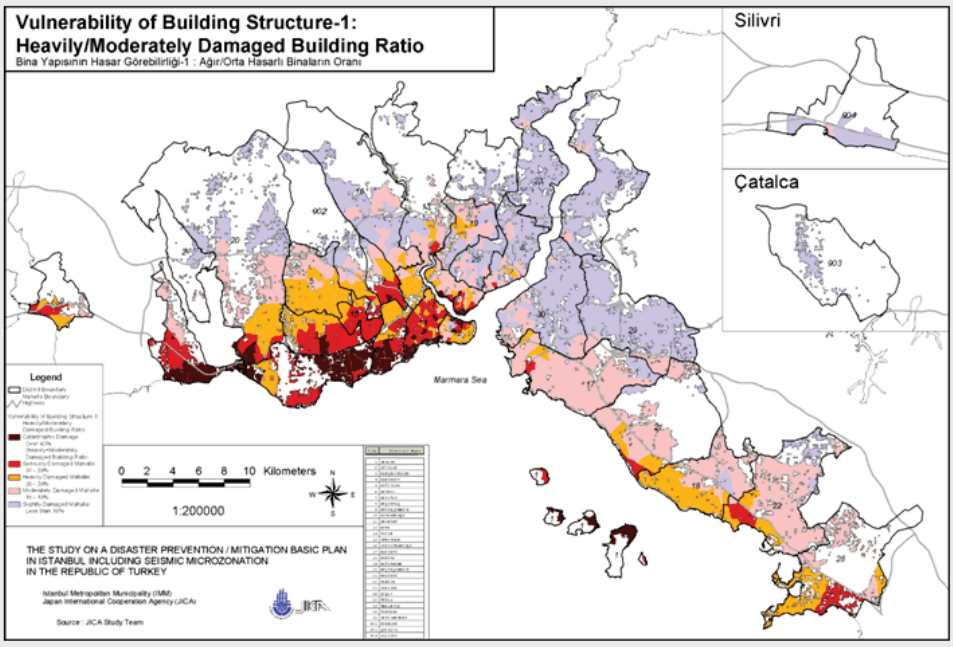



**FIGURE 6** DAMAGE RATIOS ACCOURDING TO SCENARIO C (IGM, JICA, 2002)



| ANALYSIS SCALE | 1st LEVEL ANALYSIS (Hazard Analysis/ Analysis of Present Situation) | 2nd LEVEL ANALYSIS (Vulnerability Analysis / Risk Analysis) |
|---|---|---|
| **MACROFORM** (Regional / Urban) | | |
| | Hazard Map<br>Current Settlement Areas<br>Developing Areas<br>Census Projections | Natural thresholds and external factors including land uses<br>Development trends in dense areas<br>Urban factors encouraging high quality of life<br>Conservation and regeneration areas |
| **LAND USE AND INFRASTRUCTURE** (Urban/Micro Scale) | | |
| **Land Use** | Hazard map<br>Current residential, commercial and industrial areas<br>Development on residential, commercial and industrial areas | Current urban conditions<br>Changing urban conditions<br>Un-compatible land uses<br>Development plans that affects uses in residential areas<br>Illegal business units<br>Changes in land use |
| **Open Space** | Hazard Map<br>Damage estimation<br>Shelter needs and locations | Shelter occupancy<br>Supply of shelter<br>Need for shelter<br>Accessibility and preparation of shelters |
| **Hazardous Land Use** | Risky zones<br>Hazardous land uses, locations and types | Structural features<br>Directions for transportation<br>Processes<br>Secondary effects |
| **Emergency Facilities** | Hazard map<br>Current emergency facilities | Detailed list of facilities<br>Logistic and operational features<br>Structural features of facilities<br>Location, accessibility and availability after a disaster<br>Training of crew |
| **Infrastructure** | Hazard Map<br>Current infrastructural network and location of facilities | Structural features<br>Processes about infrastructure<br>Information about infrastrctural systems and elements and their vulnerability level |
| **BUILDINGS** | | |
| | Hazard map<br>Structural Datas (Construction year Building type, Being listed or not, etc.)<br>Estimation of damage | Engineering assessment of building<br>Compare project and the current state of building<br>Structural changes in buildings |

## Risk Analysis Scale and Level

Risk analysis can be developed at three scales: 1) Macroform; 2) Land use and infrastructure; and 3) Buildings. Risk analysis on macroform examines the overall impacts of any disaster on present conditions and future development of a city. Moreover, risk analysis focuses on urban land use, open spaces, hazardous land uses, emergency facilities and infrastructure. At the last stage of the risk analysis, disaster's effects on buildings are investigated.

**Macroform**: The aim of risk analysis at macroform scale is to estimate impacts of any hazards at macro scale.

*1. Level Analysis* provides necessary information to municipalities on present and future risks to get precautions by revising their plans. Present and future trend information on settlements is overlaying with hazard maps. This synthesis will show hazard prone areas, low quality building stock which should be renovated and areas which are suitable for development. These studies should be disseminated with community for public awareness.

FACTORS

**MACROFORM**

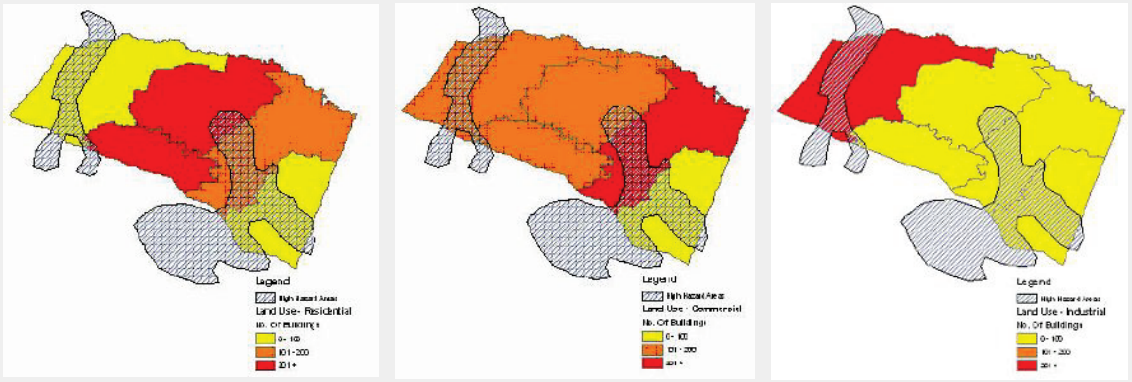
- PRIVATE AND PUBLIC INVESTMENT THAT CAN AFFECT DEVELOPMENT
- ADMINISTRATIVE BOUNDARIES
- AREAS WITH SPECIAL STATUE
- MOUNTAINS, FORESTS, RIVERS
- AGRICULTURAL LAND
- NATURAL PROTECTION AREAS
- ARCHEOLOGICAL AREAS
- SUPPORT CAPACITY FOR INCREASING POPULATION
- OPPORTUNITIES FOR URBAN REHABILITATION, CONSERVATION AND REGENERATION

*2. Level Analysis* evaluates other urban planning factors which can be grouped into 4 categories. The first comprehends analysis on outer municipality area which is able to affect inner city development. The second one covers areas of special state, archeological, natural protection, rivers, forests, agricultural land, mountains and tourism. The third analysis focuses on population distribution, density, infrastructure and land use in safer zones and carrying capacities of these zones. At the last stage, opportunities for conservation and regeneration in the inner city are evaluated.

**Land use**: The aim of land use analysis is to reveal the interaction of natural hazards on current land uses and to examine how to integrate this knowledge on land use plans.

*1. Level Analysis*, current land use (residential, commercial and industrial areas) overlays with hazard map. Within this analysis, it is indicated risky zones and land uses which are under threat. Figure 7 shows residential, commercial and industrial areas according to their distribution and densities and then how they overlay with hazardous areas. Risks on land use depend on; 1) Elements under risk (e.i.: housing units); 2) Their vulnerability (e.i.: if the construction has low quality, it means more vulnerable); and 3) Hazard (e.i: attenuation models).

**FIGURE 7** RESIDENTIAL, COMMERCIAL AND INDUSTRIAL USES OVERLAYING WITH HAZARDOUS AREAS (Methodology Handbook)



RESIDENTIAL COMMERCIAL INDUSTRIAL

Municipalities prepare risk evaluation; the table below can help how to adjust land use decisions according to risk maps. First two columns show data indicating hazard and intensity. The last four columns contain information on land use. Abbreviations on evaluation are: **H**: not available for development; **E**: municipality approves development; **S**: areas where detailed geological investigations and advanced construction process are required.

| HAZARD | INTENSITY | EMERGENCY SERVICES (e.i.: hospital, fire dept. police, critical infrastructural facilities) | HIGH OCCUPANCY BUILDINGS (e.i.: large residential buildings, school, large industries) | LOW OCCUPANCY BUILDINGS (e.i.: single family dwelling, small gathering places) | AGRICULTURAL AREAS PARKS OPEN SPACES |
|---|---|---|---|---|---|
| **Earthquake** | *High* | **H** | **H** | **H** | **E** |
| | *Medium* | **H** | **H** | **S** | **E** |
| | *Low* | **S** | **S** | **E** | **E** |
| **Liquefaction** | *High* | **H** | **H** | **H** | **E** |
| | *Medium* | **H** | **S** | **S** | **E** |
| | *Low* | **S** | **S** | **E** | **E** |
| **Land slide** | *High* | **H** | **H** | **H** | **E** |
| | *Medium* | **H** | **H** | **S** | **E** |
| | *Low* | **S** | **S** | **E** | **E** |

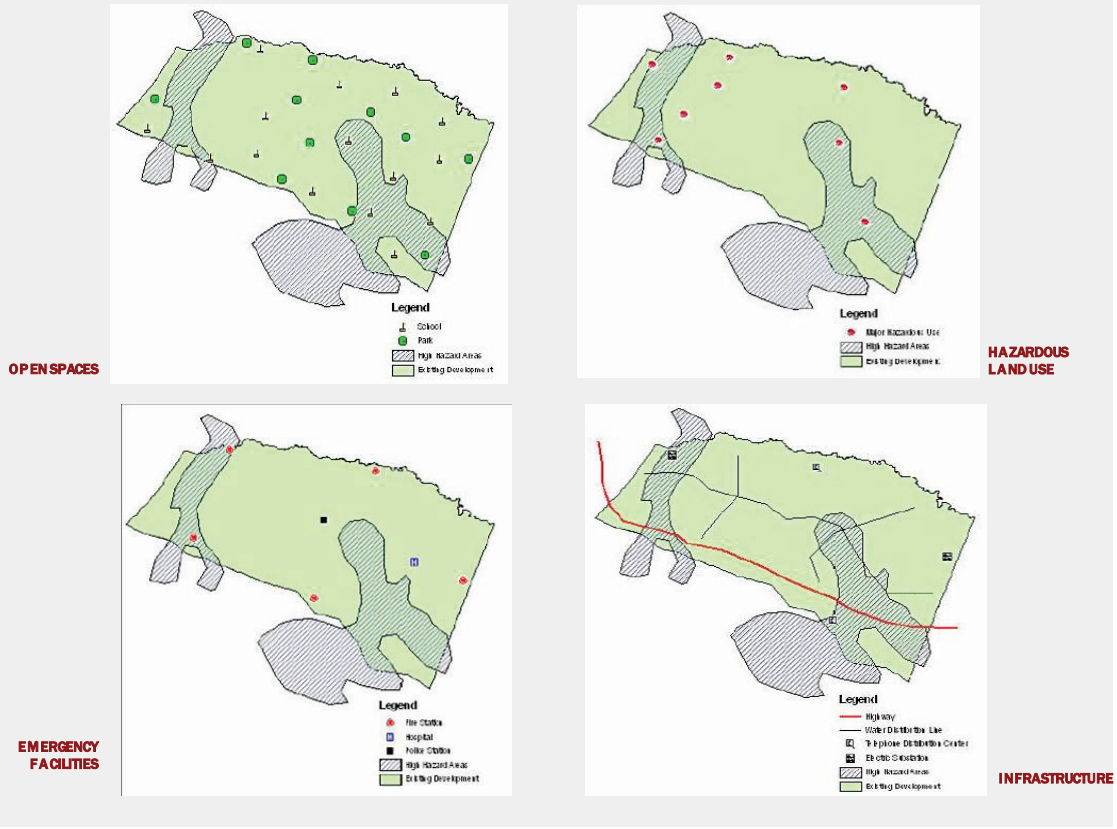
*2. Level Analysis* enables to make land use analysis in detail. At the first step land use types except residential, commercial and industrial areas are listed (e.i.: hazardous usage in commercial building). In the next step the potential of transformation of certain land uses are evaluated. The third step is for notification some incompatible land uses such as adjacency of residential and industrial areas, and therefore it is needed some buffer zone between them. The forth step focuses on residential areas and development plans of those areas. In the fifth step, it indicates illegal commercial activities. In the last step new adjustments by municipality for land use changes are examined.

FACTORS

LAND USE

- ❑ RESIDENTIAL, COMMERCIAL AND INDUSTRIAL
- ❑ OTHER (HAZARDOUS MATERIALS)
- ❑ POTENTIALITY TO CHANGE
- ❑ NEED FOR BUFFER ZONES
- ❑ REGULATIONS
- ❑ REGULATIONS ALLOWING LAND USE CHANGES

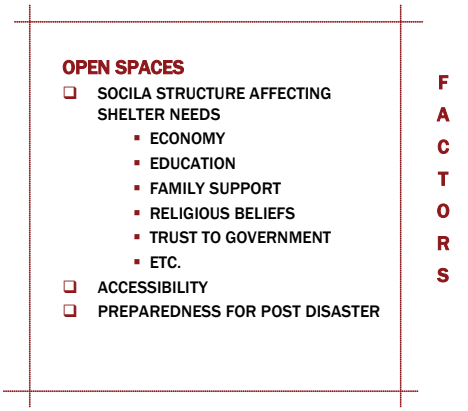
**FIGURE 8** RESIDENTIAL, COMMERCIAL AND INDUSTRIAL USES OVERLAYING WITH HAZARDOUS AREAS (Methodology Handbook)



**Open Spaces:** The aim of this analysis is to evaluate evacuation places required aftermath a disaster which would be provided by municipality.

*1. Level Analysis* covers overlays of hazardous areas and potential evacuation and temporary dwelling areas and estimation of shelter need. (Figure 8).

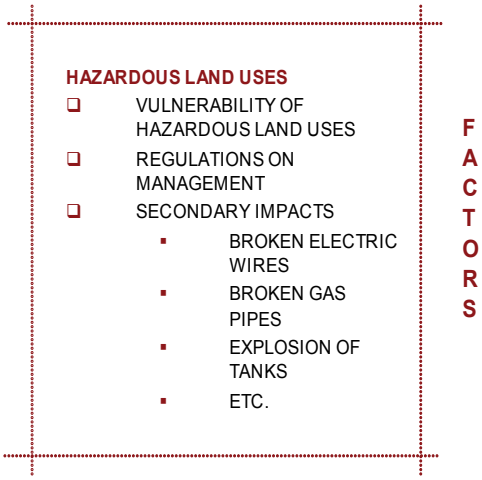
*2. Level Analysis* consists of detailed investigations on shelter usages, logistic and operational needs of temporary shelters, social structure which would affect shelter need (e.i.: economy, education, family support system, religious beliefs, trust to government), accessibility to shelters and preparation process aftermath of a disaster.




**Hazardous Land Uses:** The aim of this analysis is to understand and evaluate impacts of natural hazards on hazardous land uses.

*1. Level Analysis* aims to reveal multi hazardous areas, location and types of hazardous land uses in settlement. Hazardous land uses can be described such as gas stations, airports etc. (Figure 8).

*2. Level Analysis* takes into account small hazardous land uses. This stage covers types and locations of hazardous land uses, the process used in these facilities and secondary impacts. First, vulnerability of storage and transportation of these hazardous materials is examined. Secondly, relevant regulations on hazardous materials management and responsabilities of enterprise and municipality are examined. Finally, the probable impacts of an accident on these facilities are estimated (i.e. fires and explosions triggered by natural hazards and/or technical problems with storage tanks and equipments).





**Emergency Facilities:** The aim of this analysis is to evaluate the impacts of natural disasters on emergency facilities and system.

*1.Level Analysis*, overlays hazard maps and locational distribution of emergency facilities and systems. In this analysis, as an output, it is shown probable problematic areas due to hazards and critical facilities such as police stations, fire stations, emergency centers and hospitals (Figure 8).

*2. Level Analysis*, requires a detailed list of all kind of facilities (i.e.: pharmacies, educational facilities, dormitories, religious facilities, touristic facilities, hotels, gymnasiums, swimming pools, cinemas, theatres, cultural centres, libraries, administrative buildings, banks, warehouses, vacant buildings, bakeries and water resources).

Afterwards, logistic and operational structures of these facilities in case of emergency are evaluated (i.e. available places of emergency facilities, their capacity, types and amount of goods needed, storage of these goods, responsible people and institutions). Thirdly, structural resilience or safety of these facilities is evaluated (i.e.: soft floor, basement, extension, symmetry, height, curtain walling). Forthly, distribution and availability of emergency facilities after a peril are examined. Lastly, it is important to train responsible people for emergency situations.

**Infrastructure**: The aim of this analysis is to evaluate probable impacts of hazards on infrastructural systems.

*1. Level Analysis*, overlays hazards maps with infrastructural database. In this analysis it is exposed which infrastructural facilities are facing with risks (e.i.: water: pipelines, main distribution lines, storage, dam, well; electric: transformer station, distribution lines; telecommunication: nodes, wireless connection; gas: storage, main distribution lines; oil: storage; severage: pipelines, treatment facilities, main lines; transportation: main roads, junctions, bridges, tunnels, ports, airports)

FACTORS

**INFRASTRUCTURE**

- DETAILED LIST
  - WATER, STORAGE, ELECTRIC, OIL, ROADS, BRIDGES, TUNNELS
  - TERMINALS, STATIONS, JUNCTIONS, ETC.
- STRUCTURAL INVESTIGATION
- INTERNAL AND EXTERNAL PROCESS

*2. Level Analysis* covers preparation of a detailed list of infrastructural facilities. (i.e..: terminals, stations, junctions, tunnels, subways, heliports). Afterwards, a detailed structural analysis is done (i.e.structural system, year of construction, location, type, deficiencies, symmetry, etc.). Thirdly, management system of service providers is evaluated according to internal and external connections.

**Buildings**: The aim of this analysis is to evaluate probable impacts of natural hazards on buildings.

*1. Level Analysis*, overlays multi-hazard maps with building database consisting of construction year and building type. This information shows vulnerability level of buildings. In Turkey most of the building is constructed according to two type of structure: 1) low and medium height concrete framed buildings; 2) prefabricated, steel, wooden, masonry. In urban areas, reinforce concrete buildings are more common.

*2. Level Analysis* comprehends more detailed information on building stock and locational distribution. Firstly, engineering survey for all buildings is done. (i.e.: number of storeys, structural system, materials, year of construction, location on the parcel, design of building, soft floor, basement, extensions, symmetry, height of floors, expansion joints, curtain walling, and occupancy type and ground conditions).

Secondly, compatibility of the projects and current situation of buildings are examined. Thirdly, changes in the buildings allowed or not allowed are investigated. Lastly, in order to increase the resilience and performance of the building to promote financial opportunities, ownership of buildings is investigated.

### Part 4 –Strategies on Urban Environment for Disaster Mitigation

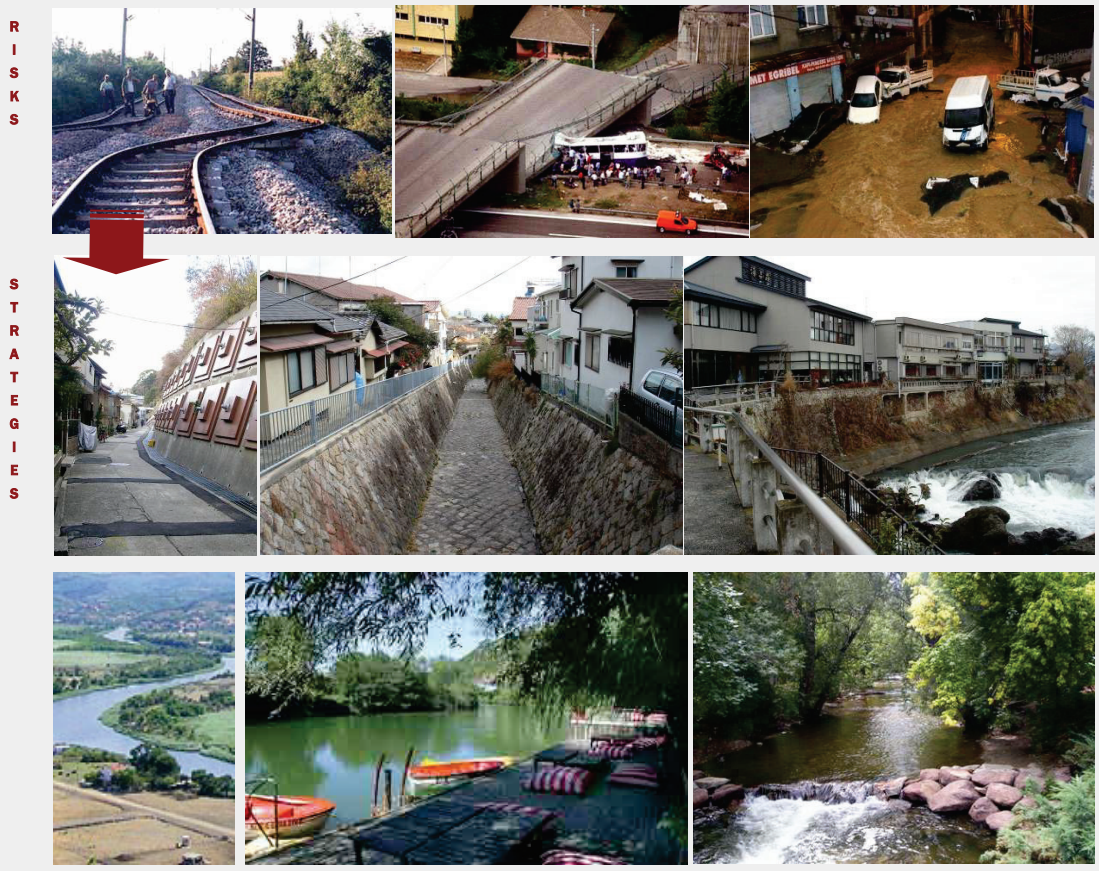
Strategies on urban environment for disaster mitigation are developed according to the findings of urban risk analysis. Urban risk analysis covers exposed objects such as population, urban facilities and their location. The further step covers response techniques and prioritization. According to the priorities, strategies on urban development should be developed (issues on disallowance or limitation of certain urban land uses).

Strategies on urban environment for disaster mitigation should be taken as a main stream by municipalities according to the special features about landuse, transportation and infrastructural system. Strategies on land use are related with main decisions and occupational volumes. Strategies on transportation and infrastructure comprehend precautions taken into consideration.

#### Landuse Strategies

- To drive Urban Growth according to probable hazards and exposed objects/areas;
- To indicate developed and developing areas according to natural hazards:
  - To prevent urban development in risky areas;
  - To relocate structure on risky areas step by step;
  - To drive new development out of risky areas;
- To develop structural strategies on residential, business, education, health etc. facilities to reduce vulnerability;
- To avoid new hazardous industrial activities; to take precaution for developed hazardous industrial activities;
- To provide adequate open spaces in city wide;
- To avoid structural development at shores;
- To take precautions at areas facing with erosion, water basins/reservoirs, forest areas to protect sensitive balance of the nature:
  - To rehabilitate for sustainability and to protect;
  - To provide financement for expropriation.
  - To study on water basin management.

**FIGURE 9** EXAMPLES TO INFRASTRUCTURAL RISKS AND STRATEGIES




## Strategies on Transportation and Infrastructure

- To favor on engineering solutions such as river rehabilitation, landslides prevention, retrofitting infrastructures when natural precautions are inadequate. (Figure 9);
- To control natural hazards using semi-natural solutions such as slope stabilization, semi-natural filled-up at shores and protection of shores (Figure 9);
- To retrofit roads and infrastructural systems when it is necessary;
- To limit infrastructural development at risky zones to discourage future development;
- To avoid new critical infrastructures; if it is not possible -to prevent the collapse of the system- to simplify the system.

## Part 5 – Community Development Strategies for Disaster Mitigation

This part aims to reveal activities that participants can easily adapt them to achieve safety living conditions. These activities can be realized in the frame of disaster mitigation planning practices or training.

As a top priority, zones or neighborhoods which need disaster mitigation planning immediately can be studied. Information taken from this training program can be integrated with planning practices in such areas. Implementation of what has been learnt in this program will boost community learning.

Secondly it is crucial to disseminate disaster awareness to all level of community, to be aware of urban risks factors, to have trainings on mitigation and preparedness and to increase the capacity of coping with disasters. Disaster mitigation training programs should be disseminated through population in this manner. However, it is important to develop these training programs and campaigns according to the target groups in order to make these activities efficient and sustainable.

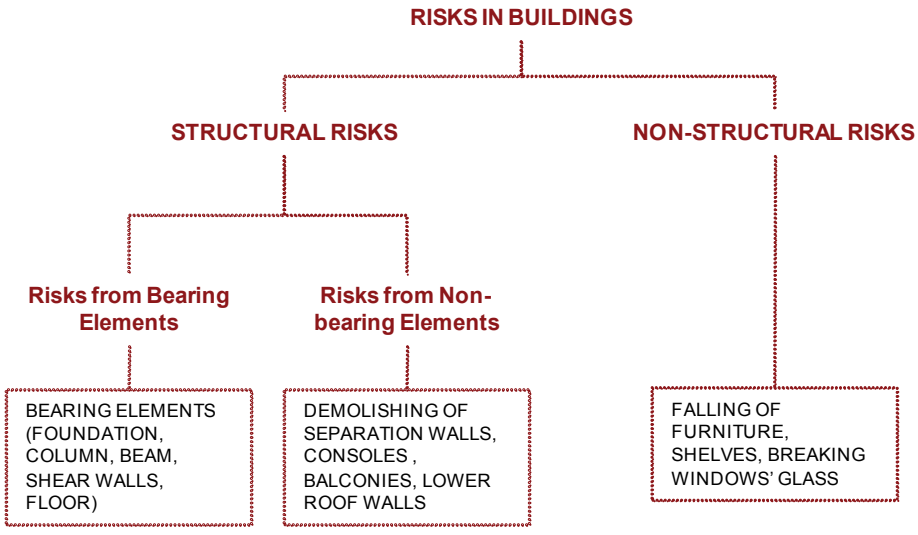
## Part 6 – Risks and Strategies on Built-up Areas for Disaster Mitigation

In Turkey, regulations on building construction and design are developed according to new technological and scientific development. The main reason that there are still devastating impacts of earthquakes, is not to well implement current regulations and lack of control. This stuation shows that building stock in Turkey faces with serious risks.

In this section, types of risks at building scale will be presented. Moreover, strategies on structural precautions and building inspections will be discussed.

### Risk Types in Buildings

Risks in buildings are classified in two groups: **1)** Risks related with structural elements; **2)** Risks related with non-structural elements. The first group is divided in two sub-categories: **1a)** Risks related with damages on non-bearing structural elements; **1b)** Risks related with damages on bearing structural elements. This section focuses on 1a. This type of damages can be devastating and moreover, buildings may collapse. The second type of risks is due to non-structural elements.



## Factors Affecting Risks in Buildings Due to Structural Elements

Structural risks can be groups as (Figure 10): 1) Risks caused by ground conditions and lack of engineering applications; 2) Non-projected interventions in building; 3) Irregularities in building structure; 4) Past damages received in buildings.

**FIGURE 10: RISKS CAUSED BY GROUND CONDITIONS AND LACK OF ENGINEERING APPLICATIONS**


*1. Risks caused by ground conditions and lack of engineering applications (Figue 11)* :

- Development at high risky zones (i.e. fire at Tupras due to 1999 Marmara Earthquake);
- Development close to active faults;
- Not to consider ground conditions in project design stage and therefore mis-application in building basement (i.e. carrying capacity of soil and liquefaction).
- Not to implement development regulations on building density and building heights.

**FIGURE 11:** BUILDINGS NOT IN CONFORMITY WITH SOIL CONDITIONS


TUPRAS FIRE

CONSTRUCTION NEAR TO FAULT

CONSTRUCTION ON SOFT AND LIKELY LIQUEFIED SOIL

*2. Modifications Not In Conformity With Building Project*:

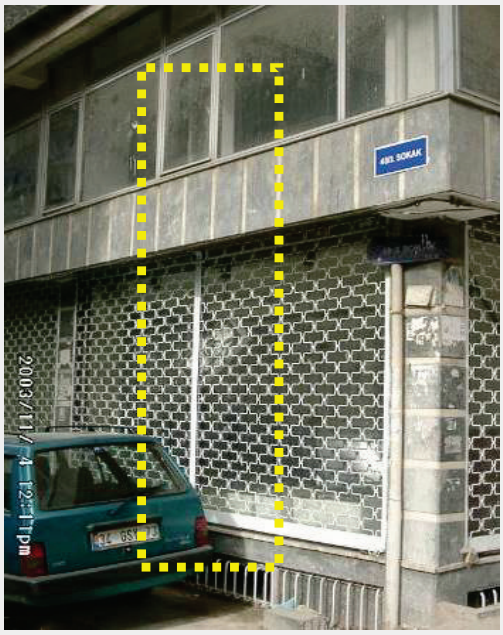
- Lack of relevant information on earthquake parameters of a building without project such as vertical and horizontal loadings, ingredients, ground conditions and bearing structural system.;
- Additional loadings on vertical and horizontal carrier system affecting statics of building;
- To cut columns and other bearing system on ground floor to provide additional spaces for shops (Figure 12);
- Not to use proper materials at necessary amount indicated in projects (e.i.: Low quality of concrete, no specific conditions for concrete production and foundry, lack of horizontal and vertical elements, un-appropriate elements in construction);
- To stress vertical displacement rigidity of building due to shear walls at basement where freedom at columns height diminishing during the construction process.

*3. Risks related with structural discontinuity*.

- To enhance additional torsionning impacts due to vertical and horizontal discontinuity; discontinuity of shear walls and columns (Figure 13);
- To design ground floors of buildings for commercial purposes where bearing elements, columns are not well constructed, therefore to form soft floors. In the case of earthquake, without necessary carrying system it can occur vertical displacements and complete destructions in building ;

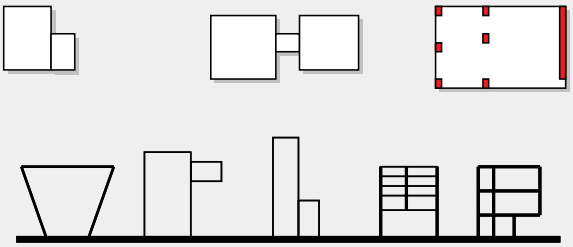
- To provide large distant openings without using appropriate equipment, materials, anchorage method, mis-placement of columns and therefore to loss the resilience of building independent from any ground shaking;
- Not to construct floor and vertical elements correctly.

**FIGURE 12** INAPPROPRIATE MODIFICATIONS ON BUILDING




DISCONTINUITY OF COLUMNS

**FIGURE 13** IRREGULARITY IN BUILDING STRUCTURE



*4. Risks related with past received damages.*

- According to aging and environmental conditions, corrosion at building materials due to low quality ingredients.;
- According to the damages received in the past earthquakes, to reduce resilience of certain bearing elements of building.

### Mitigation Strategies for Buildings

Besides the risks in buildings and losses according to these risks, in **Turkish Earthquake Resistant Design Code** revised in 2007 (www.bayindirlik.gov.tr), there are some standards on how to evaluate building safety measures and retrofitting.

Mitigation strategies for building can be categorized into two groups: **1)** Restoration or retrofitting of buildings; **2)** Destruction/Relocation/Reconstruction.

Strategies cited above are building scale mitigation measures. **Restoration** covers interventions to bring back buildings to their initial performance before they had received damage. **Retrofitting** covers interventions to increase performance of structural elements of buildings. **Demolishing and reconstruction** cover intervention strategies for poor buildings which have to be demolished and rebuilt.

Other mitigation strategies are upper scale strategies which are strongly connected with decisions taken in development plans. Density reduction and urban regeneration are some of them.

## RESTORATION AND RETROFITTING

Restoration covers interventions to bring back buildings to their initial performance before they had received damage. Retrofitting covers interventions to increase performance of structural elements of buildings.

Retrofitting is used in following cases: improvement in building codes and incompatibility of old buildings with the new codes; change in occupation purpose (e.i. when a residential building is converted to dormitory, it is important to calculate new vertical and horizontal loadings); damages received due to past earthquake(s); aging due to time and environmental conditions; and buildings which do not fit safety standards with low structural performance.

Before starting retrofitting implementation, it is important to assess resilience of building. Therefore, structural geometry and equipments' details are examined; ground conditions and earthquake zonation of the parcel are examined; properties of materials used in building construction are investigated; if building received damages, these damages are determined; data on building are evaluated, a detailed mechanical model is set and structural analyses are done; according to the results, resilience, ductility and rigidity of building are revealed and deficiencies according to mechanical features are identified and reported. Report should contain information of building concerning following aspects: plan, material and ground conditions, bearing structure, horizontal and vertical elements, level of damage, axis loading of bearing elements, torsion momentum and sharing force, discontinuity in building and when it is necessary recommendations on retrofitting.

After having detailed information about the building, retrofitting activities can have a start. In the retrofitting process, it is important to provide alternatives to end users on: architectural limitations on usage to reduce vulnerability, easy construction, production speed, implementation procedure and financement. According to the retrofitting method chosen, analyses are done once more in order to see the effectiveness of the method chosen and therefore production of retrofitting can be installed. During the implementation of a retrofitting project, it is crucial to take account about materials and details used in the selected method.

After the earthquakes occurred in 1999 in Marmara and Duzce, renovation/retrofitting in damaged buildings and retrofitting in non-damaged buildings are done. However, not until 2007, there was standard implementation method or regulation to realize these retrofitting methods. Consequently, several different methods are implemented. It can be assumed that many of these methods were far away to make buildings resilient. In 2007, with the re-adjustments in Retrofitting Code, investigations of buildings against earthquakes and retrofitting activities have been standardized according to relevent regulation.

### Retrofitting Approaches

Structural strengthening can be applied by two basic approaches; member strengthening and system rehabilitation. If only some members of the structural

system are weak in terms of seismic resistance, these members (such as columns, beams, etc.) may be strengthened individually. This approach is called member strengthening.

When the structure is globally weak in terms of seismic resistance, it may be uneconomical to strengthen all the structural members. In such cases, the disturbance to the occupants may also be unacceptable. In these cases, instead of strengthening all structural members, adding new and sufficiently strong structural members, which are designed to resist a large portion of the potential seismic effects, may be more preferable. In many cases it may be necessary to using both approaches together.

### Examples for Retrofitting Works

Reinforced concrete jacketing, strengthening using steel plates and corners, strengthening using fiber reinforced polymers are among common member strengthening methods for existing reinforced concrete structures. Attention must be paid for adequate connection of newly added concrete parts to the existing concrete and continuity of added longitudinal retrofitting through joints and to the foundations, when necessary.

Due to significant insufficiencies and presence of a variety of structural weaknesses of existing structures in Turkey, system rehabilitation generally becomes more feasible and preferable in Turkey. The most common system rehabilitation scheme is addition of structural shear walls to the existing structural system. Attention should be paid for potential variation of structural stiffness and resulting increase in seismic demand, potential increase in torsional effects, potential need to consider foundation strengthening and adequate connection of new shear wall to the existing structural system. While system strengthening using diagonal steel braces is also common in several countries, such as USA and Japan, this method is not generally feasible because of very low quality of concrete frequently found in existing structures and the need to transfer concentrated loads at connections of steel braces and existing structural system.

A newly developed strengthening technique for low-rise structures is strengthening the infill walls of existing reinforced concrete frame structures and integrating the infill walls to the structural system. For utilizing this method, the infill walls should be surrounded by columns and beams, and the walls should be continuous from the ground floor to the top of the building. For strengthening of infill walls, fiber reinforced polymers and either prefabricated or cast-in-situ concrete panels can be used, provided that these are sufficiently anchored to the existing structural system (Figure 14).

For masonry structures, demolishing and rebuilding of the damaged or weakened walls, reducing the sizes of openings on the structural walls, addition of horizontal and vertical simple reinforced concrete members (such as lintels), getting adequate measures for prevention of out-of-plane failure of the walls (such as adequately spaced supporting members), application of wire-meshed shotcrete for enhancement of shear resistance and structural integrity. In addition fiber reinforced rods, plates and sheets are recently being common for strengthening of masonry walls.

Seismic strengthening is a very special field in construction industry and thus requires specialized expertise in all stages from planning and design to the construction. Unspecialized intervention can increase the risk of damage rather than reducing. Tragic consequences can be met if necessary attention is not paid for seismic strengthening applications (Figure 15).

**FIGURE 14** EXAMPLE TO STRENGTHENING

STRENGTHENING REINFORCED CONCRETE WALLS WITH FIBER POLYMERS

**FIGURE 15** WRONG STRENGTHENING APPLICATION

A WRONG STRENGTHENED BUILDING IN KAYNAŞLI IN DUZCE EARTHQUAKE WHICH CAUSED DEATHS

## DEMOLISHING AND RECONSTRUCTION

It is a real challenge for engineers to give the decision about reconstruction or strengthening. There are many factors, which may be effective on this decision. These include social, cultural, legal, financial, architectural and technical issues. In ordinary cases, where the rest of the issues do not have an important effect on the decision, and if cost is the only effective parameter, 40% of the cost of the reconstruction is considered as an upper threshold for strengthening decision.

**DEMOLISHING AND RECONSTRUCTION- RETROFITTING COST/ DR COST > %40**

### Mitigation Strategies In Terms Of Structural Safety

It is very important to enforce related codes and standards during the construction of new buildings. This will help the reduction of number of vulnerable buildings in time. This requires a reliable and standard **Inspection System**. Utilization of a strict inspection system and standardized legal permit procedures are among major mitigation strategies for safety of new structures. Widespread utilization of **Compulsory Earthquake Insurance (DASK)** may be very helpful in recovery stage after potential future earthquakes. Through inspection system, all design and

construction phases are expected to be inspected thoroughly by experienced and independent engineering firms. **Building Occupation Permit** is the document necessary for occupation of the building. This document should normally be a proof for certificating the building for all aspects, such as legal issues, seismic resistance, etc.

| STRATEGIES RELATED TO BUILDING SAFETY | LEGAL REGULATIONS | ENFORCEMENT SCOPE |
|---|---|---|
| BUILDING INSPECTION | ❑ LAW NO 4708 -2001- BUILDING INSPECTION LAW | ❑ BUILDING INSPECTION ACCORDING TO RULES AND STANDARDS THAT ARE DETERMINED BY PROTECTING LIFE AND PROPERTY |
| BUILDING OCCUPATION PERMIT | ❑ LAW NO 3194, DEVELOPMENT LAW | ❑ GIVING BUILDING OCCUPATION PERMIT AFTER CONSTRUCTION |
| OBLIGATORY EARTHQUAKE INSURANCE | ❑ DECREE LAW NO 587 | ❑ PROVIDING FINANCIAL LOSSES CAUSED BY EARTHQUAKE DAMAGE<br>❑ TAKING LOSSES UNDER GUARANTEE BY THE OBLIGATORY EARTHQUAKE INSURANCE |

## BUILDING INSPECTION

After 1999 Marmara and Duzce Earthquakes, several important revisions are made in regulations about building inspection. After these revisions, in several provinces (particularly developed and highly populated ones), independent private inspection companies are given serious responsibility for proper design and construction of new buildings (Law No 4708 -2001- Law Related with Building Inspection. Before this law, according to Law No 3194, Development Law, the responsibility was given to the engineers, architects and urban planners for preparation and application of building plans. Unfortunately, the inspection mechanism could not be executed properly in practice. Some tragic examples are collapse of existing buildings under gravity loads, such as recently collapsed buildings in Konya and Zeytinburnu.

The main target of the Law 4708 is the provision of a proper design and construction during all phases towards protection of life and property. These include complying with the building code, all other related codes and standards (such as seismic design code, reinforced concrete design and construction standard). Law No 4708 regulates the rules and methodologies related with inspection of design and construction as well. Law is valid for all buildings in and out of all contiguous areas and municipal borders, except public buildings and facilities described in Article 26 of Law 3194 (Development Law).

Building inspection is executed by the independent private inspection firm according to the service agreement signed by the inspection firm and the building owner. While it is not permitted the building owner to transfer his rights about selection of the inspection firm to the constructor, in practice, the constructor may be effective on the selection of the inspection company. In such cases, the reliability and efficiency of the inspection can be suspicious. The cost of the inspection is paid by the constructor through the municipality. It is an unfortunate fact that in practice, many times inspection firms, which do not perform a strict inspection, are preferred rather than reliable and experienced inspection firms. In addition, some constructors prefer some so-called independent inspection firms, which are actually not independent due to their several relationships with the constructor.

## BUILDING OCCUPATION PERMIT

Construction process starts with obtaining the building permit from the municipality upon submission of necessary documents and project designs. After obtaining the building permit, the construction should begin within two years and completed within five years according to the structural and architectural design approved by the inspection company. With the exception of buildings, which are not subject to building permit, any construction, which began without building permit or constructed without abiding the building permit or its attachments, the construction is stopped and sealed by the municipality. Following the decision of the municipal committee (belediye encümeni) or provincial administrative council, the building is demolished by the municipality or governorship. The cost of demolishing is then requested from the building owner.

The construction process, which begins with building permit, is completed with the building occupation permit. Unfortunately, due to violations of several aspects of zoning code and related codes and standards, a large portion of existing buildings do not have building occupation permit, although they have been using for years. In contrast, it is obligatory to obtain building occupation permit upon completion of the construction. Although it is not legal, related service companies provide infrastructure services to the buildings, which do not have building occupation permit. In order to motivate building owners to apply for building occupation permit, such illegal practices should not be allowed. In addition, some buildings called gecekondu are totally illegal.

In the process of issuing building occupation permit, upon the application of the building owner, department of science affairs of the municipality checks whether the construction is completed in agreement with the building permit and its attachments. Upon the submission of documents related with social security, fiscal directorate and local clinic, the municipality processes the building occupation application within 30 days.

## COMPULSORY EARTHQUAKE INSURANCE (DASK)

After 1999 Marmara and Duzce Earthquakes, Compulsory Earthquake insurance application became mandatory by the decree law No 587. The basic target of the decree law is to put the rules and principles of the obligatory insurance, which is for compensating the loss related with the building damage after potential earthquakes. By this decree law, the concept of right-ownership, defined by Disaster Law (Law No 7269) long time ago, is changed. The persons, who lose their buildings, are not right-owner anymore. Therefore, the state has no more responsibility to compensate any damage occurred due to earthquakes. The damages are to be compensated by the Compulsory Earthquake Insurance System. According to decree law, all independent units in the coverage of Condominium Ownership Law (No. 634) are subject to Compulsory Earthquake insurance.

This insurance covers secondary hazards such as fire, explosion and landslide, which occur because of earthquakes. The maximum time for Natural Disasters Insurance Institution (DASK) to compensate the cost of the damage is 30 days. It is clear that the amount of compensation is limited with the insurance value. In Deed Office, Compulsory Earthquake Insurance is required for any application related with buildings. Further damages related with earthquakes over the official insurance value of the building can be compensated via additional private earthquake insurances.

# Dictionary and References

**Infrastructural systems**: Systems of water, swerage, electric, gas and telecommunication.

**Land use**: Different land usages such as residential, commercial, industrial, urban facilities.

**Working areas**: Areas for agriculture, industry and services

**Natural hazards**: Natural Phenomena which is not possible or hard to prevent the occurrence such as earthquake, volcanic eruption, landslide, flood.

**Urban facilities**: Facilities such as health, education, administration, culture and religion.

**Secondary hazards**: Hazards triggered by a primary hazard such as landslide triggered by earthquake.

**Residential areas**: Areas where the entire or the majority of occupancy are related with residential purposes.

**Risk**: In the case of the occurence of any hazard, potential losses according to the vulnerability level of exposed objects.

**Urban planning**: Science to organize space according to the future needs and trends of people and settlements by displaying all components of urban environment (built environment, natural environment, economic environment and social environment)

**Modification permit**: Permission document which indicates that alterations which would be done in the building are legally approved by the municipality

**Hazard**: Phenomena which may have negative impacts to human life and settlements

**Technological (industrial) hazards**: Usually man-made hazards which occur often due to lack of attention and control such as traffic accidents, explosions and fires

**Transportation**: Network which connects different land uses and settlements.

**Construction (building) inspection**: According to Building Inspection Law (4708) and Development Law (3194), concultancy at construction stage of buildings with controls on all projects, construction process and related documentation.)

**Construction permit**: Permission obtained by the municipality which indicates all primary studies and projects are accomplished according to regulation

**Occupancy permit**: Permission obtained from the municipality after the construction of building which indicates building is constructed according to regulations and purposes indicated in project.

**Green areas**: Recreational, open space inside and outside of settlements such as play grounds, parks, forest etc.

**Mitigation**: Actions taken to reduce risks and vulnerability, and when it is possible hazards.

**Vulnerability**: Potentials and weaknesses of exposed elements against hazards

**Compulsory Earthquake Insurance (DASK)**: Insurance policy which partially covers losses in buildings caused by earthquakes

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Notes


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REPUBLIC of TURKEY
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