PLANNING FOR ISTANBUL'S EARTHQUAKES AND URBAN RENEWAL

WPI

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1) ABSTRACT

Istanbul, the capital of Byzantine and Ottoman Empires for over a millennium, had a distinct and historical role in the world. Today, with increased immigrations and poorly developed settlements, the distinct cultural heritage of Istanbul has deteriorated. Furthermore, the infrastructure is inadequate. Most importantly, the earthquake fault lines in Marmara Sea are expected to "break" within the next 30 years, causing chaos to the city of Istanbul and its inhabitants. In order to plan for such a devastating event, the impact of an earthquake and tsunami were evaluated to determine the best urban planning to preserve Istanbul's complex historical sites, while addressing physical (structural) and infrastructural problems.

2) SUMMARY

Istanbul, the most populated city of Turkish Republic has been the capital of the two of the world's most dominating empires, the Byzantine and Ottoman Empires. Istanbul has its coasts on The Marmara Sea, an inland sea in northwestern Turkey, and the Mediterranean Sea via the Black Sea. Historic Istanbul is made up of seven hills which occupy the majority of the peninsula near the Golden Horn, an inlet emptying in to the Strait of Bosporus.

Over many centuries, religious buildings have been built to satisfy the needs of the communities. The monumentality of these buildings represents the powers of the Ottoman and Byzantine Empires. Emperors or sultans funded the construction of the best monuments.

From the foundation of the Byzantine Empire in AD 325, Istanbul's house types can be ranked into three categories according to their class ranks: the domi, the tabernae, and the insulae. During Ottoman Empire, people could build houses next to each other with whatever urban pattern they chose. The community lived harmoniously no matter how rich you were or what sociopolitical status you had. However, there was a tendency to maximize isolation of individual houses within a dense urban setting. Centralization of the kulliye and surrounding it with houses formed the common basis of a mahalle, creating a sense of community. This dense urban formation provided an easy access for all to the necessities of the community.

During the Tanzimat Period in 1850s, the Western influence changed the form of buildings. The roads were widened in some parts of Istanbul, especially where the rich Jewish or Armenian families lived. The use of the wood to build houses was minimized

since there were so many fire hazards. Alternative options such as bricks from Europe were used.

The immigration from Anatolia to Istanbul increased significantly since 1950s, because of Turkey's declining economy. Therefore, it became an unpleasant metropolitan city due to the decline of architectural achievements, and an increase of "gecekondus" and skyscrapers with undesirable human scale buildings. These give an impression of being a poorly planned city. The increasing probability of an earthquake with a 7.4 magnitude in the Richter scale, or a tsunami created by the break of faults at the Marmara Sea, will directly impact Istanbul and will immensely lower the quality of life

Turkey has always been in danger of potential tectonic earthquakes throughout its history. The fault lines in Turkey surround the whole country. An earthquake with magnitude of between 6.8 and 7.5 with a 60% probability is predicted in the Marmara Sea in next 30 years. This will be due to fault fracture in the Marmara Sea and will cause a large area of devastation and result in many deaths in Istanbul.

Throughout history Istanbul also has been overwhelmed by tsunamis of different sizes and magnitudes. The southern coastal area of Istanbul is a "near-field hazard" zone, a zone that is 30 minutes away from tsunami possibilities. It is difficult to generalize the effects of near-field tsunamis, due to the large variability over short distances of the height of tsunamis and their destructiveness.

Four scenarios were developed as the basis for analyzing what to do: do nothing, reinforce buildings, systematic teardown/build, high rise construction, and move inhabitants to other cities.

Scenario 1:

The first scenario describes what the residents of Istanbul are doing at this point in time, in order to address the problem of planning for expected earthquakes or tsunamis. Although there are schools and government institutions what are working to make earthquake resistant buildings, no improvements are being made to preserve history or upgrade the infrastructure.

Scenario2:

No matter how difficult the planning and the economic struggle may be, the cultural feeling and the atmosphere in Istanbul provides a natural, compelling feeling which attracts the residents to remain a part of Istanbul. Therefore, the second scenario deals with strengthening the existing buildings or tearing down the weak buildings and rebuilding, as needed. The infrastructure of Istanbul must be repaired or renewed in many parts of the city since Istanbul does not have satisfactory infrastructure for most of the city. As a result, the cultural heritage must be preserved by isolating it from the squatter settlements, unstable buildings, and commercial buildings within the City.

Scenario3:

Seventy five percent of the buildings in Istanbul are illegal or unauthorized settlements, with two thirds being gecekondus (squatter settlements) and the other third being unplanned buildings without permit. The cost to rebuild or strengthen these buildings may be more than the benefit to rebuild or strengthen these buildings. A solution would be to tear down all of the weak, crooked and unauthorized buildings and replace them with 10 to 15- story tall buildings. This will preserve history, achieve earthquake safety, and enable building of responsible infrastructure. To preserve history,

squatter settlements around the historical sites and potential high-rise construction sites must be removed. Furthermore, the historical buildings should be strengthened and renovated. Ten to fifteen story tall buildings should only be constructed on non-historical sites and on newly built parts of Istanbul. The reduction of squatter and other unauthorized settlements near historical sites will increase opportunity for tourism. New governmental agencies must be formed to enforce and regulate construction policies. War on poverty will be more successful since there is likely to be more tourist attraction around the historic sites.

New infrastructure could be more difficult due to a possibility of higher densities within the city. City streets in newly built high-rise complexes must meet the minimum size standards for an emergency team to be able to respond efficiently.

Scenario4:

Turkey is made of two peninsulas which provides the opportunity for commercialization based on transportation and shipping. Moving some of the inhabitants of Istanbul to any sea coast city would be reasonable as long as the infrastructure for commercialization is provided. Canakkale is the ideal city since it shares similar geographical features. Istanbul and Canakkale both have straits connecting to the Sea of Marmara and both have lands in Asia and Europe. This geography would enable moving some of inhabitants from Istanbul to Canakkale, which will provide similar economic opportunities. Ideally, businessmen in need of access to the Aegean Sea can move their companies to Canakkale. The government will have to provide incentive for institutions to relocate. Once the job market developed, the residents of Istanbul will follow it and move into Canakkale. The buildings in Istanbul must be inspected for earthquake resistance. Since 75% of the buildings are structurally very weak, then at least 75% of

the residents of these buildings must be moved to Canakkale. Also, the regions likely to be hit by a tsunami should be evacuated immediately for the safety of people.

Constructing Canakkale's infrastructure will not be as complicated compared to Istanbul because it will mostly be built from the beginning. It will be easier to design streets with wider roads, bigger pipes and sewage systems, all of which are difficult to build in Istanbul. As a result, emphasizing on Canakkale's infrastructure work is more favorable since it will attract more people and industries around these populated locations which will not have any infrastructure deficiencies. When industrial development starts taking place in Canakkale, it will create jobs which in return will attract even more people, lessening the population in Istanbul and mitigating some of the problems in the city.

Best Alternative:

Of the four scenarios, "Moving inhabitants to Canakkale" or "Reinforcing Istanbul" scenarios are most appropriate since they provide the highest quality of life. A choice "Moving the city" and "Reinforcing" scenarios was made using a survey done with 100 random residents of Istanbul of which 76% decided on reinforcing Istanbul. Therefore, it is not ideal to move the inhabitants to another city, since the residents are hesitant, want to remain in Istanbul and enjoy the historical heritage with the idea of staying in Istanbul.

2) ISTANBUL BACKGROUND

A) INTRODUCTION

Referred as Constantinople during the Byzantine Empire, the name of Istanbul comes from a derived Greek word "stanbulin" which means "to the city" and was used by many Byzantinian residents. The name also could have been derived from Islambol ("where Islam abounds") according to some 15th century documents (Celik 22).

Istanbul, the most populated city of Turkish Republic (Figure 1-1), has been the capital of the two of the world's most dominating empires, the Byzantine and Ottoman Empires. Historically, the most important difference of these two empires was their religious beliefs, which were represented by religious monuments throughout the city. The two empires also built aqueducts, cisterns, hippodromes and so on for the betterment of their societies. Figure 1-1 shows the map of Turkey along with Istanbul and capital of Turkey, Ankara.

Figure 1- 1 Map of Turkey

Geographically, Istanbul has always been an easily accessible location for trading. Istanbul has its coasts on The Marmara Sea, an inland sea in northwestern Turkey, and the Marmara Sea via the Black Sea. The Strait of Bosporus separates Asia from Europe. Within Turkey Istanbul borders the regions of Tekirdag and Kirklareli, and Kocaeli is located on its east. The largest river in the region, Riva, flows into the Black Sea. However, Istinye River and Buyuk River flow into the Bosporus. (Akat 6). Figure 1-2 shows the areal view of Istanbul on both Asian and European Continents surrounded by Black Sea and Marmara Sea:

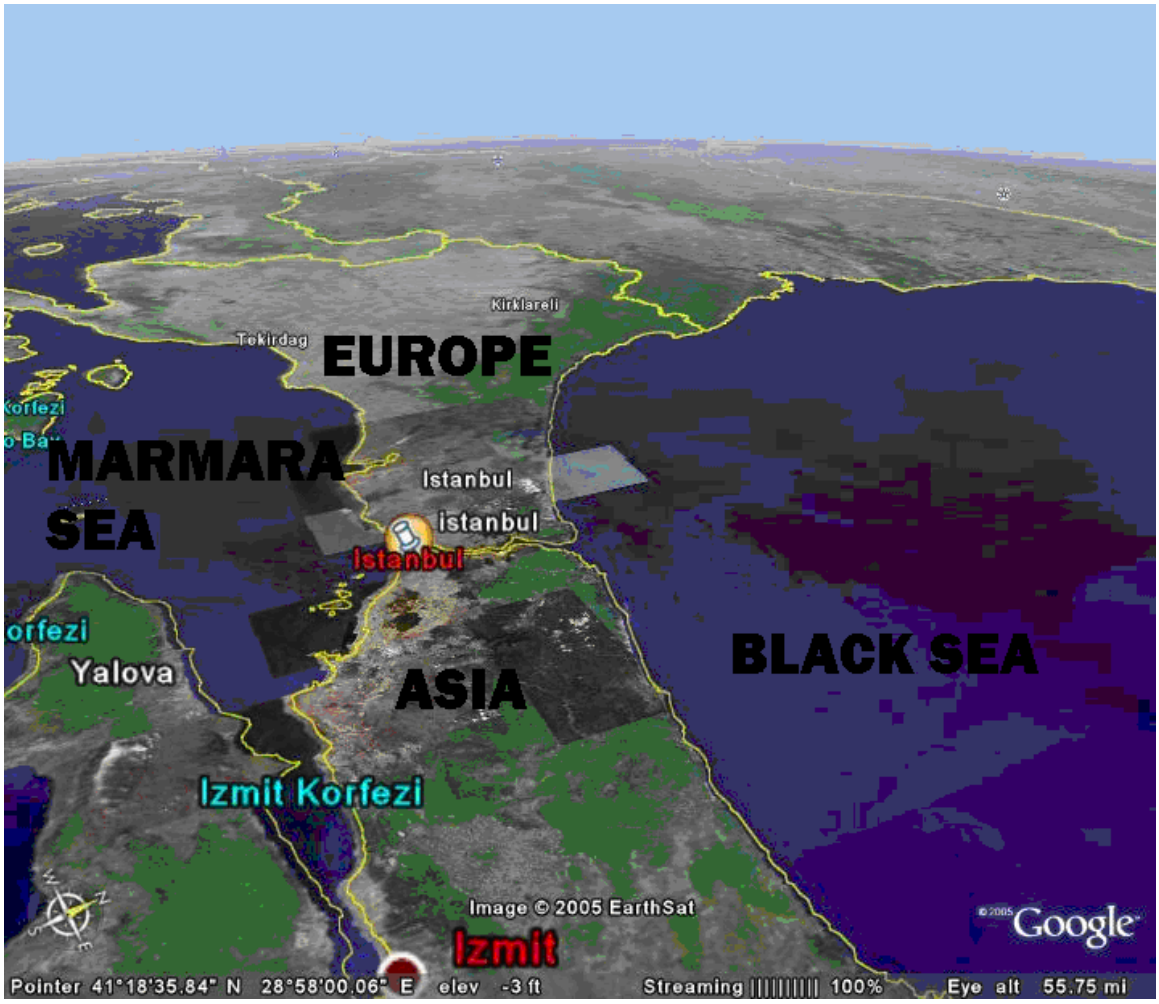


Figure 1-2 Aerial view of Istanbul and surrounding seas

Since Istanbul was built on top of the hills and surrounded by water, it was easily defendable. This advantageous geographical positioning of the city has given it protection throughout its history, which allowed Istanbul to become one of the most highly recognized commercial cities. The importance of the city, in return, gave many powerful emperors and sultans the chance to build monumental and functional buildings. The figure 1-3 shows an aerial view of Istanbul and the circled portions designates the seven hills of Istanbul which is known as the Old Istanbul.

Figure 1-3 Map of Istanbul

B) FIRST SEVEN HILLS OF OLD ISTANBUL

Historic Istanbul is made up of seven hills which occupy the majority of the peninsula near the Golden Horn, an inlet part of the Strait of Bosporus. The population of the city increased expanding inward from the first hill (Seraglio Point) to the center of this peninsula since during the Byzantine Era. Thick and long walls were built to define the borders of the city (see Figure 1-3) and to protect the residents of the empire. As the centuries passed, Istanbul expanded in a dramatic fashion, especially within the last forty years.

Figure 1-4 Map of the City Walls

The Byzantine and Ottoman Empires built their most significant buildings in Old Istanbul which consists of seven hills. These historic buildings are centrally focused and usually built on firm grounds mainly on top of the hills. The Byzantines built religious and open spaces. However, the Ottomans built kulliyes, complexes which will be discussed later. Figure 1-5 shows the location of each one of these seven hills. The first six of the seven hills consist of historical sites as follows:

1st Hill- Topkapi Palace, Hagia Sophia, and SultanAhmet Kulliye (Blue Mosque)
2nd Hill- Serpent's Column, obelisk of Theodosius, and Nuriosmaniye Mosque
3rd Hill- Beyazit Kulliye, Istanbul University, and Suleymaniye Kulliye
4th Hill- Fatih Kulliye
5th Hill- Yavuz Sultan Selim Kulliye
6th Hill- Mihrimah Sultan Kulliye (Edirnekapi)
7th Hill- not a historic site; used by Kocamustafapasa community
(http://www.azizistanbul.com/hakkinda.asp)

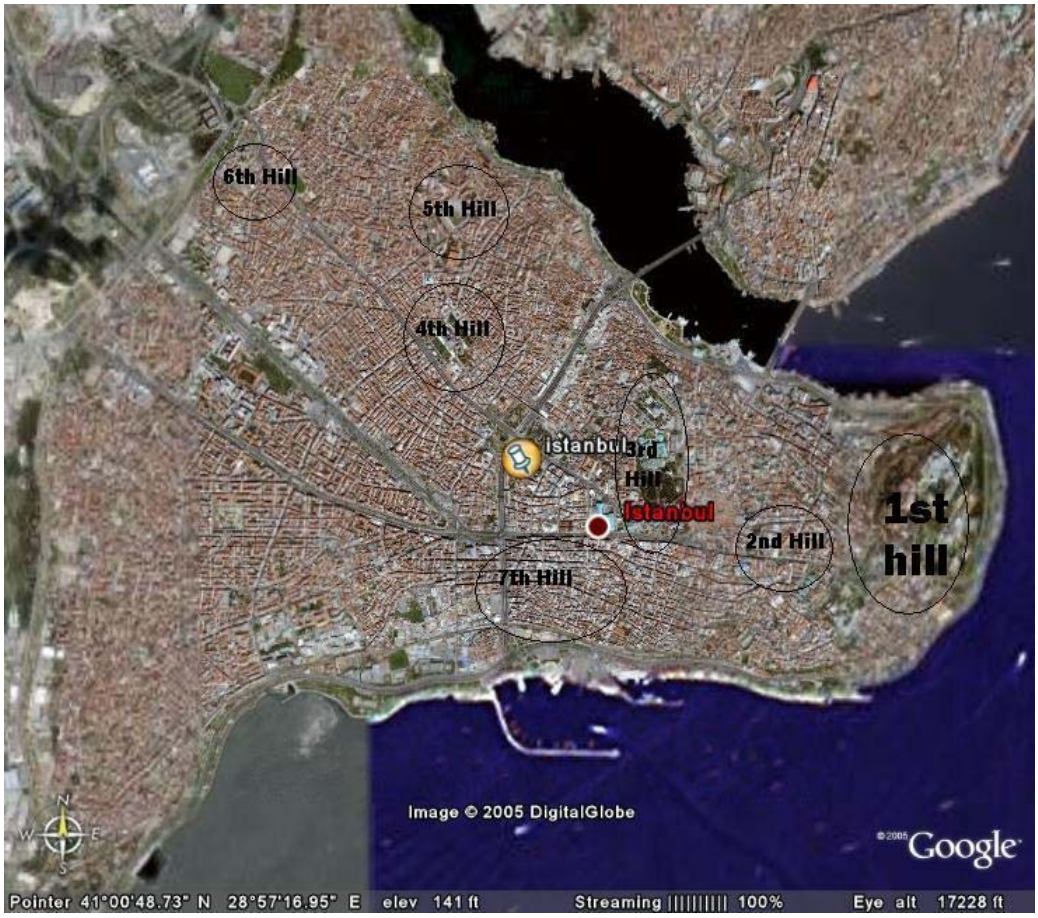


Figure 1-5 Seven Hills of Istanbul

C) FIRST SETTLEMENTS

The origins of the formation of the city are incorporated in to the Greek Mythology. According to the legend, Byzas, leader of Megare, was told by oracle of Delphi to build a new city opposite to the land of the blind. When people of Megare reached the Seraglio Point (Sarayburnu in Turkish), the tip of the first hill, they saw the Phoenician, colony of Chalcedon. They realized that since the Phoenician colony was blind to the beauty of Seraglio, they decided that this was the place oracle has mentioned. They named the city Byzantion after their leader (Akat 10).

Archeological excavations suggest early settlement in the second court of Topkapi Palace (see Figure 1-3) during the 7th century BC and in the fourth millennium at Fikirtepe in Kadikoy. After that time the city, most importantly Seraglio Point, has been occupied by Macedonians, Greeks, Venetians, and Ottomans. Istanbul has always been a place of conflict because of its location (Akat 10).

D) THE IDEA OF MONUMENTALITY

Over many centuries, religious buildings have been built to satisfy the needs of the communities. Monumentality of these buildings represent the powers of the Ottoman and Byzantine Empires. Emperors or sultans funded the construction of the best monuments.

E) URBAN PLANNING DURING BYZANTINE EMPIRE:

a) Monumentality & Open space:

The main emphasis of the Byzantine Empire (325-1453) was monumentality and open space for the community (Celik 11-16). The most important religious building of Byzantine Empire was Hagia Sophia which was the center of the religious life. Hagia Sophia had the largest dome in the world for a thousand years, until Michelangelo's Saint Peter's Basilica (Vatican) and Sinan's Selimiye Mosque (Edirne) surpassed it in years 1593 and 1575.

The Hippodrome having capacity of holding over hundred thousand viewers was the symbol of civil activities. It had the shape of a horseshoe and was used for both theological controversies and chariot races (Akat 20). Figure 1-6 shows the major constructions during Byzantinium Empire including Hagia Sophia and the Hippodrome.

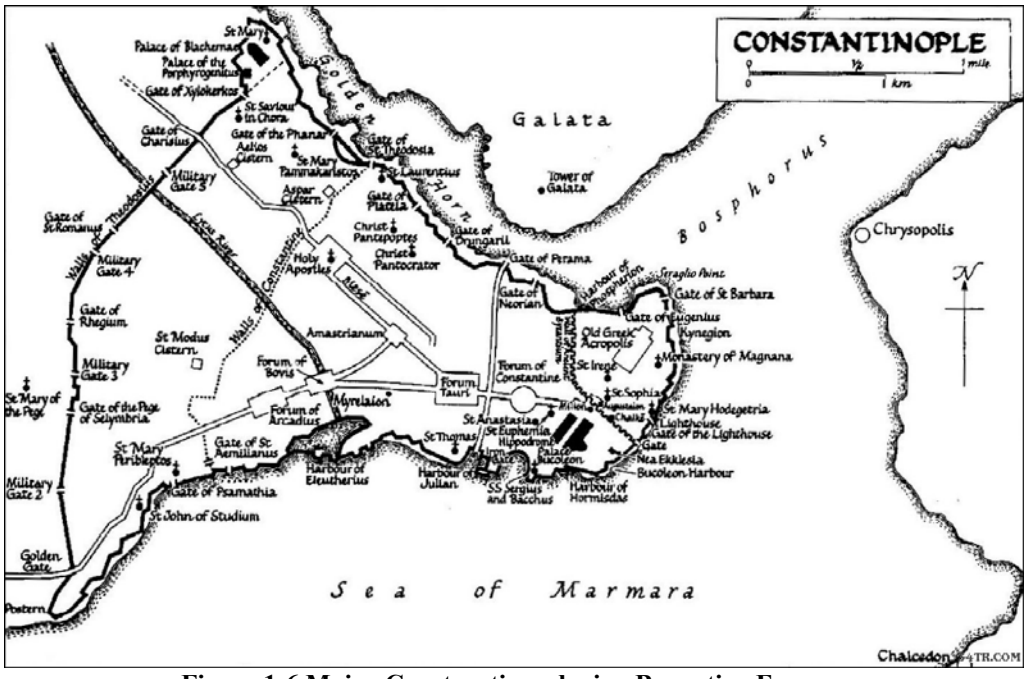


Figure 1-6 Major Constructions during Byzantine Era

b) Houses:

After the foundation of the Byzantine Empire in 325, Istanbul's house types can be broken into three categories according to their class ranks: the domi, the tabernae, and the insulae. Celik defines these buildings as follows:

> "The domi were large two stories, single-family mansions with pillared central halls, inhabited by wealthy and notable families. The tabernae were the modest residences of the common people, built along the main streets and at crossroads, often with shops on the ground floor. The insulae, limited to thirty meters in height, served as multistory tenement blocks" (Celik Introduction 17).

By the 10th century, houses were two to three story high buildings with outward projections on upper floors. This use of bay windows also occurred in Ottoman houses. Based on Roman types, the plan of the house consisted of rooms that opened to a large hall. This plan is strongly implemented in many of the Ottoman houses (Celik 21). Figure 1-7 shows a view of the dense construction in the Old Istanbul.

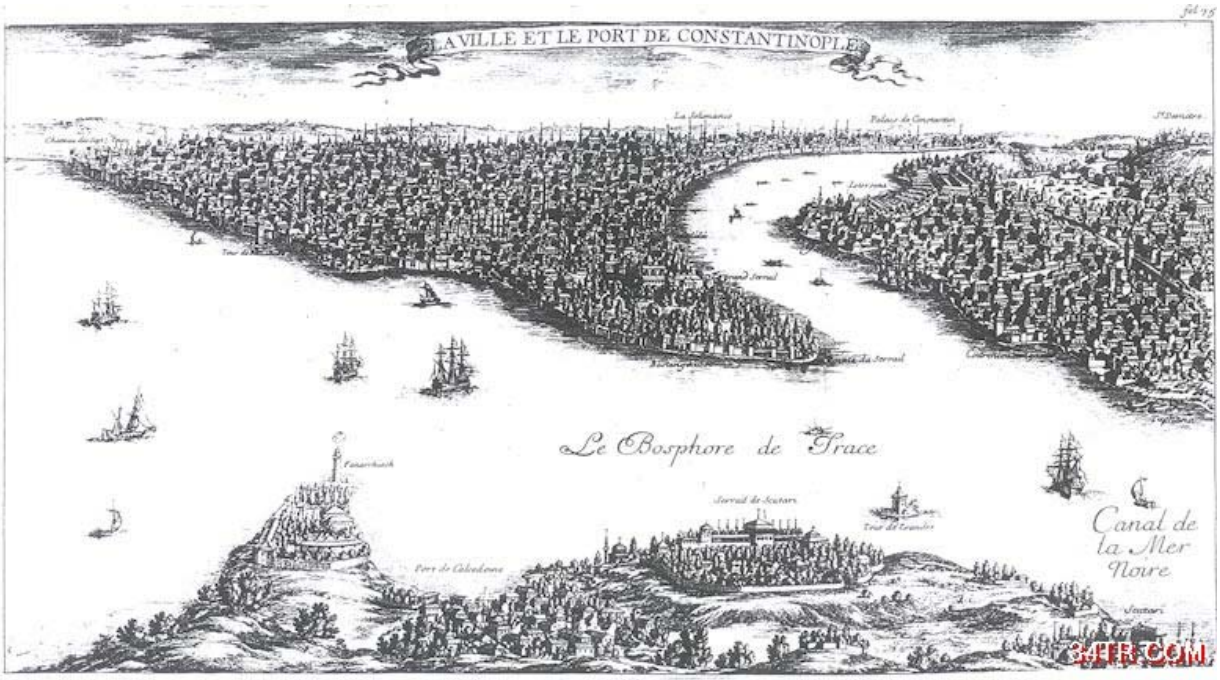


Figure 1-7 A View of Seven Hills of Old Istanbul

F) URBAN PLANNING DURING OTTOMAN EMPIRE:

a) Houses:

Under Ottoman Empire's control after conquering Istanbul in 1453, there was no class rank among the communities in Istanbul. The rich and poor could build houses next to each other. Since the sociopolitical status and income never acted as a way of defining urban pattern, it allowed people of different degrees of wealth to live in a community harmoniously. However, there was a tendency to maximize isolation of individual houses within a dense urban setting. This resulted in the organization of residential pockets around dead-end streets, which acted as semipublic paths. The privacy of women also was of great importance when forming the communities. (Celik 8)

In different parts of the Istanbul, there were many ethnic groups. Muslims lived in the central part of the peninsula, and the Armenians, Greeks and Jews settled along the shorelines, mainly in Galata (across the seven hills). (Celik 3)

After the conquest of Istanbul in 1453, Sultan Mehmet II repaired the walls of Thedosian, allowed refugees to settle back into their houses with the right to practice their own religions. Prisoners were given the right to pay their ransoms and live in the city in "exchange for temporary tax exemption" (Celik 22). This allowance for different ethnic backgrounds increased the population of Istanbul. However, the most affective method used to populate Istanbul was the obligatory settlement given ethnic groups from different parts of the Ottoman Empire by Sultan Mehmet II.

b) Kulliyes:

Kulliyes (see Figure 1-8) are complexes usually formed to honor the sultan or a person of importance. They were built on top of the hills and were the centers planned to focus or to permit for easier access by the community for their activities and to fulfill their needs. The idea for common good is especially emphasized in such buildings. The kulliyes provided the needy with food, the injured with healthcare, the students with religious and scientific knowledge, and jobs for many to run the kulliyes. This economical, social, and spiritual opportunity allowed the community to enjoy a quality of life. The courtyards of the mosque were used as socialization areas. (Celik 6-7)

Figure 1-8 Kulliye of Suleyman the Magnificent

Besides the main kulliyes on top of the hills, there were smaller complexes throughout the city. However, these regions consisting of smaller complexes were not as highly crowded. (Celik 6-7)

c) Vakifs:

Historically one of the most important factors that greatly distinguished the Ottoman Empire was the formation of its vakifs. These were pious foundations to support different Islamic institutions. This was one of the main ways of funding the kulliyes. Besides the vakifs, the rich (usually the Sultans, and the royal families) always made their generous donations for many public works. The vakifs also encouraged, supported and built many public works such as caravanserais (a large inn), hamams (bathhouse), and commercial centers. The revenues received from shops and other facilities helped the vakifs to run projects for the benefit of the community. (Kuran 17-18).

d) Imperial Corps of Architects:

The Imperial Corps of Architects was an institution which incorporated many aspects of civil engineering, architecture, and urban development. Started in 1525, the Imperial Corps of Architects lasted about 350 years (Gunay 21). It provided to the community the necessities such as roads, bridges, forts, aqueducts and water fountains. It set the building specifications. It made rules and regulations on how to build and what materials to use. (Kuran 17-18). Kulliyes took no more than a decade to be completed. Maintenance of public works as well as works of the royal families was part of this Corps' job. The Imperial Corps of Architects gained its prominence by the time of Great Sinan. Figure 1-9 shows some of the works done by Imperial Corps of Architects under Sinan's supervision, when the Ottoman Empire's power was at its peak (Kuran 22):

Section code	Type of building	Conditions of buildings					Total
		Undetected	Nonexistent	Renewed	Ruined	Original state	
I	Mosque	4	16	21	2	64	107
II	Small Mosque	1	29	13	2	7	52
III	Mausoleum	6	6	0	1	32	45
IV	Theological School	3	31	2	3	35	74
V	House of Readers	0	3	1	0	4	8
VI	Elementary School	1	0	0	0	5	6
VII	Dervish lodge	1	1	2	0	2	6
VIII	Hospital	0	0	0	0	3	3
IX	Lodging House	2	11	1	1	7	22
X	Caravansary	2	9	3	6	11	31
XI	Palace	4	32	0	0	2	38
XII	Kiosk	0	4	0	0	1	5
XIII	Cistern	0	6	0	0	2	8
XIV	Public Bath	5	24	6	8	13	56
XV	Bridge	0	0	0	0	9	9
XVI	Aqueduct, Pool	0	0	0	0	7	7
	Total	29	172	49	23	204	477

Figure 1-9 The Construction during Great Sinan's Era

e) Formation of City:

Social and cultural values of the Ottoman Empire encouraged the formation of the mahalles (neighborhoods). Centralization of the kulliye and surrounding it with houses formed the common basis of a mahalle, creating a sense of community. This dense urban formation provided an easy access for all to the necessities of the community (Figure 1-10). Private property was more important than public property. Members of the community was given the right to freely build houses according to their wishes long as they didn't disturb the harmony of their community (Celik 23).

Figure 1-10 Mahalle leading to a Mosque

f) Decline of Ottoman Empire (1700s to 1900s):

The lack of a planned street pattern since the Byzantine Empire reflected a sense of uniqueness. At the same time the complexity of the city needed a new way of planning. The Ottoman classical architecture, with its centralization of kulliyes and surrounding them with mahalles, was no longer the ideal urban plan when the concepts of Westernization became highly regarded. Western influences of urban form consisted of three main traditions:

> "1) Law and legislation regarding city planning issues
> 2) Urban design principles, which enforced by the new laws and regulation, called for the creation of an efficient street network, monumental public squares, regular street faced, and a uniform urban fabric.
> 3) The field of architecture recently invented in Europe. (Celik Introduction 17)"

During the Tanzimat Period in 1850s, the Western influence changed the formation of buildings. The roads were widened in some parts of Istanbul, especially where the rich Jewish or Armenian families lived. The use of the wood to built houses was minimized since there were so many fire hazards. Alternative options such as bricks from Europe were used.

The 19th century caused a "recasting of the traditional urban policies (based on Islamic law)". Urban institutions, administration, and organizations were replaced with new ones adopted from European models. Furthermore, Tanzimat Period established other types of buildings, matching to the modern Westernized lifestyles. During the mid of 19th century, a highly regarded Armenian architect family, named The Balyans, incorporated many western designs into palaces (ex. Dolmabahce Palace) and mosques (ex. Ortakoy Camii) (Celik Introduction 16).

It seemed the Ottoman Empire wanted to catch up to the technological, scientific, and living standards of the Western culture, in order to improve its quality of life in Istanbul. However, these changes were only apparent in the richer European settled towns in Istanbul, especially in Taksim (see Figure 1-11). The roads were longer and wider and the architecture of the buildings was highly westernized. The dress code was also western influenced. Although the figure below can be dated as being taken after the foundation of the Turkish Republic, since there are Turkish Flags, its incorporation of western influence is obvious.

Figure 1-11 Western Movement in Istanbul

G) ISTANBUL AFTER OTTOMAN EMPIRE

After the collapse of the Ottoman Empire, Turkish Republic was established in 1923 following a four year revolutionary war. Istanbul no longer was the capital of an empire or a country. A substantial increase in migration to Istanbul took place since the beginning of 1900s; Figure 1-12 shows the growth of Istanbul to 1994.

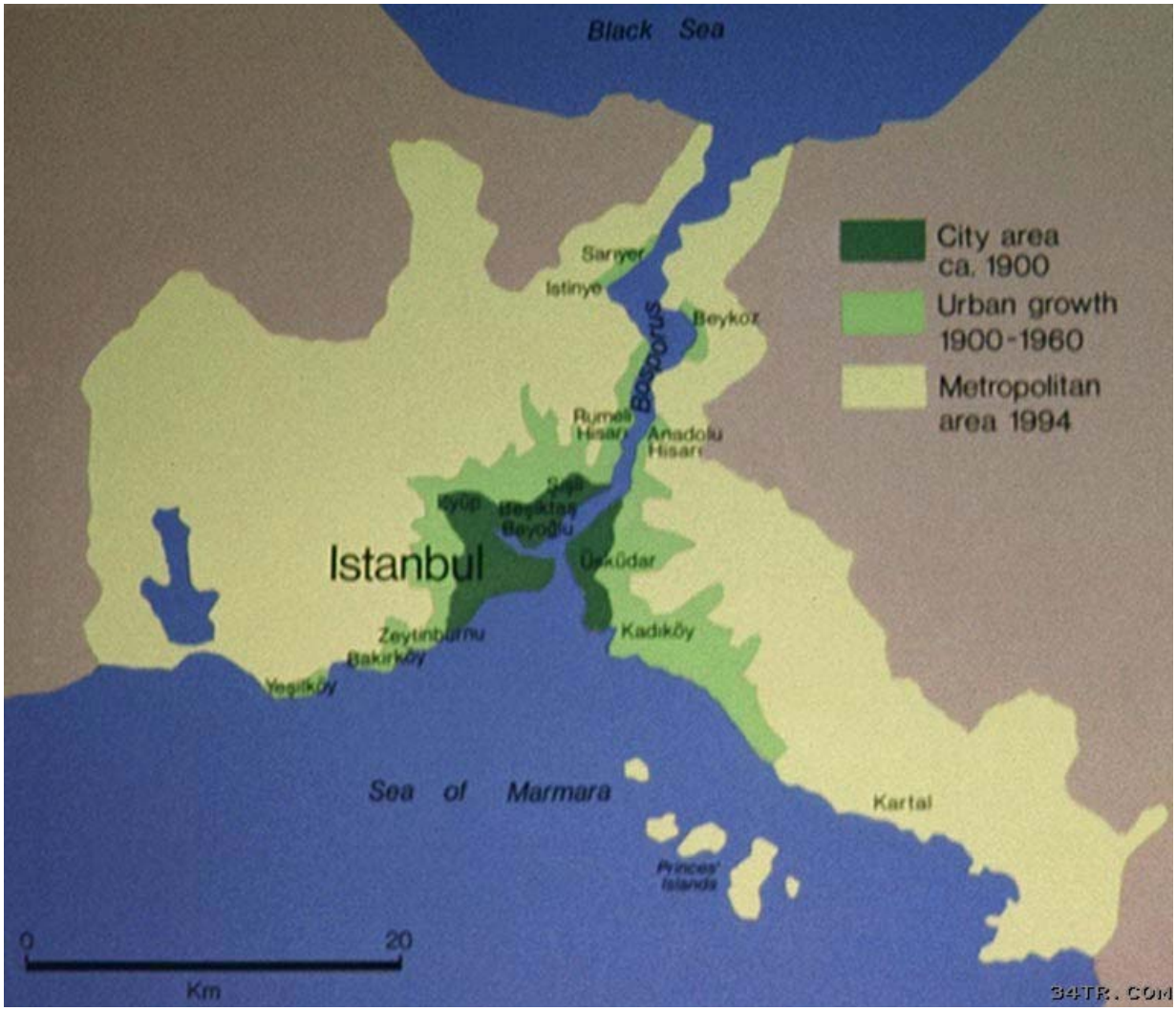


Figure 1-12 Population increase in Istanbul

a) **New Ways of Construction:**

Historical sites of Istanbul are mainly located on the first seven hill of Istanbul. However, most of the historical buildings were demolished in order to construct new roads, and new buildings were mainly positioned outside of the first seven hills. With the advance of technology, steel construction allowed high-rise buildings (See Figure 1-12), whereas the concrete buildings were favored over to wood, due to concrete's fire-resistance.

Figure 1-13 Skyscrapers in Istanbul

b) Gecekondus:

The immigration to Istanbul from Anatolia where the living standards are lower than in Istanbul increased significantly since 1950s, because of Turkey's declining economy. The poor, needing a shelter, built gecekondus (gece= night, kondu=put). They are illegal and quickly built, and very unstable buildings of the poor who do not own the property (See Figure 1- 14).

Figure 1-14 A Typical "gecekondu" Site in Istanbul

Immigration of the poor of Turkey to Istanbul due to the new and rapid uncontrolled developments over the last 50 years has led to a high population density. If a natural disaster were to occur, the gecekondus and many other illegally constructed buildings (usually 4 to 5 story tall buildings) including high rise constructions would likely collapse. This natural disaster is predicted to occur from an earthquake or tsunami within the next 30 years (Ercan 1).

H) EARTHQUAKE

An earthquake is a sudden and sometimes catastrophic shaking of the Earth's surface caused by rapid movement of the Earth's rocky surface (the outer layer that averages 10km thick under oceans and up to 50 km thick on the continents). Earthquakes occur suddenly when energy stress stored within the faults is released, causing the ground to shift. Faults result in cracks in Earth's crust where rocks on either side of the crack have moved. Figure 1-15 shows the global fault lines of the world.

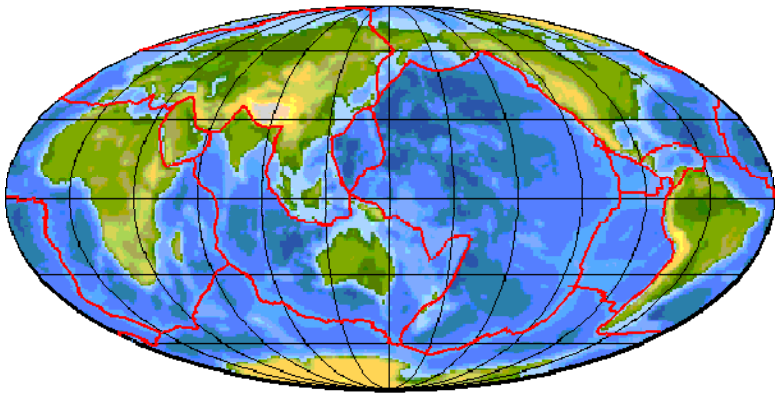


Figure 1-15 Global Fault Lines

The destruction resulting from an earthquake depends on its magnitude and its depth, which determines the extent of shaking that occurs. Earthquakes vary from small, unnoticeable shaking to large shocks felt over thousands of kilometers. Earthquakes can deform the ground, make buildings and other structures collapse, and create tsunamis.

Size of an earthquake can be measured by the Richter scale. It is also called the M_L Scale for local magnitude**,** which is an absolute measure of earthquake size. Richter magnitude is a base-10 logarithmic scale obtained by calculating the logarithm of the combined horizontal amplitude of the largest displacement from zero on a seismogram which measures the seismic movement of the ground at a measuring station. However,

the energy of an earthquake is proportional to the square root of the cube of the amplitude (www.wikipedia.com)

The frequency and the locations of earthquakes have been monitored for the most of the 20th century. There have been two types of forces that cause earthquakes. One type is tectonic forces, and the other is volcanic forces.

a) Tectonic Earthquakes:

Tectonic earthquakes are caused by the sudden release of energy stored within the rocks along a fault. The released energy is produced by the strain on the rocks due to movement within the Earth, called tectonic deformation. There are two tectonic plates that have their edges within 50 km of Istanbul. These tectonic plates are made of either oceanic or continental crust or the very top part of the mantle, a layer of rock inside the earth. Figure 1-16 shows the major tectonic plates of the world.

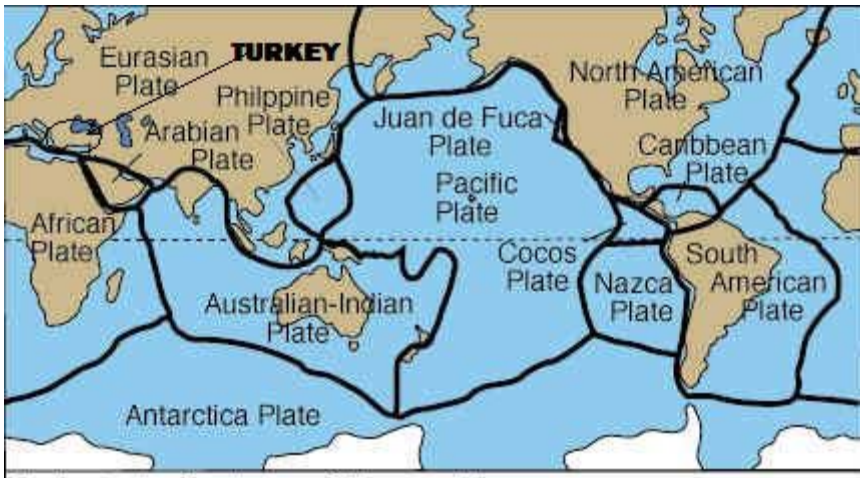


Figure 1-16 Major Tectonic Plates of the World

b) Volcanic Earthquakes:

Active volcanoes cause volcanic earthquakes when the faults slip in the same way as tectonic earthquakes. Volcanic earthquakes are caused by the upward movement of magma under the volcano, which strains the rock locally and leads to an earthquake. As

the fluid magma rises to the surface of the volcano, it moves and fractures rock masses and causes continuous vibrations that can last up to several hours or days. Volcanic earthquakes occur in areas that are associated with volcanic eruptions. (Mertol)

c) Earthquakes in Turkey:

Turkey has always been in danger of potential earthquakes throughout its history (Figure 1-17). The fault lines in Turkey surround the whole country (Figure 1-17 and Figure 1-18), and this makes any city vulnerable to earthquakes. Since 1900, there have been 115 devastating earthquakes measured by General Directorate of Disaster Affairs Earthquake Research Department in Turkey (Ercan 1-7).

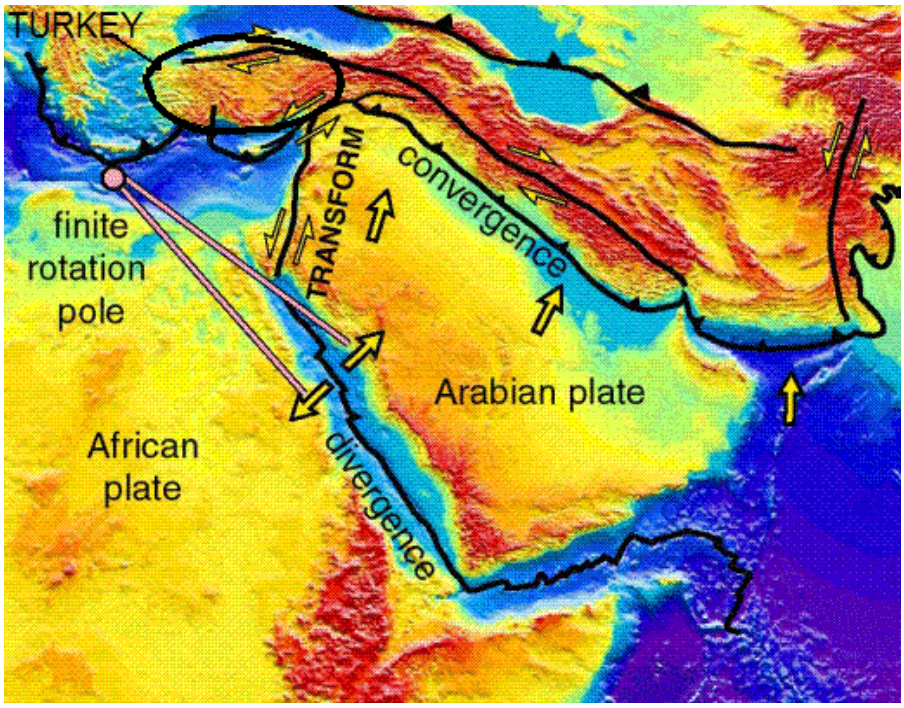


Figure 1-17 Fault Line Map for Middle East

ACTIVE FAULT MAP OF TURKEY

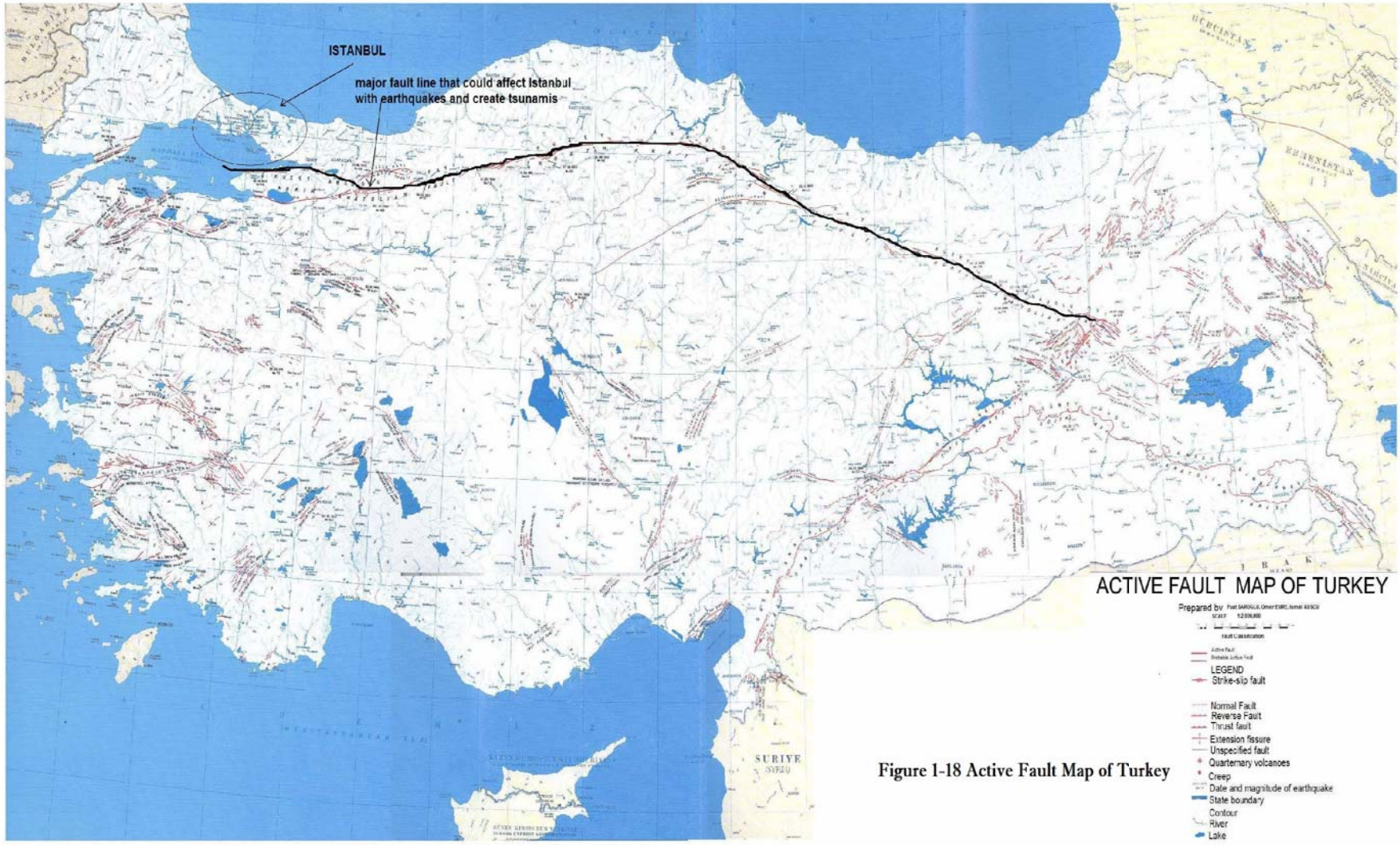
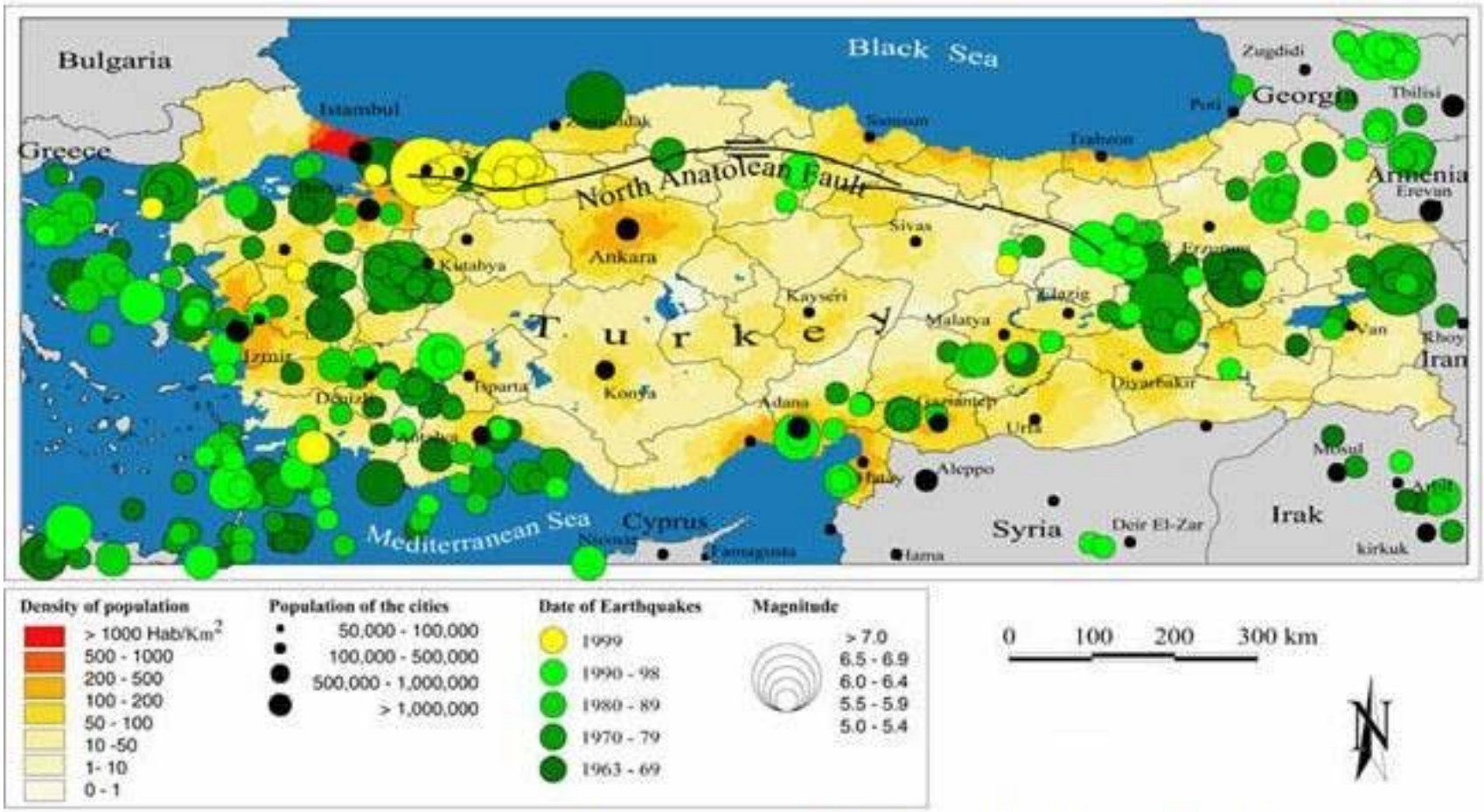


Figure 1-18 Active Fault Map of Turkey

Major Earthquakes in Turkey

- Magnitude 5 and higher between 1963 and 1999 -

UNEP



Data sources: UNEP/GRID-Geneva
Human Population and Administrative Boundaries Database for Asia
& CNSS Worldwide Earthquake

Figure 1-19 Major Earthquakes in Turkey

Figure 1-20 lists the most intensive and consistent earthquakes happened from 1902 to 2003 in Turkey in decreasing order of magnitude.

Date	Magnitude (Ms)	Location	Dead	Wounded	Severely damaged buildings	Latitude (N)	Longitude (E)	Depth (km)
26.12.1939	7.9	Erzincan	32962	-	116720	39.8	39.51	20
17.08.1999	7.4	Kocaeli	15000	32000	50000	40.7	29.91	20
18.03.1953	7.4	Yenice-Gönen	265	336	9670	39.99	27.36	10
09.08.1912	7.3	Mürefte	216	466	5540	40.6	27.2	16
12.11.1999	7.2	Düzce	845	4948	15389	40.79	31.21	11
06.05.1930	7.2	Hakkari	2514	-	3000	37.98	44.48	70
26.11.1943	7.2	Tosya-Ladik	2824	-	25000	41.05	33.72	10
01.02.1944	7.2	Bolu-Gerede	3959	-	20865	41.41	32.69	10
22.07.1967	7.2	Adapazarı	89	235	5569	40.67	30.69	33
28.03.1970	7.2	Gediz	1086	1260	9452	39.21	29.51	18
24.11.1976	7.2	Çaldıran-Muradiye	3840	497	9552	39.12	44.16	10
22.09.1939	7.1	İzmir-Dikili	60	-	1235	39.07	26.94	10
25.04.1957	7.1	Fethiye	67	-	3100	36.42	28.68	80
26.05.1957	7.1	Bolu-Abant	52	100	4201	40.67	31	10
31.03.1928	7	İzmir-Torbalı	50	-	2100	38.18	27.8	10
20.12.1942	7	Niksar-Erbaa	3000	6300	32000	40.87	36.47	10
06.10.1944	7	Ayvalık-Edremit	27	-	1158	39.48	26.56	40
23.07.1949	7	İzmir-Karaburun	1	7	824	38.57	26.29	10
17.08.1949	7	Karlıova	450	-	3000	39.6	40.6	40
16.07.1955	7	Aydın-Söke	23	-	470	37.65	27.26	40
06.10.1964	7	Manyas	23	130	5398	40.3	28.23	24
13.09.1924	6.9	Pasinler	310	-	4300	39.96	41.94	10
18.03.1926	6.9	Finike	27	-	190	35.84	29.5	10
13.08.1951	6.9	Kursunlu	52	208	3354	40.88	32.87	10
19.08.1966	6.9	Varto	2394	1489	20007	39.17	41.56	26
06.09.1975	6.9	Lice	2385	3339	8149	38.47	40.72	32
07.12.1988	6.9	Kars-Akyaka	4	11	546	40.96	44.16	5
04.12.1905	6.8	Çemisgezek	-	-	15	39	39	30
30.10.1983	6.8	Erzurum-Kars	1155	1142	3241	40.2	42.1	16
13.03.1992	6.8	Erzincan-Tunceli	653	3850	6702	39.68	39.56	27
28.04.1903	6.7	Malazgirt	2626	-	4500	39.1	42.5	-
04.01.1935	6.7	Erdek	5	30	600	40.4	27.49	30
20.02.1940	6.7	Kayseri-Develi	37	20	530	38.4	35.3	30
22.05.1971	6.7	Bingöl	878	700	5617	38.85	40.52	3
19.04.1938	6.6	Kırşehir	149	-	3860	39.44	33.79	10

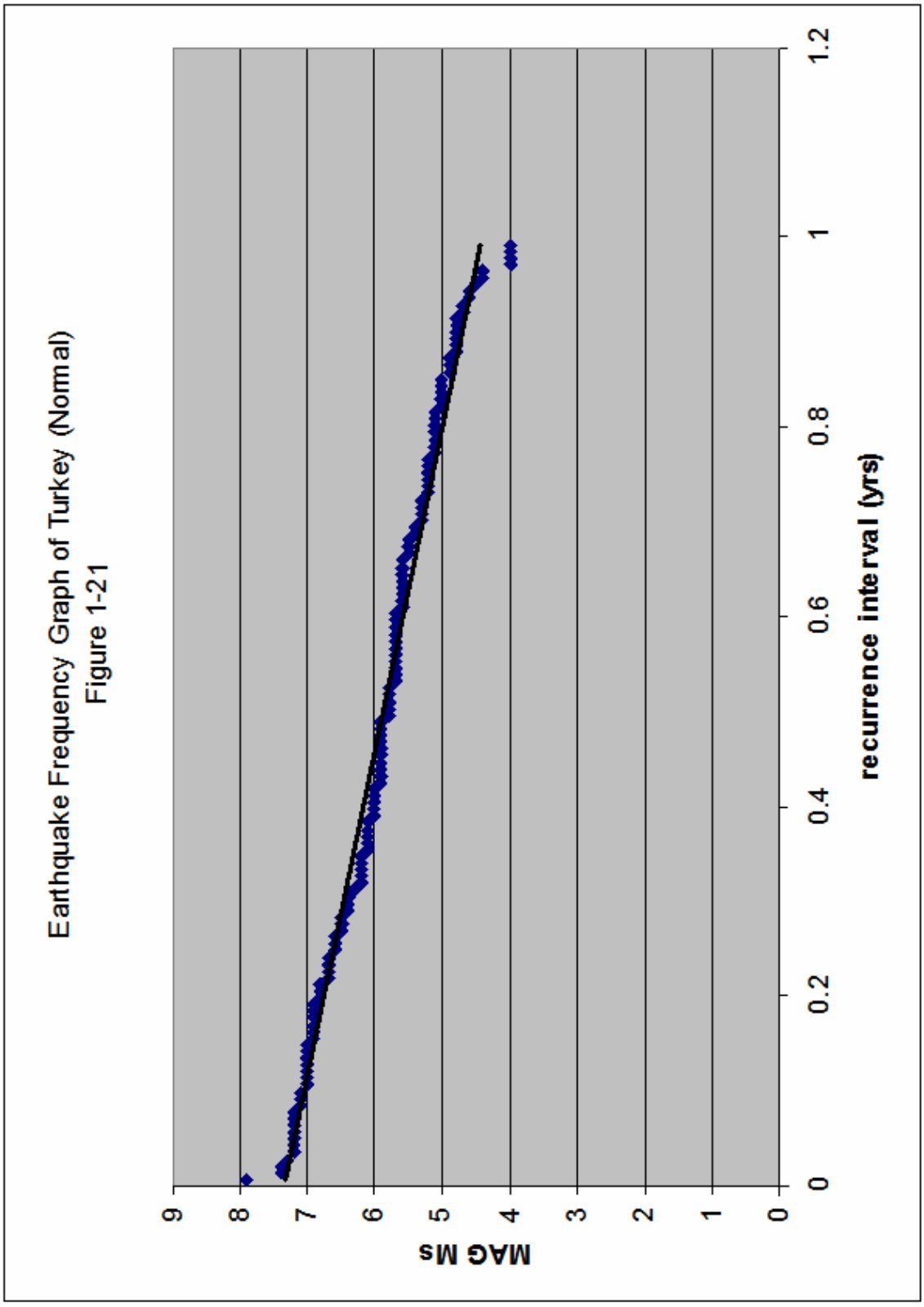
20.06.1943	6.6	Adapazarı-Hendek	336	-	2240	40.85	30.51	10
28.03.1969	6.6	Alasehir	41	186	4372	38.55	28.46	4
03.02.2002	6.5	Afyon-Sultandağı	42	325	4401	38.46	31.3	6
23.05.1961	6.5	Marmaris	-	9	61	36.8	28.7	70
03.09.1968	6.5	Amasya-Bartın	29	231	2073	41.81	32.39	5
01.05.2003	6.4	Bingöl				38.94	40.51	6
07.09.1953	6.4	Kursunlu	2	-	230	41.09	33.01	40
20.02.1956	6.4	Eskisehir	2	-	1219	39.89	30.49	40
18.09.1963	6.3	Çınarcık-Yalova	1	26	230	40.77	29.12	40
01.05.1935	6.2	Digor	200	-	1300	40.09	43.22	60
25.06.1944	6.2	Gediz-Usak	21	-	3476	38.79	29.31	40
26.07.1967	6.2	Pülümür	97	268	1282	39.54	40.38	30
14.01.1969	6.2	Fethiye	-	-	42	36.11	29.19	22
12.05.1971	6.2	Burdur	57	150	1389	37.64	29.72	30
27.01.2003	6.1	Tunceli-Pülümür	1	-	67	39.41	39.8	16
18.05.1929	6.1	Sivas-Susehri	64	-	1357	40.2	37.9	10
15.11.1942	6.1	Bigadiç-Sındırgı	7	-	1262	39.55	28.55	10
23.03.1969	6.1	Demirci	-	-	1100	39.1	28.4	9
06.06.2000	6.1	Çankırı-Orta	-	-	-	40.63	33.03	10
23.05.1941	6	Muğla	2	-	500	37.07	38.21	40
20.03.1945	6	Adana-Ceyhan	10	-	650	37.11	35.7	60
14.06.1964	6	Malatya	8	36	678	38.13	38.51	3
30.07.1967	6	Akyazı	2	40	-	40.7	30.4	18
25.03.1969	6	Demirci	-	-	1826	39.25	28.44	37
07.08.1925	5.9	Afyon-Dinar	3	-	2043	38.1	29.8	20
21.11.1939	5.9	Tercan	43	-	500	39.82	39.71	80
10.09.1941	5.9	Van-Ercis	194	-	600	39.45	43.32	20
12.11.1941	5.9	Erzincan	15	-	500	39.74	39.43	70
11.12.1942	5.9	Çorum	25	-	816	40.76	34.83	40
19.04.1970	5.9	Çavdarhisar-Kütahya	-	2	41	39.1	29.7	18
14.06.1979	5.9	Foça	-	-	22	38.92	26.89	-
18.09.1984	5.9	Erzurum-Balkaya	3	35	187	40.9	42.24	10
01.10.1995	5.9	Dinar	94	240	4909	38.18	30.02	24
27.06.1998	5.9	Adana-Ceyhan	146	94-0	4000	36.85	35.55	23
10.02.1903	5.8	Zara	-	-	1500	39.9	37.8	-
20.11.1945	5.8	Van	-	-	1000	36.63	43.33	10
03.01.1952	5.8	Hasankale	133	-	701	39.95	41.67	40
05.05.1986	5.8	Malatya-Sürgü	8	24	824	37.95	37.8	10

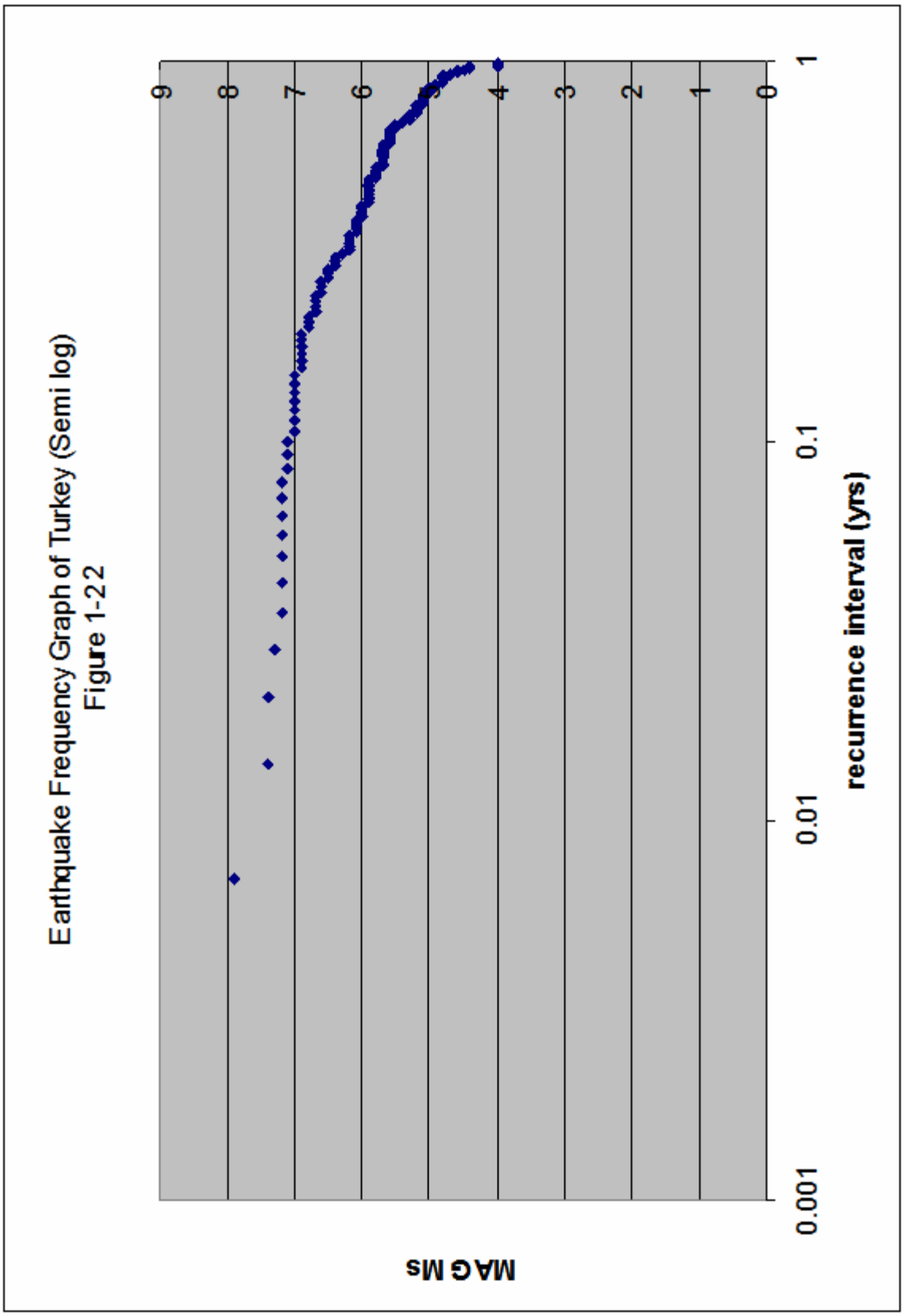
15.12.2000	5.8	Afyon-Bolvadin	6	82	250	38.6	31.2	6
10.04.2003	5.7	İzmir-Urla				38.19	26.69	19
13.09.1999	5.7	Kocaeli	-	-	-	40.8	30.03	5
22.10.1926	5.7	Kars	355	-	1100	40.94	43.88	10
19.07.1933	5.7	Denizli-Çivril	20	-	200	38.19	29.79	40
13.12.1941	5.7	Muğla	-	-	400	37.13	28.06	30
31.05.1946	5.7	Varto-Hınıs	839	349	1986	39.29	41.21	60
08.04.1951	5.7	İskenderun	6	10	13	36.58	35.85	50
25.04.1959	5.7	Köyceğiz	-	-	59	36.94	28.58	30
13.06.1965	5.7	Denizli-Honaz	14	217	488	37.85	29.32	33
03.03.1969	5.7	Gönen	1	-	20	40.08	27.5	6
23.04.1970	5.7	Demirci	-	43	150	39.1	28.7	28
09.03.1902	5.6	Çankırı	4	-	3000	40.65	33.6	-
13.04.1940	5.6	Yozgat	20	-	1250	40.04	35.2	30
05.04.1944	5.6	Mudurnu	30	-	900	40.84	31.12	10
21.02.1946	5.6	Kadınhan-Ilgın	2	-	509	38.24	31.79	60
31.08.1965	5.6	Karlıova	-	-	1500	39.3	40.79	33
07.03.1966	5.6	Varto	14	75	1100	39.2	41.6	26
06.04.1969	5.6	Karaburun	-	3	443	38.5	26.4	16
06.06.1986	5.6	Sürgü-Malatya	1	20	1174	38.01	37.91	11
21.11.1942	5.5	Osmancık	7	-	448	40.82	34.44	80
22.10.1952	5.5	Misis	10	-	511	37.25	35.15	70
11.03.1963	5.5	Denizli	-	-	54	37.96	29.14	40
10.02.1944	5.4	Düzce	-	-	900	41	32.3	10
14.08.1996	5.4	Çorum-Amasya	-	6	707	40.73	35.28	12
13.05.1924	5.3	Çaykara	50	-	700	40	42	30
04.09.1962	5.3	Iğdır	1	22	-	39.96	44.13	40
07.04.1967	5.3	Adana-Bahçe	-	-	91	37.4	36.2	32
16.12.1977	5.3	İzmir	-	-	40	38.4	27.19	24
23.09.2000	5.2	Hendek-Akyazı	-	-	-	40.79	30.76	5
05.02.1949	5.2	Harmancık	-	-	150	39.89	29.35	40
16.07.1972	5.2	Van	1	-	400	38.3	43.3	46
01.02.1974	5.2	İzmir	2	20	47	38.55	27.22	31
26.03.1977	5.2	Palu	8	26	842	39.34	43.5	25
27.03.1982	5.2	Muş-Bulanık	-	-	424	39.23	41.9	38
04.10.1914	5.1	Afyon-Bolvadin	400	-	1700	38	30	15
02.05.1953	5.1	Karaburun	-	-	73	38.51	26.55	60
18.06.1953	5.1	Edirne	-	-	323	41.55	26.55	30
07.07.1957	5.1	Basköy	-	-	300	39.37	40.46	60
22.11.1963	5.1	Denizli	-	-	298	37.07	29.68	60
24.09.1968	5.1	Bingöl-Elazığ	2	40	-	39.2	40.2	8
25.03.1975	5.1	Kars-Susuz	2	26	762	40.95	42.96	25

20.09.1999	5	Marmara Adası	-	-	-	40.74	27.46	21
10.01.1940	5	Niğde	58	-	586	38	34.7	-
25.10.1959	5	Hınıs	18	-	300	39.25	41.63	50
26.04.1972	5	Ezine	-	-	400	39.5	26.3	25
30.04.1976	5	Ardahan	4	-	300	41.2	42.6	-
15.12.1934	4.9	Bingöl	12	-	200	38.85	40.55	-
19.08.1976	4.9	Denizli	4	28	887	37.67	29.17	-
05.07.1983	4.9	Biga	3	-	85	40.33	27.21	7
16.12.1938	4.8	Kırşehir	-	-	300	39.52	33.91	10
07.04.1966	4.8	Adana-Bahçe	-	-	100	37	35.3	-
02.07.1970	4.8	Gürün	1	-	150	38.8	36.7	19
02.04.1976	4.8	Doğu Beyazıt	5	13	236	39.91	43.76	14
25.03.1977	4.8	Lice	8	17	210	38.58	40.03	29
09.12.1977	4.8	İzmir	-	-	11	38.56	27.47	-
08.02.1926	4.7	Milas	2	-	598	36.8	27.1	30
22.03.1972	4.7	Sarıkamış	-	4	100	40.4	42.2	2
04.02.1950	4.6	Kığı	20	-	100	39.5	40.6	30
26.07.1960	4.6	Tokat	-	-	22	40.56	37.25	40
23.03.1936	4.5	Kars-Kötek	-	-	100	39	42	30
10.04.1960	4.4	Germencik	-	-	100	37.73	27.8	40
30.06.1981	4.4	Antakya	-	-	2	36.17	35.89	63
26.02.1960	4	Bitlis	-	-	80	38.49	41.52	40
10.02.1962	4	Mus	-	-	97	38.7	41.45	-
24.03.1964	4	Siirt	1	-	100	37.95	42	-
12.07.1966	4	Varto	12	-	90	39.17	41.56	-

Figure 1-20 Earthquakes in Turkey from 1902 to 2003 (http://www.deprem.gov.tr/haber.htm)

Referring back to data from Figure 1-20, Earthquake Frequency of Turkey is plotted on Figure 1-21 and in semi log format on Figure 1-22 to show how the recurrence years are related to the magnitude of earthquakes in Richter scale.


Earthquake Frequency Graph of Turkey (Nomal)
Figure 1-21
MAG Ms
recurrence interval (yrs)
0
1
2
3
4
5
6
7
8
9
0
0.2
0.4
0.6
0.8
1
1.2


Earthquake Frequency Graph of Turkey (Semi log)
Figure 1-22
MAG Ms
recurrence interval (yrs)
0.001
0.01
0.1
1
0
1
2
3
4
5
6
7
8
9

d) Earthquakes in Istanbul:

A future earthquake in Istanbul could cause a large area of devastation and result in many deaths. In case of a major disaster in Istanbul, there are only three hospital beds for every ten people in the population. Many of the 1.2 million buildings in the city will collapse even if the majority of the construction is built on firm soil. In case of an earthquake larger than 7.0 in magnitude, there will be $150 billion dollars worth of damage and between 150,000 to 200,000 people could be trapped under collapsed buildings. To prevent such a disaster, there has to be an investment of $5 billion dollars to develop earthquake resistant buildings (Ercan 1-12).

An earthquake with magnitude of between 6.8 and 7.5 with a 60% probability chance is predicted in the Marmara Sea in next 30 years. This will be due to fault raptures in the Marmara Sea (Figure 1-23) coming from the North Anatolian Fault (The Solution to Earthquake in Istanbul).

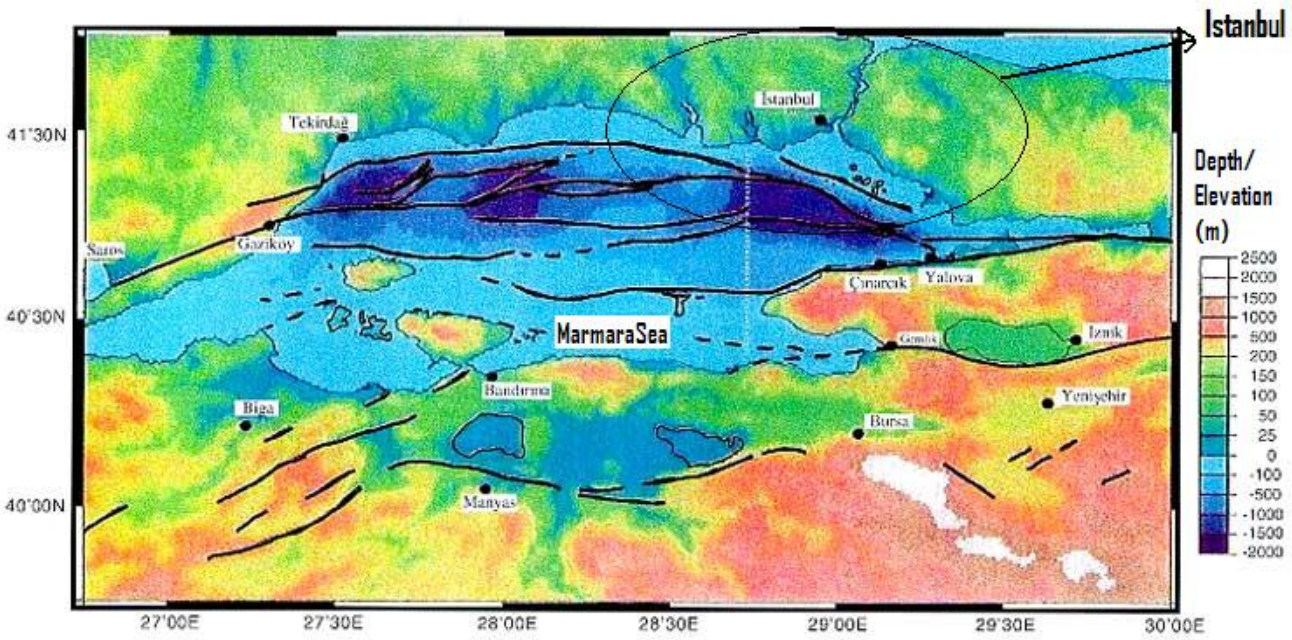


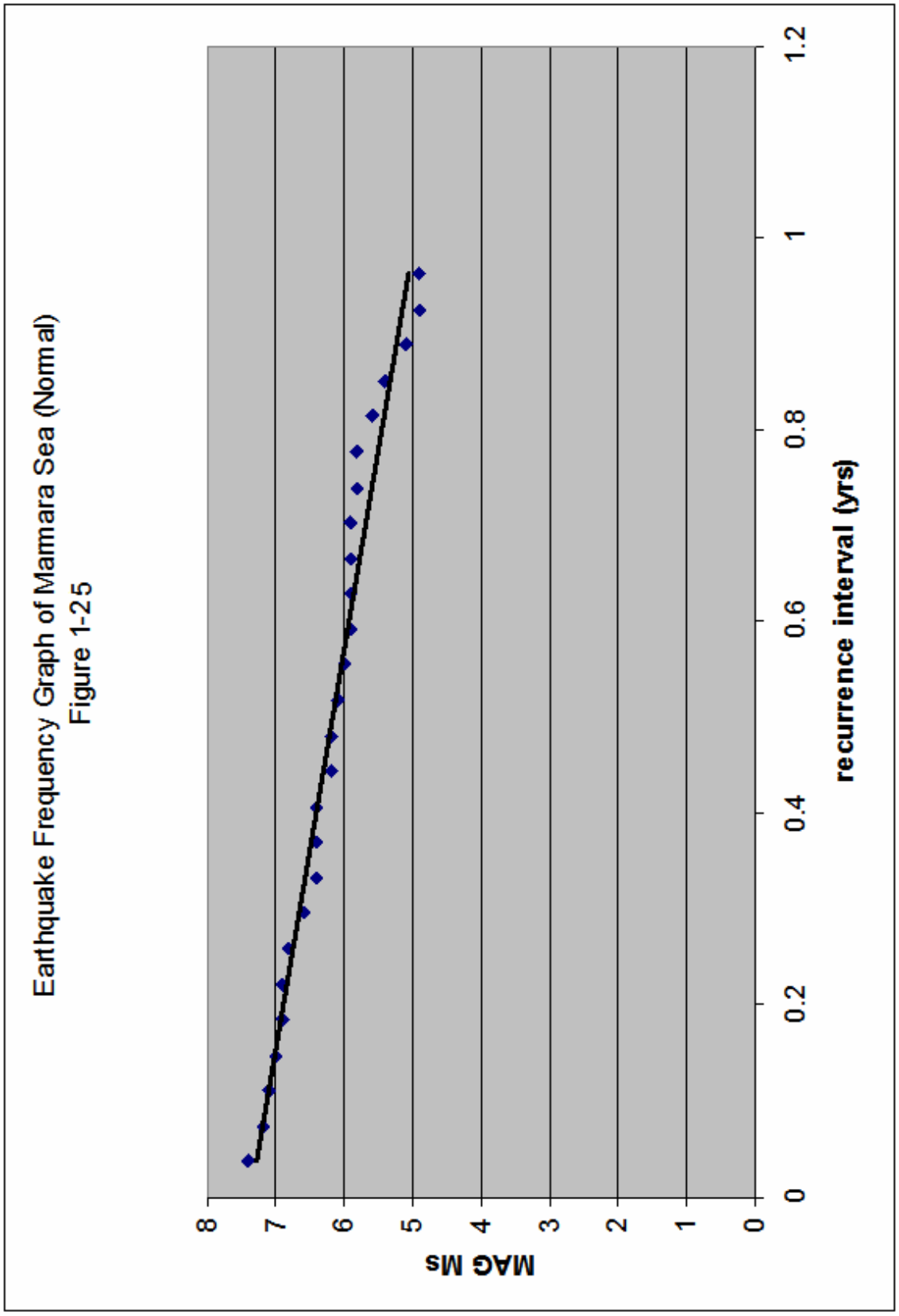
Figure 1-23 Past Ruptures in Marmara Sea.

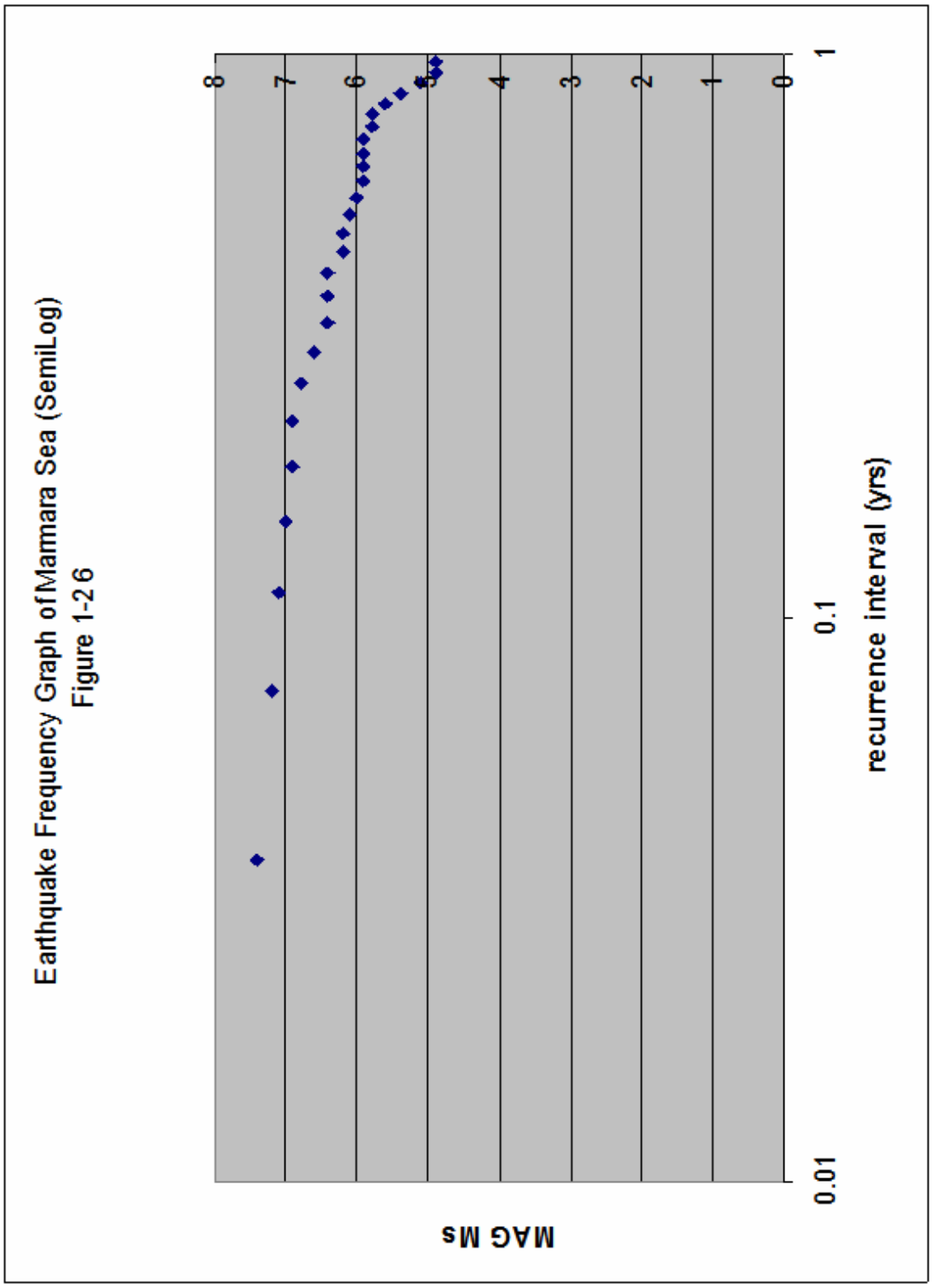
Figure 1-24 shows the major earthquakes that occurred from 1901 to 1988. There hasn't been a major earthquake for the last 14 years.

Date	Longitude-Latitude (North--South)	Magnitude (Ms)
1912.08.09	40.75--27.20	7.4
1953.03.18	40.00--27.50	7.2
1967.07.22	40.67--30.69	7.1
1957.05.26	40.57--31.00	7
1919.11.18	39.35--27.44	6.9
1964.10.06	40.30--28.23	6.9
1944.10.06	39.64--26.52	6.8
1975.03.27	40.45--26.12	6.6
1935.01.04	40.64--27.51	6.4
1943.06.20	40.68--30.47	6.4
1963.09.18	40.65--29.15	6.4
1928.05.02	39.41--29.45	6.2
1942.11.05	39.38--28.08	6.2
1956.02.20	39.96--30.11	6.1
1969.03.03	40.08--27.50	6
1901.12.18	39.40--26.70	5.9
1903.05.26	40.65--29.00	5.9
1905.10.22	40.60--28.30	5.9
1965.08.23	40.51--26.17	5.9
1909.10.29	40.26--29.64	5.8
1983.07.05	40.33--27.21	5.8
1971.02.23	39.62--27.32	5.6
1966.08.21	40.33--27.40	5.4
1988.04.24	40.88--28.24	5.1
1979.07.18	39.66--28.65	4.9
1983.10.21	40.14--29.35	4.9

Figure 1-24 Data of the Marmara Earthquakes (http://www.angelfire.com/de2/zelzele/tablo1.html)

Referring back to data from Figure 1-24, Earthquake Frequency of the Marmara Sea is plotted on Figure 1-25 and in semi log format on Figure 1-26 to show how the recurrence years are related to the magnitude of earthquakes in Richter scale.

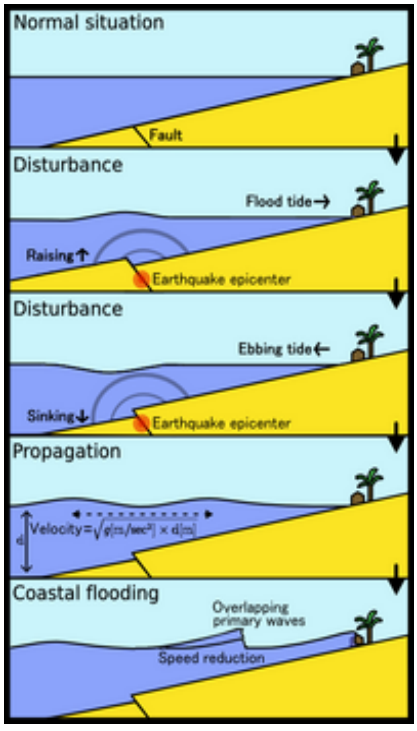

Earthquake Frequency Graph of Mamara Sea (Nomal)
Figure 1-25
MAG Ms
recurrence interval (yrs)
0
1
2
3
4
5
6
7
8
0
0.2
0.4
0.6
0.8
1
1.2


Earthquake Frequency Graph of Mamara Sea (SemiLog)
Figure 1-2 6
MAG Ms
8
7
6
5
4
3
2
1
0
0.01
0.1
1
recurrence interval (yrs)

I) TSUNAMI

Earthquakes, landslides, volcanic eruptions and large meteorite impacts all have the potential to create a tsunami. Tsunamis are a series of waves created because of rapidly displaced water (on a massive scale) in a lake, a sea, or an ocean. The effects of a tsunami can range from inconspicuous to large destruction.

The term tsunami was first used by Japanese fishermen who returned to their port to find the area surrounding the harbor devastated, even though they were not aware of any wave in the open water. Because a tsunami has a much smaller wave height offshore, and a very long wavelength, often hundreds of kilometers long, it is generally unnoticed at sea as it passes. The tsunami waves are formed as the displaced water mass moves under the influence of gravity to regain its equilibrium. They then spread out across the ocean, like ripples on a pond (Encarta).



Tsunamis have been historically referred to as tidal waves because as they approach land they become violent rushing tides. (Internet Public Library)

a) Causes:

The most common cause for tsunamis is an undersea earthquake. An earthquake which is too small to create a tsunami by itself might cause an undersea landslide that can result in a tsunami. Tsunamis can be created when the sea floor suddenly deforms and vertically displaces the overlying water (Figure 1-27).

Figure 1-27 Tsunami generated by an earthquake

As seen on Figure 1-28, the North Anatolian Fault line has been an active fault line at various times of the last century. The last rupture occurred in Kocaeli on August 17, 1999. The continuation of the fault line extending into the Marmara Sea is predicted to rupture in the near future.

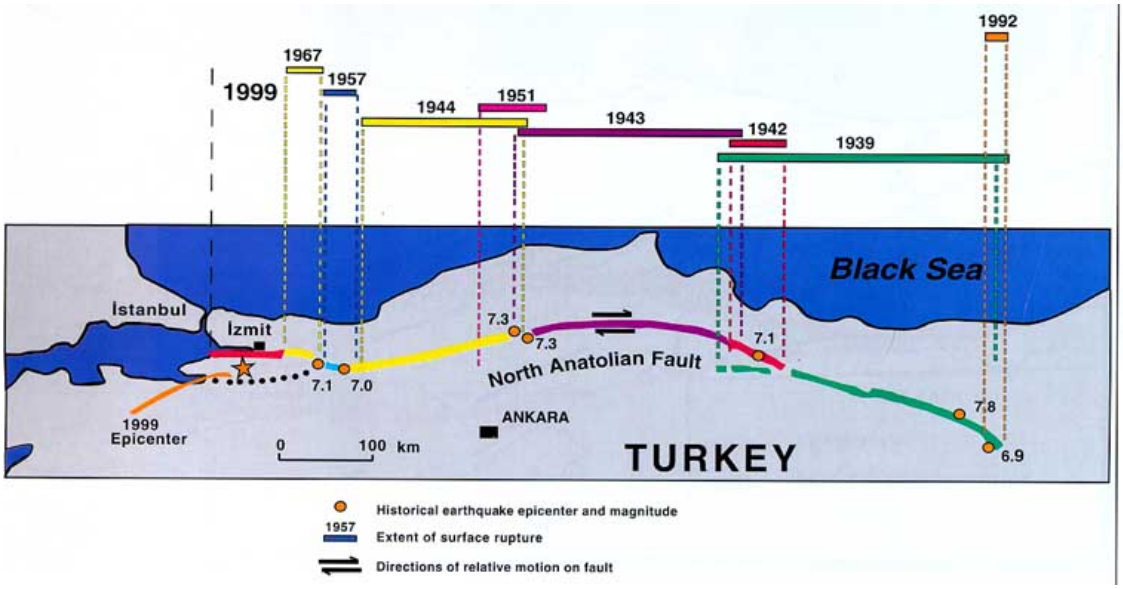


Figure 1-28 Major Earthquake Ruptures in the North Anatolian Fault

The North Anatolian Fault could affect Istanbul with earthquakes and create tsunamis. Figure 1-29 shows the fault as it reaches the Marmara Sea.

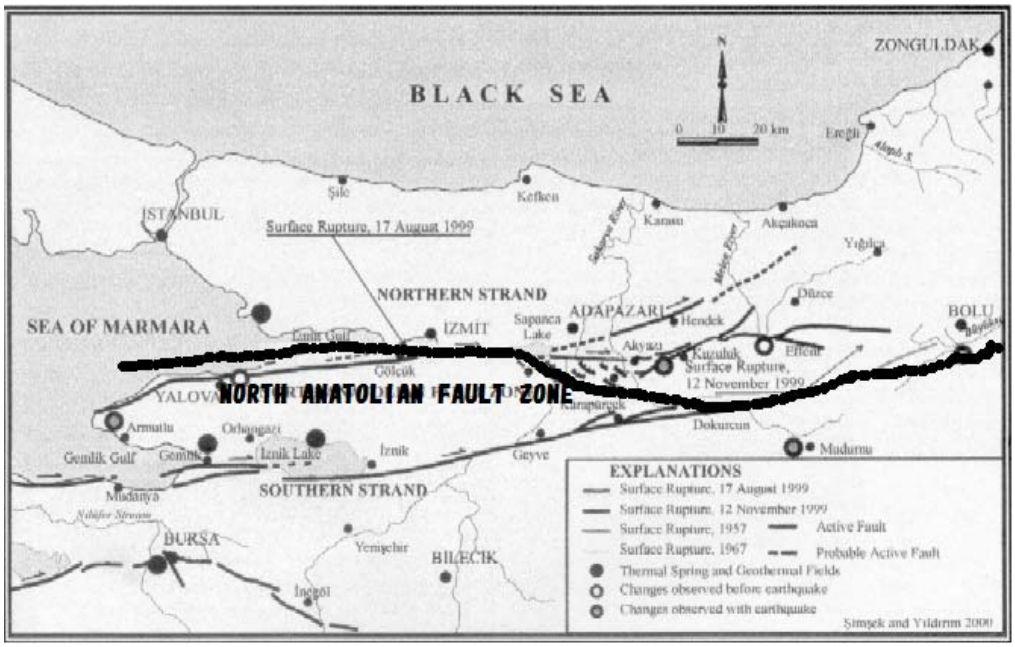


Figure 1-29 Fault lines of Istanbul

A crack at the bottom of the sea will cause large amounts of water to displace and create a series of waves with very long wavelengths and short amplitudes in the beginning. As it travels the wavelengths will become shorter and the amplitude will be larger with a very high speed towards the shore line, leading to huge devastations (Figure 1-30).

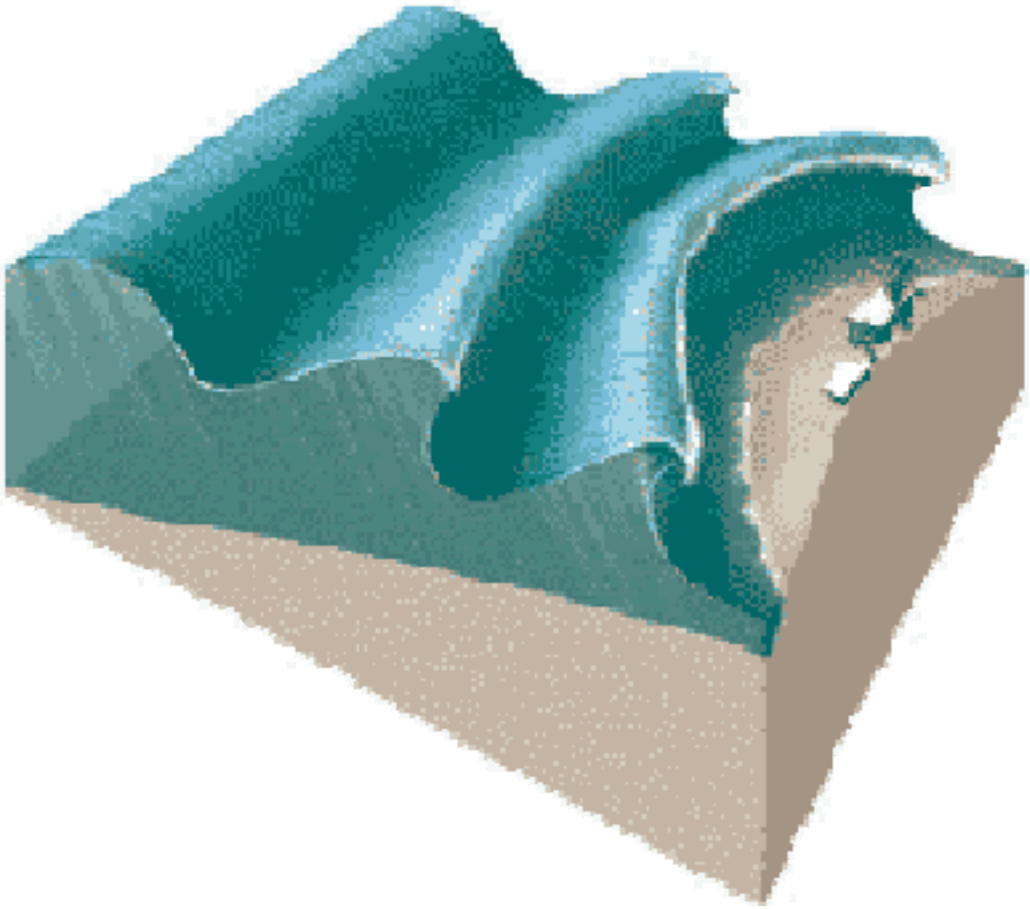


Figure 1-30 Formation of a Tsunami

b) Signs of a Tsunami:

Figure 1-31 shows the signs of a tsunami:

- An earthquake may be felt.
- Large amounts of gas may bubble to the water surface and make the sea look like it is boiling.
- The water in the waves may be unusually hot.
- The water may smell of rotten eggs (Hydrogen Sulfide) or of petrol or oil.
- The water may sting the skin.
- A thunderous boom may be heard.
- A roaring noise as of a jet plane may be heard.
- A noise similar to the periodic whoop-whoop of a helicopter may be heard.
- A whistling sound may be heard.
- The sea may withdraw to a considerable distance.
- A flash of red light might be seen near the horizon.
- As the wave approaches the top of the wave may glow red. **Figure 1-31 (Internet Public Library)**

Tsunamis are rare and difficult to predict. Although scientists can quickly detect an undersea earthquake with seismometers, not all undersea earthquakes will produce a tsunami. Other factors, such as the topography of the ocean floor at the epicenter, are also involved (Internet Public Library).

c) Istanbul and Tsunamis:

Throughout history Istanbul has been overwhelmed by tsunamis of different sizes and magnitudes. The southern coastal area of Istanbul is a “near-field hazard” zone, a zone that is 30 minutes away from tsunami possibilities. It is difficult to generalize the effects of near-field tsunamis, due to the large variability over short distances of the height of tsunamis and their destructiveness.

Even though the historical records of near-field tsunamis are often incomplete, because of insufficient data and data quality, especially for older events, there are still many events well documented events. During last 1600 years, at least 21 historic

tsunamis are known to have occurred in Istanbul. About half of them impacted Istanbul's coasts on the Sea of Marmara. In the years 557, 1231, 1343 and, 1344 the sea flooded 2 to 3 km onto the land. In 1509, the tsunami wave height was more than 6 meters above sea level. Sea flooded the area behind the city walls and onto the streets (Alpar 1-4).

Figure 1-32 indicates where tsunami will hit Istanbul. It is the main figure for the following four graphs afterwards (from Figure 1-33 to 1-36):

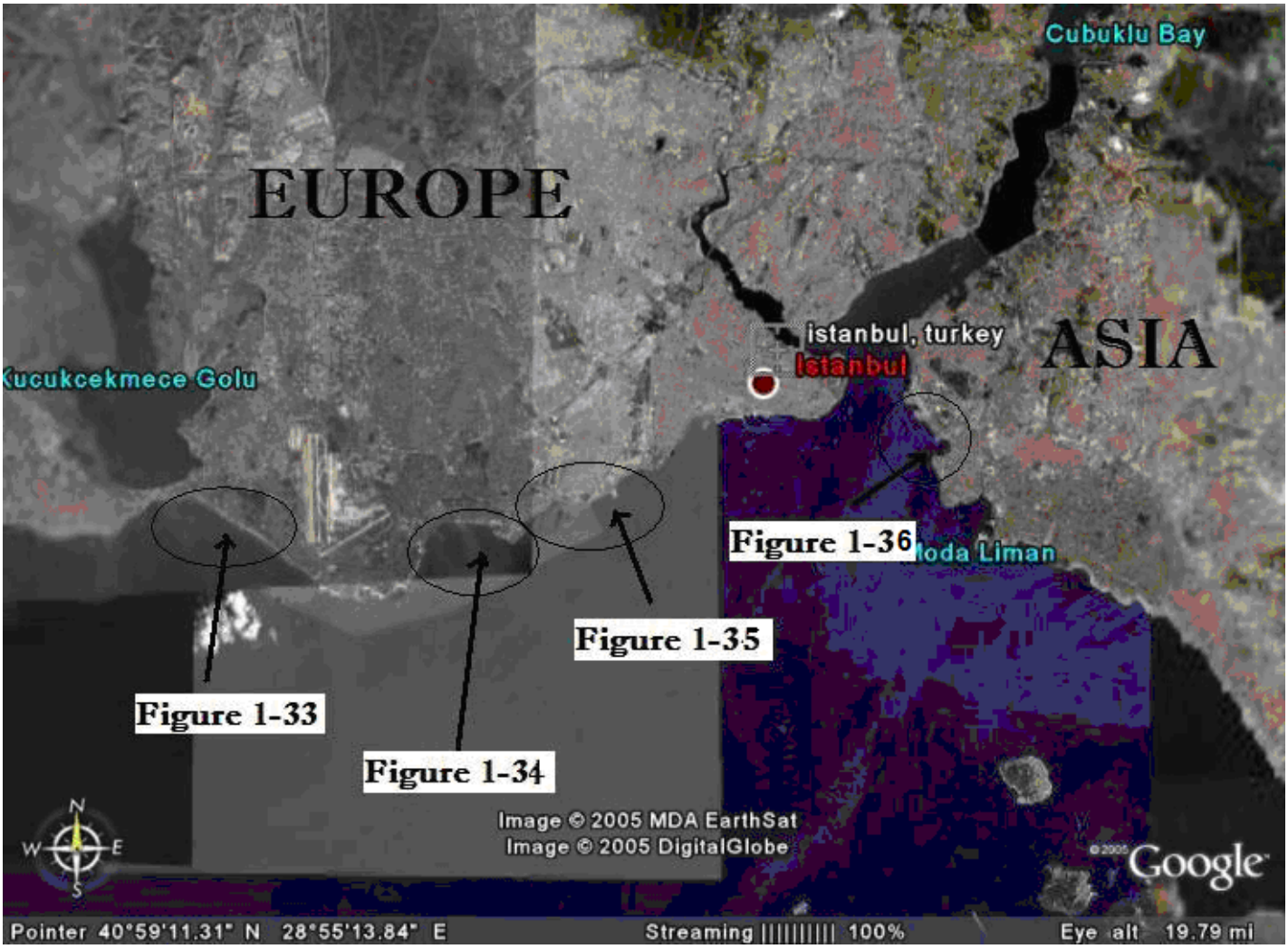


Figure 1-32 Overview of a part of Istanbul (Google Earth)

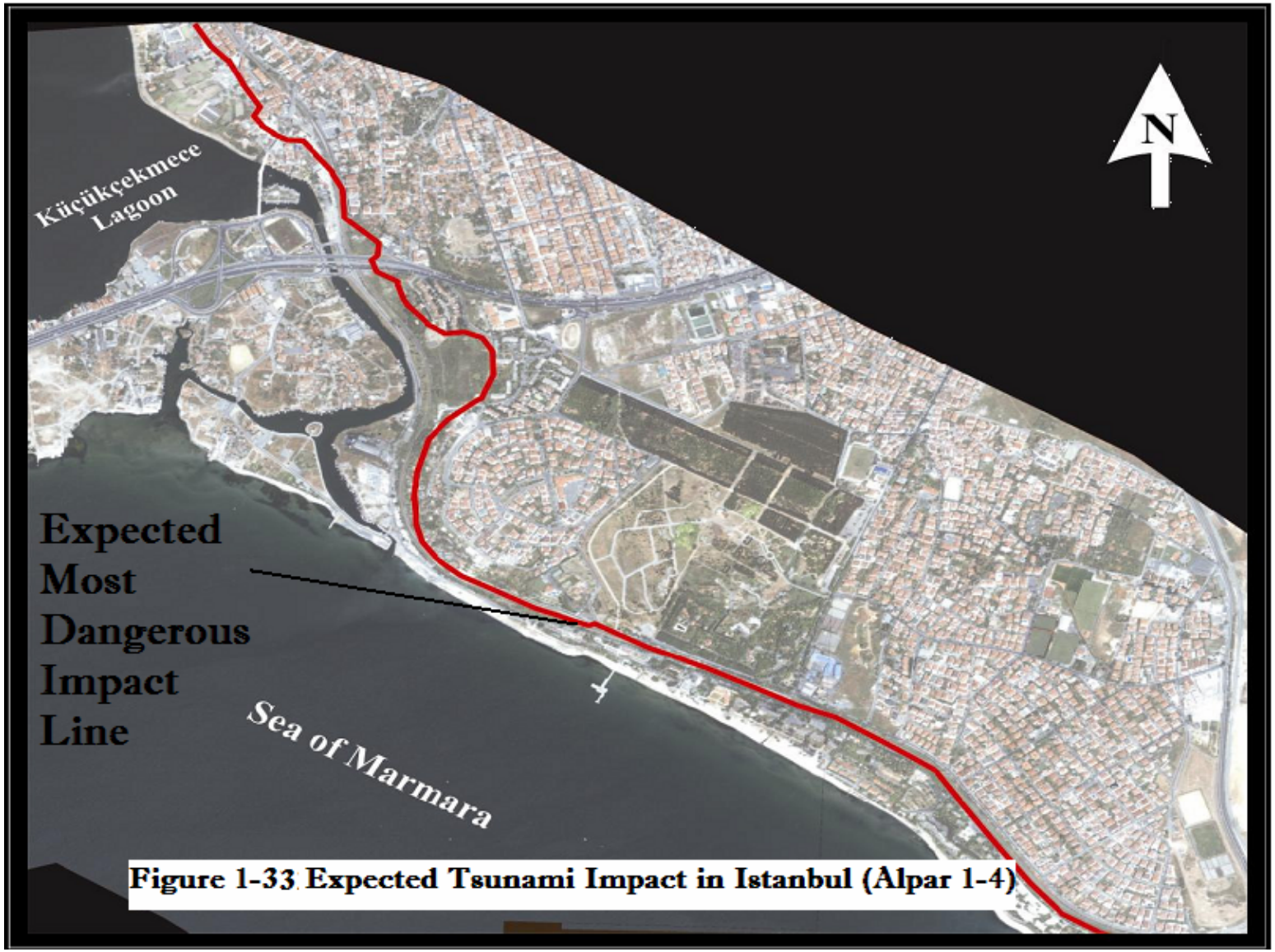


Figure 1-33 Expected Tsunami Impact in Istanbul (Alpar 1-4)

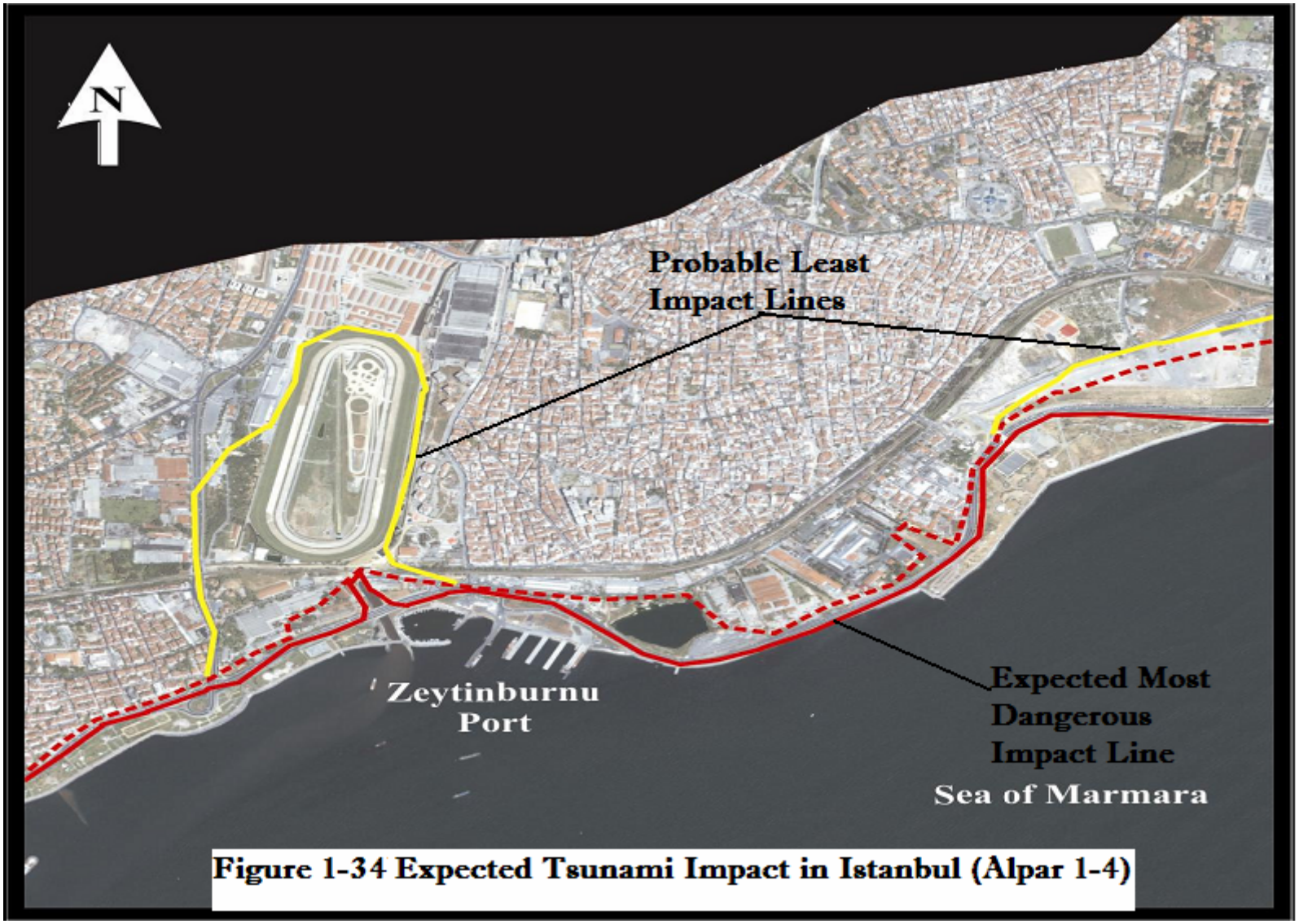


Figure 1-34 Expected Tsunami Impact in Istanbul (Alpar 1-4)

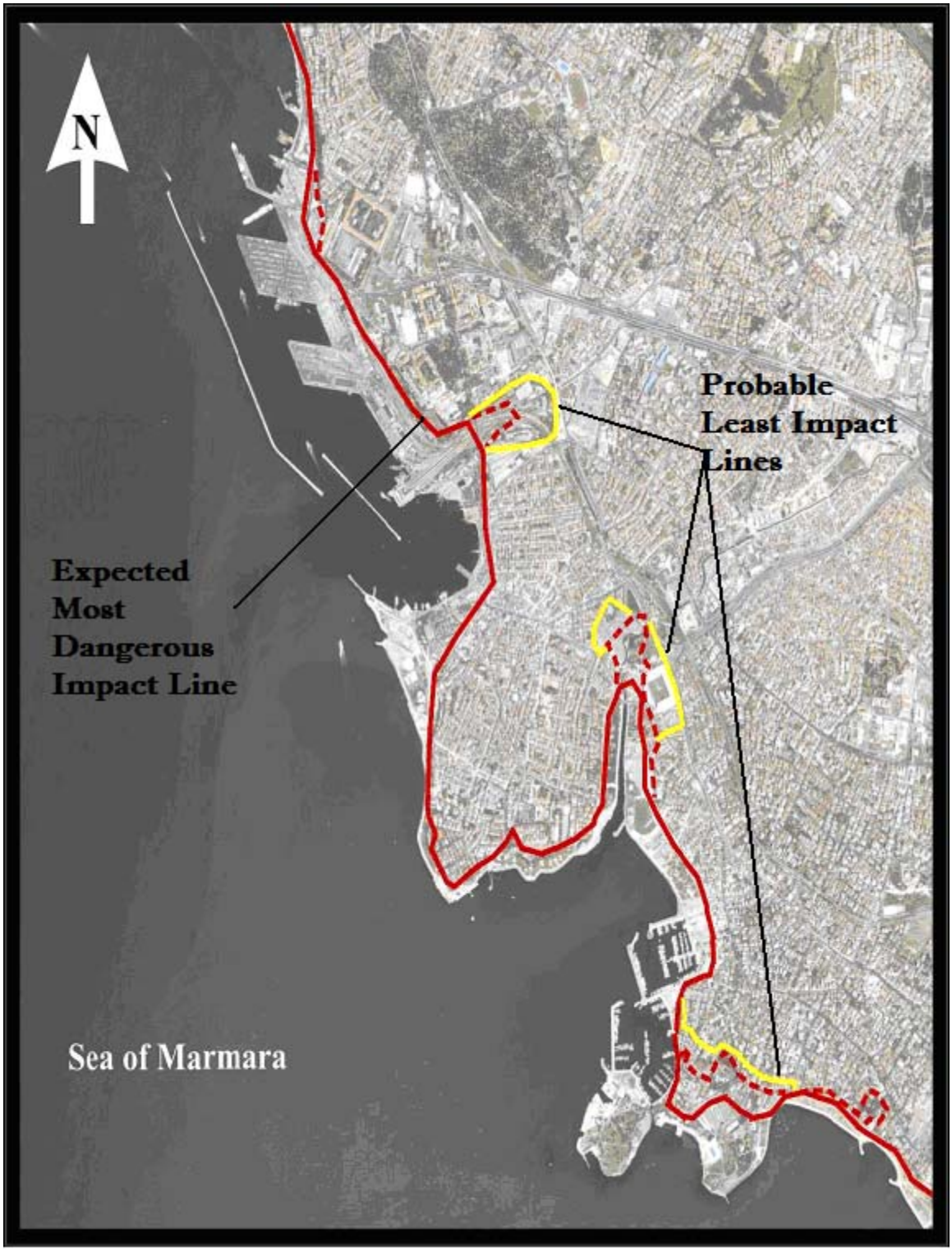


Figure 1-35 Expected Tsunami Impact in Istanbul (Alpar 1-4)

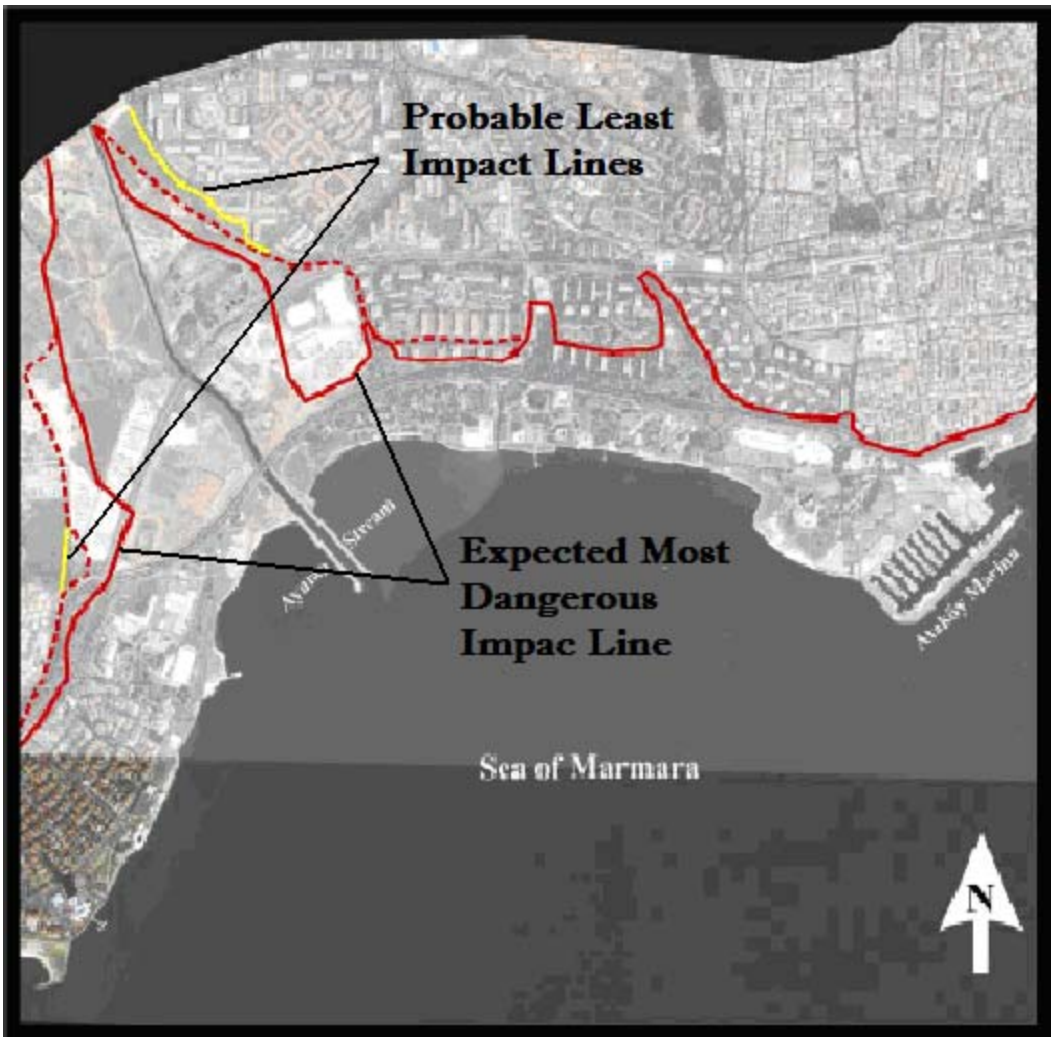


Figure 1-36 Expected Tsunami Impact in Istanbul (Alpar 1-4)

With a possible earthquake occurring near Istanbul in Marmara Sea, a tsunami is likely. Evidence of this possibility was observed in 1999 as irregular wave patterns occurred around the Prince islands and in the Strait of Istanbul. When the expected earthquake and tsunami happen, there will be great economic and societal consequences. In order to minimize these consequences, Istanbul needs to rethink the standards through ideal urban planning and development (Alpar 1-4).

3) PROBLEM STATEMENT

Istanbul, once the capital of powerful Byzantine and Ottoman empires, was one of the well developed strategic cities in the world until 1950s. However, now it has become an unpleasant metropolitan city due to the decline of architectural achievements, an increase of "gecekondus", and skyscrapers of undesirable human scale of construction. The coming of a highly predicted earthquake with a 7.4 magnitude in Richter scale or a tsunami created by the break of faults at the Marmara Sea will directly impact Istanbul and will immensely lower the quality of life. Istanbul's future needs to be evaluated because of the expected devastation from poor urban planning in combination with the predicted natural disasters.

A) GOAL

The goal of the project is to make a recommendation to reduce the damage of future tsunamis and earthquakes while developing a conception for Istanbul.

B) OBJECTIVES:

Objectives are specific actions which support the goal of this project. The objectives of this project include preserving history, planning an earthquake/tsunami safe Istanbul, and providing a well built infrastructure.

- The historical sites of Istanbul will be preserved so that Istanbul maintains its historical prominence and help in the redevelopment of its urban plan.
- An earthquake/tsunami safe Istanbul will minimize death toll and structural damage. Also, it will allow Istanbul to progress as an urban planned city.

- Creating a well built infrastructure in Istanbul will provide better environment. It could also prevent further calamities from happening after the earthquake and tsunami take place.

These three objects can be attained using the eight methods of change, which are discussed in the Methodolgy Section.

Istanbul's future will be analyzed by comparing alternatives that were developed, and then evaluating each alternative in terms of time, money, and quality of life. The best alternative should optimize each of this project's objectives, for both before and after these devastating calamities occur.

4) METHODOLOGY

The methodology is the process of collecting data to analyze the four different alternatives or scenarios. Each scenario can best be analyzed using eight methods of change. However, scenario 1 is discussed more in general to provide insight in what Istanbul is facing. Then, scenarios will be compared and contrasted in terms of time, money and quality of life. On these bases, the best alternative was to be determined.

C) COMMON ELEMENTS:

To fulfill the three objectives eight methods of changes were used for each of the four scenarios. These eight methods of change are common to each scenario and are discussed below for each scenario;

1. **Construction:** Most of the buildings are not inspected by any governmental or non-governmental institutions, even though the government has made more requirements on the foundation inspections. Buildings are usually built without authorization. There are an insufficient number of qualified engineers to build

structurally sound construction. It is very easy to become a builder in Turkey and builders usually cannot fulfill the responsibilities of an engineer.

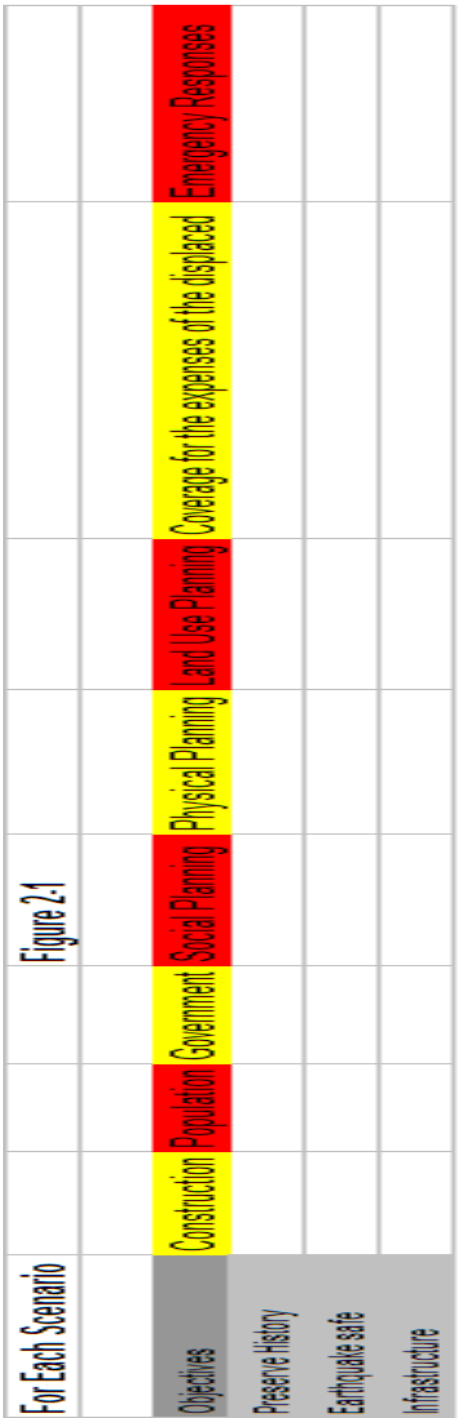
2. **Population:** Istanbul's population has tremendously increased from 500 thousand to 15 million people in the last five decades. Turkey's economic struggle in other parts of the country resulted in this significant increase. Population increase resulted in badly developed constructions called gecekondus (squatter settlements). Moreover, the city's density boundaries expanded rapidly. Also, unemployment has become a huge problem.
3. **Government:** Government does not enforce or implement enough restrictions and laws, even with the use of its agencies. These governmental divisions are loosely connected, which does not allow them to work together nor follow their own regulations. Furthermore, the government does not have the budget to spend on emergency units, infrastructure and anything else. The government does not have a good tax system to collect national revenue.
4. **Social Planning:** The natural environment is not taken into account in the social planning of Istanbul. As a result the earthquake and tsunami danger zones are not well known and construction is allowed in these dangerous zones, without the authorization or constructional requirements. Even on the firm ground, the buildings are not strong enough resist earthquake disasters.
5. **Physical Planning:** The physical planning in Istanbul is a combination of multi dimension, human scale and monumental buildings, but these buildings were not constructed consciously to establish the character of the city. There are not many

alternative passageways and the ones that exist are too narrow to function properly in a moment of emergency.

6. **Land Use Planning:** Land Use Planning in Istanbul does not satisfy human needs such as elaborate architectural buildings and public parks. There is not enough space to have shelters for the homeless in an emergency situation.
7. **Expense Coverage for the Displaced:** There is not enough coverage for the expenses of the displaced for an emergency situation. Even though there is an earthquake insurance which everyone has to pay for, it only covers building damages; there is no other insurance for either tsunamis or other types of disasters.
8. **Emergency Responses:** Emergency units do not have the necessary equipments or enough vehicles, so the emergency responses are not ready for any kind of natural disaster. Moreover the response time is slow and units do not have proper training. As a result these units usually do not know exactly how to react in critical moments.

B) METHODOLOGY MATRIX

The matrix provided on figure 2-1 and figure 2-2 summarizes the methodology of the project.



BEFORE AND AFTER AN EARTHQUAKE (IQP)		Alternative Objective Matrix		Figure 2-2	
Reduce the impact of a future tsunami & earthquake while developing urban planning in Istanbul					
		Alt1	Alt2	Alt3	Alt4
Objectives		Do nothing- (Majority)	Reinforce; systematic teardown/build	Highrise	Move inhabited to other cities
Preserve History					
	Construction				
	Population				
	Government				
	Social Planning				
	Physical Planning				
	Land Use Planning				
		Alt4	Alt2	Alt3	Alt1
		Do nothing- (Majority)	Reinforce; systematic teardown/build	Highrise	Move inhabited part to safezone
Earthqauke safe					
	Construction				
	Population				
	Government				
	Social Planning				
	Physical Planning				
	Land Use Planning				
	Cover expenses of displaced				
		Alt4	Alt2	Alt3	Alt1
		Do nothing- (Majority)	Reinforce; systematic teardown/build	Highrise	Move inhabited part to safezone
Infrastructure					
	Population				
	establish emergency responses				
	Government				
	Social/Physical /Landuse Planning				

C) SCENARIOS:

Different scenarios are the alternatives which should support the objectives. The four scenarios are: do nothing, reinforce buildings (systematic teardown/build), high rise construction, and move the inhabitants to other cities. Following are the different scenarios (alternatives):

a) Alternative 1: Do nothing

The idea of "do nothing" is the main option that many people are considering today in Turkey. This is due to many different mentalities of the Turkish society.

b) Alternative 2: Reinforce, Systematic Teardown, and Rebuild

Reinforcement will strengthen the buildings that can then resist earthquakes and tsunamis. However, there are also some buildings that are likely to collapse. The buildings in the tsunami zone should not be allowed and must not be kept as danger zones. In order to prevent any collapses or extreme damages, systematic teardown and rebuilding of unsafe buildings should take place.

c) Alternative 3: High rise construction

High rise construction will consist of tall buildings at least 10 stories high. They will be earthquake resistant and will allow more space for transportation and the environment. These massive scale structures are likely to be made out of concrete.

d) Alternative 4: Move inhabitants to other cities:

Istanbul has always been a highly recognized and commercialized city. Istanbul's economic and strategic importance is mainly acquired from its connection to both Asia and Europe (Figure 2-2). Furthermore, the Strait of Bosporus allows an easier access for

commercialization to the Black Sea, the Marmara Sea, the Aegean Sea and the Mediterranean Sea.

Figure 2- 2 Istanbul

The people of Turkey, especially from eastern Turkey, prefer to migrate to Istanbul so that they can improve their standard of living (Figure 2-3). Before reaching its population capacity, Istanbul could satisfy the needs of its residents in a well developed urban plan and environment setting. However, nowadays the uncontrollable migration has resulted in overpopulation and ugly urban development.

Figure 2- 3 Map of Turkey

In order to reduce the number of people influenced by the expected upcoming earthquake and tsunami, Canakkale would prove to be a good alternative. In Turkey, Canakkale has similar advantages to Istanbul in commercialization due to its geographical location (Figure 2-4). It is located on a Strait of Bosporus which connects the Aegean Sea to the Marmara Sea. It also can connect Asia to Europe if a bridge was built. However, it has not been as populated or as commercialized as Istanbul. With proper planning, Canakkale will be a good alternative since Canakkale has Istanbul's similar attractive elements.

D) DATA COLLECTION

a) Fifth National Conference on Earthquake Engineering:

- Contains 121 files from the cd bought from Istanbul Technical University about earthquakes mainly researches done by academicians

b) Newspaper Articles from Turkey Containing Data on Earthquakes and Tsunami:

- Futuristic assumptions on how bad it will be.

c) Information Provided by the Government of Turkish Republic:

- Population Data
- Building Data
- Maps
- Infrastructure
- The actions to be taken after earthquake
- Human conditions from personal and tourist information

d) Interviews with:

- Mr. Tamer Hergunsel: (Mehmet's father) has been in construction businesses in Libya and afterwards in Turkey for more than two decades. He was interviewed about the construction business, his experiences pertaining to this project.
- Mr. Danyal Hergunsel; (Mehmet's uncle) worked in many nonprofit organizations to improve the quality of life in Turkey. He, a metallurgist, also worked as a consultant to the Eregli Steel Co., which is the leading steel producer in Turkey. He discussed his lifetime experiences regarding quality of life in Istanbul.

- Mr. Halil Gokcan, who graduated from Istanbul University, explained his earthquake experience in Istanbul.

e) Google Earth:

- Interactive maps from earth.google.com

f) Survey:

- Information attained will be used to help pick the best alternative

g) Books (listed also in works cited):

- Istanbul and Earthquake by Dr. Ahmet Ercan
- Before and After Earthquake by Mr. Erhan Karaesmen from Atilim University
- The Remaking of Istanbul by Ms. Zeynep Celik
- The Solution to Earthquake in Istanbul by Mr. Ercan Oygun

h) Internet:

- Many sources including pictures will be searched from online

5) DATA ANALYSIS:

Istanbul has become an overcrowded city. Over a span of 3000 years, from BC 2900s to 1950s the population grew by 500,000 people. The population increased significantly over the last 50 years and is now about 14 million. This growth was the result in industries that brought jobs to the area. Businesses targeted the wealthy people of Istanbul, and factories were built in order to fulfill the needs of their customers. This caused a rapid growth in Istanbul's population due to the need for factory workers. Now Istanbul supports 60% of Turkey's economy and is known as the Golden City by its people. Low income families have moved to the city in hopes of finding jobs but have burdened the poorly developed infrastructure. Seventy-five percent of Istanbul's buildings are unplanned and unauthorized. (Ercan 4) Moreover, they are unsafe, not earthquake resistant, disturb historical preservation, and the infrastructure is inadequate for the number of people.

A) SCENARIO 1: DO NOTHING

The first scenario of four describes what the residents of Istanbul are doing at this point in time, in order to address the problem of planning for expected earthquakes or tsunamis. Although there are schools and government institutions are working to make earthquake resistant buildings, no improvements are being made to preserve history or upgrade on infrastructure.

a) Preserve History (Scenario 1):

Istanbul's cultural heritage and its significance to the world are not well known. If Istanbul continues on the same path, many historic buildings will either be ruined or discoveries underneath Istanbul's ground level by the archeologists will not take place. Figure 3-1 shows the torn-down walls that are part of historical heritage and they need restoration.

Figure 3-1 The Torn-down Walls of Istanbul

The majority of the constructions in the historic sites are squatter buildings (See Figure 3-2). They not only break apart the harmony of historic sites but also continue to get taller as the space in Istanbul becomes more limited. Therefore, the government must work harder to preserve historic sites from these illegal settlements.

Figure 3-2 Squatter Settlements around the Historical Sites

Due to illegal, usually squatter settlements, social, physical and land use planning are inadequate in Istanbul (See Figure 3-3). Although the Istanbul community is dissatisfied with the planning situation, the residents of Istanbul have not taken the necessary changes. Furthermore, historic buildings must be protected more since there have been many instances of stolen artifacts, tiles, and many other precious materials that carries Istanbul's cultural importance.

Figure 3-3 Undeveloped Planning in Istanbul

b) Earthquake Safe (Scenario 1):

If there is no action taken, the buildings in Istanbul will continue to be very unsafe. These unsafe buildings will be majorly affected by a devastating earthquake (See Figure 3-4). Hence, the population will be in chaos when the earthquake hits. Buildings in Istanbul do not reflect adequate land use planning since 75 % of the buildings are unauthorized and are done according to inclinations of the builders. Alternative passageways and escape routes are not adequate.

Figure 3-4 Newly Constructed Building Tilted due to an Earthquake

If the government does not address the predicted earthquake disaster (See Figure 3-5), emergency shelters will especially be needed. Even though there are local emergency depots which contain equipment such as shovels and axes, they are completely inadequate to address Istanbul's needs after an earthquake or a tsunami (Hergunsel T. 2006).

Figure 3-5 A Rescue Operation after an Earthquake Disaster.

Professor Mete Sozen from Purdue University and Polat Gulkan from ODTU, along with Senator Ersin Arioglu from Republican Party, had a meeting with the Prime minister of Turkey, Recep Tayip Erdogan midway through November 2005. The meeting's subject was the expected devastating earthquake event and the outcomes of conference, "Race against Time", in Aydin on June 16th, 2005. According to the observations of Turkish and international experts, there is a high possibility for a high magnitude earthquake within 30 years. The fault lines will break about 10 km away from Istanbul; 10% of the human scale buildings near the seacoast will collapse. Additionally, 25% will have to be rebuilt. It is predicted to cost about 60 to 80 billion dollars.

Rescuing responses will substantially be delayed due to the expected earthquake as discussed in the Race against Time conference. The narrow streets will not be usable meanwhile bridges that are not reinforced will not be useable. Furthermore**,** hospitals will not be easily accessible and the airport and ship ports will be inactive. Additionally, mosques and other buildings used for worshiping will suffer collapsing. Also, the petrol and natural gas sources will probably be damaged and result in huge fires. As a result, police, firefighters, and armed forces will not be able to reach to the earthquake regions and will be incapable to help anyone (www.vatanim.com.tr/root.vatan?exec=yazareskiyazilar&wid=11&@@=18&kelime=).

c) Infrastructure (Scenario 1):

It can be expected that the financial center and the infrastructure of Istanbul will collapse as a result of the expected earthquake. City will lose bank information systems, phone lines, computer systems, water, natural gas and energy transportation routes. It is important to remember almost 88% of the bank centers are located in Istanbul; this interruption will directly impact Turkey.

After the predicted Istanbul earthquake, there is a possibility of sea waves being created by the vibrations of the earthquake. If this happens, the low altitude regions may be submerged (See Figure 3-6). All the ship ports and other warehouses could be damaged. All the possible pipelines in the infrastructure might lose their functions.

Figure 3-6 Low Altitude Regions Likely to Submerge due to the Expected Tsunamis

According to the prime ministers instructions, an earthquake coordination foundation should be established and a 25 billion dollar loan taken from the international banks (www.vatanim.com.tr/root.vatan?exec=yazareskiyazilar&wid=11&@@=18&kelime=). The prime minister told the participating scientists to give him more time to take these steps first and then inform the public. There are talks but not enough actions to solve Istanbul's problems.

B) SCENARIO 2: REINFORCE AND REBUILD

No matter how difficult the planning and the economic struggle may be, the cultural feeling and the atmosphere in Istanbul provides a natural, compelling feeling which attracts the residents to remain a part of Istanbul. Therefore, the second scenario will deal with strengthening the existing buildings or tearing down the weak buildings and rebuilding, as needed.

a) Objective 1: Preserve History (Scenario 2)

For over 1500 years Istanbul was the capital for two prominent empires; the Byzantine and Ottoman Empire. Istanbul has become a city of cultural importance over the centuries. The areas of Old Istanbul and Uskudar should be declared as official cultural centers by the Municipality of Istanbul because of many cultural assets in the regions shown on Figure 3-7:

Figure 3-7 Historically Prominent Old Istanbul and Uskudar sites

As Danyal Hergunsel indicated in his interview (2006), “Istanbul is not just Turkish people’s land but a land for all in this world because it has so much history to offer to the world.” Therefore, Turkey as well as other countries must come to the understanding of Istanbul’s historic importance (See Figure 3-8). Repairing or reinforcing the historic constructions without damaging or altering is a serious task that needs to be carefully considered.

Figure 3-8 Historically Prominent Commerical City- Old Istanbul & Beyoglu

1) **Construction (Preserve History- Scenario 2):**

The construction around the historic sites must be stopped immediately (See Figure 3-9). Any non-historic building around the historic buildings should gradually be removed within one mile distance where archeological excavations can be initiated to discover what is beneath Istanbul, which will reflect the cultural importance of the city.

Figure 3-9 Many Unplanned Buildings Crowding Historic Galata Tower in Beyoglu, Istanbul

If there is any construction close to the historic towns, it must match the original construction styles. Using similar types of architectural styles and materials would enable the constructions to blend in with the historic towns.

The careful restorations of historic buildings to their original states also must take place in order to preserve history. More open space around the historical monuments is needed to preserve history and earthquake safety of the historical sites. This space can be

obtained by tearing down the unstable buildings and rebuilding in different region. Then, archeologists can excavate to discover more possible priceless monuments and not damage any historical heritage. This will prevent a repeat of what happened in the construction of the underground subway in Aksaray-Kartaltepe area. As it can be seen from the figure 3-10, lack of restoration many of historical buildings results in severe and irreparable damages.

Figure 3-10 A Typical Historic Villa ruined due to Lack of Restorations

2) **Population (Preserve History- Scenario 2):**

The historic locations must be preserved as national heritage. Therefore, the residents must be moved to newly developed villages in Istanbul, especially around the Black Sea coast (See Figure 3-11). By eliminating the dense population and construction, the historic sites can gain more space, giving chance to more archeological excavations and discoveries. The newly found archaeological treasures of Istanbul would definitely show a city of rich cultural heritage and assets. The new discoveries can bring more attraction from tourists and lead to a better recognition of Istanbul. To make more tourist visits possible, only hotels should be built near the historic towns. In turn, the Municipality of Istanbul will gain higher revenue due to the increase in tourist attraction and Istanbul's cultural significance will be reflected all over the world.

Figure 3-11 Unattractive, Unplanned and Undeveloped Residences close to Blue Mosque

3) **Government (Preserve History- Scenario 2):**

The government needs to take control of the renovation of historic sites. It cannot allow any construction in these places (See Figure 3-12), since priceless historic assets can be damaged during the construction. Instead, the government should support excavation to expose and share cultural heritage. The buildings, such as hotels built around historic towns must harmoniously match the historic buildings styles and designs. Also, the government needs to choose local residents to assist the government with supervising and taking the appropriate actions to move the residents from these cities.

Figure 3-12 Cacaphonic constructions over the past 50 year in the Old Istanbul

4) **Social & Land use Planning (Preserve History- Scenario 2):**

The buildings around the historic towns have to be human scale and fit in with the surrounding environment. Restricting construction in historic towns will enable Istanbul to become a greener and more attractive city (See Figure 3-13). In addition to this, poverty needs to be eliminated to make the city more attractive. Health centers and shelters for the poor have to be provided. These common needs of Istanbul community must be satisfied.

Figure 3-13 Green and Attractive Dolmabahce Palace in Besiktas, Istanbul

b) Objective 2: Earthquake Safe (Scenario 2)

Since 75 to 80% of the construction in Istanbul is not able to withstand a possible earthquake of 7.5 Richter scale magnitude, either reconstruction or reinforcement of the buildings is necessary. This will depend on how structurally sound a building is found to be. The residents of the areas where the tsunami will hit, on the Marmara Sea Coasts of Istanbul, must be moved to the newly planned development areas on the Black Sea Coast of Istanbul.

1) **Construction (Earthquake Safe-Scenario 2):**

Starting from the foundation of a building, all constructions must be tested for earthquake resistance. After the Kocaeli Earthquake in 1999, the government has been enforcing regulations and policies regarding the construction of buildings. In addition to retrofitting unstable building, the new developments must be planned according to emergency evacuation, human needs, and earthquake resistance regulations. Moreover, one of the tasks the government will have to undertake will be to remove the buildings from the Marmara Sea Coasts where the tsunamis will hit. Then, these areas should be kept as green space.

Figure 3-14 Structurally Unsound Buildings after Kocaeli Earthquake in 1999

2) Population (Earthquake Safe-Scenario 2):

The new urban plan for Istanbul will provide the security to the residents without moving them outside of the city. However, the population density will change in some towns. Tsunami danger zone residents will have to be moved into safe zones (See Figure 3-15). Those that are in earthquake danger zones will have to be moved to temporary locations while their houses are being rebuilt (See Figure 3-15).

Figure 3-15 All Residents in Tsunami Danger Zones must be Moved

Figure 3-16 Very High Population Density near Tsunami Danger Zones

3) **Government (Earthquake Safe-Scenario 2):**

The government must not tolerate poor construction and must keep increasing pressure on its agencies to enforce the regulations and policies of earthquake resistant construction. The local governments must also start taking responsibility with respect to disaster management. All the retrofitting processes, the clearance of unstable unauthorized buildings, and the rebuilding must be done under the supervision of the government officials.

4) **Social Planning (Earthquake Safe-Scenario 2):**

In the case of an expected tsunami or earthquake, the provisions and shelter for residents must be met according to governmental disaster prevention program. The human needs must always be taken into account. Hospitals, communication centers, fire-stations, police quarters, major commercial centers and storage facilities must be prepared and ready before the disasters to be able to provide emergency services after the disasters. Moreover, cars should not park on narrow streets and must be towed in order for emergency response teams to act quickly to a disaster (See Figure 3-17).

Figure 3-17 Emergency Responses Delayed due to Cars Parked on Narrow Streets

5) **Physical Planning (Earthquake Safe-Scenario 2):**

Due to the expected earthquake, alternative passageways must be built. All buildings must be human scale and multidimensional.

6) **Land Use Planning (Earthquake Safe-Scenario 2):**

Municipal parks, street layout, recreation facilities, zoning and location of public buildings, as well as other design elements, are all components of a community that can encourage the standard the quality of living. Land use policies and programs that support the standard of living should consider better zoning plans, greener redevelopment. There also must be more effective programs to implement all the zoning and other policies for the land use control.

7) **Cover expenses (Earthquake Safe-Scenario 2):**

The expenses of scenario 2 must be taken as the responsibility of the entire community. The City must be ready to insure and provide the necessary needs for the people who will be waiting for their new buildings in other areas, due to the teardown-rebuild process of unstable and unauthorized buildings. Furthermore, the earthquake insurance must be ready to cover most of the expenses of those displaced after earthquakes, if the buildings collapse (See Figure 3-18). In order for this to happen, the government must require the residents to pay for earthquake insurance. Also, the government must look into other funds and revenues to cover expenses for earthquake readiness programs, planning, and aftermath.

Figure 3-18 The earthquake insurance will hopefully cover the unexpected building damages resulted by earthquakes

c) Objective 3: Infrastructure (Scenario 2):

The infrastructure of Istanbul must be repaired or renewed in many parts of the city since Istanbul does not have satisfactory infrastructure for most of the city. Usually during the day, water shortages and electricity outages are common parts of people's lives and they rely heavily on coal for heat, which adds to pollution (See Figure 3-19).

Figure 3-19 The Effect of the Usage of Coal Heating Systems and Car Gasses in Istanbul

One of the problems of Istanbul is the lack of natural gas pipes, which have only been added to the infrastructure in a few parts of the city. Without switching to the natural gas, the air pollution from the coal heating will continue to increase. Another problem is that not enough waste water and treatment plants are built. The houses surrounding the water supply reservoirs must be prevented from polluting the drinkable water. The Strait of Bosporus must be cleaned up of any toxic waste. Depending on how good the infrastructure is, the population density may have to be reduced in some towns, and in others the pipes must be upgraded and the roads improved for better access.

1) **Population (Infrastructure- Scenario 2):**

In most of the towns in Istanbul, the population density must be decreased since the infrastructure is not sufficient enough to handle the present density. Ideally, a satisfactory infrastructure could be built to address that problem. However, it would be very expensive since there is not enough space to construct pipes that would increase the infrastructure capabilities to cope with the people's many other difficulties.

2) **Establish Emergency responses (Infrastructure- Scenario 2):**

Alternative roadways must be established in order to respond to any kind of disaster on time (See Figure 3-20).

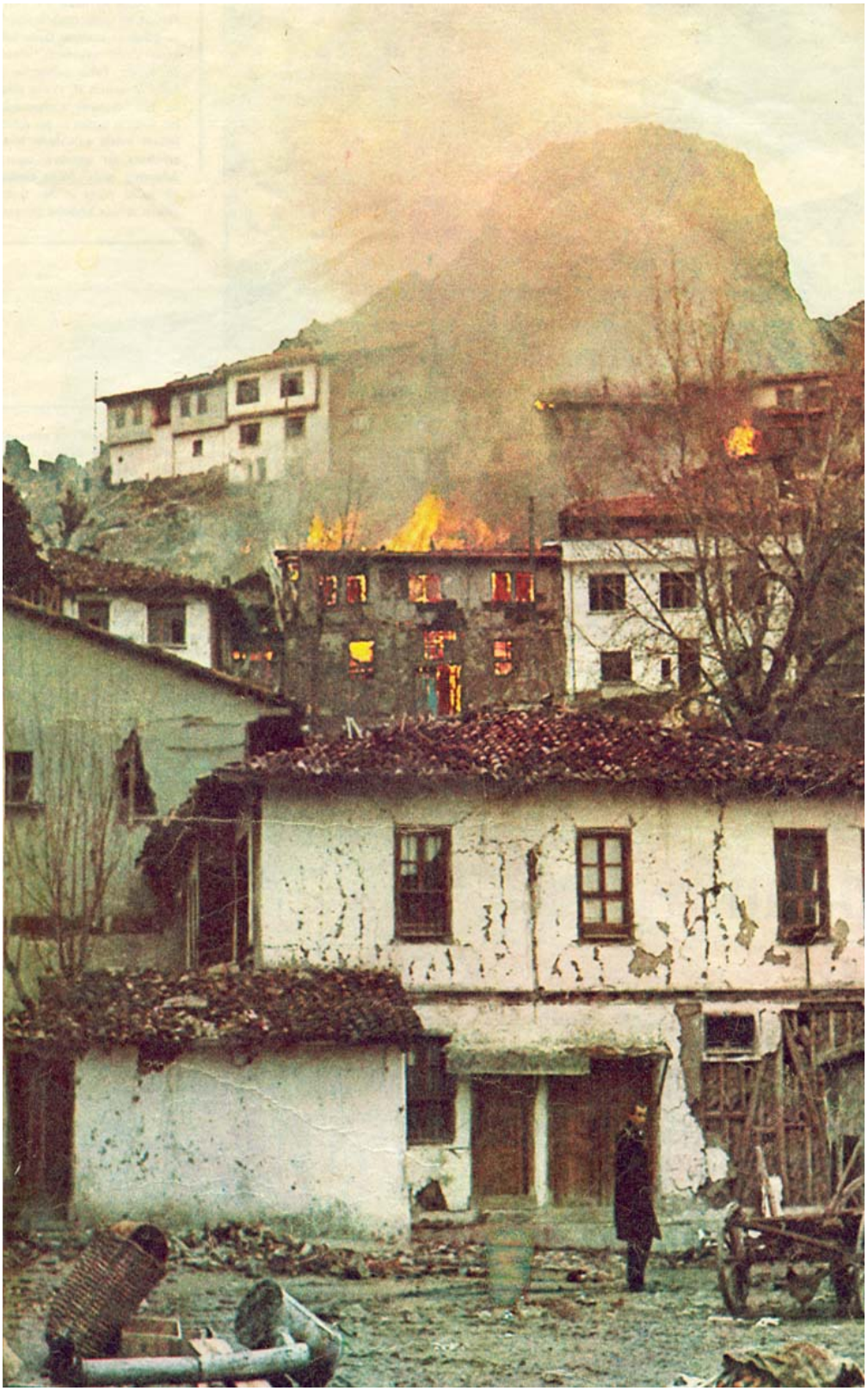


Figure 3-10 Inadequate Emergency Responses due to Insufficient Infrastructure

3) **Government (Infrastructure- Scenario 2):**

The government has the responsibility through city planning and brings an end to unauthorized construction. The City must not only plan economically, but also, the most sufficient solution to improve the quality of life for the people of Istanbul.

Figure 3-21 Streets Just for the Pedestrians in Between Human Scale Buildings Needed to Provide a Harmonious Sense of Community

4) **Social/Physical (Infrastructure- Scenario 2):**

Social and physical planning must be implemented in accordance with the needs of the community. As a result, the cultural heritage must be preserved by isolating it from the squatter settlements, unstable buildings, and commercial buildings within the City.

C) SCENARIO 3: HIGHRISE BUILDINGS

75% of the buildings in Istanbul are crooked illegal and unauthorized settlements with two thirds being gecekondus (squatter settlements) and the other third being unplanned buildings without permit. The cost to the city will be more than the benefit to rebuild or strengthen these buildings. One solution would be to tear down all of the crooked and unauthorized buildings and replace them with 10 to 15-story tall buildings. This will preserve history, achieve earthquake safety, and build responsible infrastructure.

a) Objective 1 Preserve History (Scenario 3):

High-rise buildings will help preserve historical sites and enable Istanbul to have more parks and green spaces around historical sites.

1) Construction (Preserve History- Scenario 3):

To preserve history, squatter settlements around the historical sites and potential high-rise construction sites must be removed. Furthermore, the historical buildings should be strengthened and renovated. Ten to fifteen story tall buildings should only be constructed on non-historical sites and in newly built parts of Istanbul. Therefore, the residents of these squatter settlements living around the historic buildings need to be moved to places such as shown in figure 3-22:

Figure 3-22 High-rise Construction with Open Space

2) **Population (Preserve History- Scenario 3):**

The reduction of squatter and other unauthorized settlements near historical sites will increase opportunity for tourism (See Scenario 4 for more details on tourism in Istanbul). Therefore, population near the historical sites will be reduced. The high-rise buildings will enable residents to move from the historic places to newly developed high-rise construction complexes (See Figure 3-23).

Figure 3-23 High-rise Construction in a Non-Historic Site

3) Government (Preserve History- Scenario 3):

New governmental agencies must be formed to enforce and regulate construction policies. By using preventive policies, many unauthorized buildings will be demolished in the historic sites. The residents of these buildings will be encouraged to move into the newly built high-rise complexes. Therefore, historic sites can be appealing and naturally friendly as shown in Figure 3-24.

Figure 3-24 Naturally Friendly Dolmabahce Palace in Besiktas, Istanbul

4) Social Planning (Preserve History- Scenario 3):

War on poverty will be more successful since there is likely to be more tourist attraction around the historic sites. Once the tourism industry develops, the economy will be boosted by more job opportunities and this will in turn decrease poverty. In addition to economic improvements, the historical sites will have nature friendly building as shown in figure below:

5) **Physical Planning (Preserve History- Scenario 3):**

By determining buildings which will potentially collapse in the expected earthquake, the structurally weak buildings will be demolished. In turn, structurally stable and taller buildings will be built on non-historical sites. This will provide more green space.

Figure 3-25 High-rise Constructions and Green Space

6) **Land Use Planning (Preserve History- Scenario 3):**

High-rise buildings must not be built near historical places to keep the cultural heritage pure and attractive to both the residents and the tourists.

b) Objective 2: Earthquake Safe (Scenario 3)

High-rise constructions will be earthquake safe and enable safe evacuation.

1) **Construction (Earthquake Safe- Scenario 3):**

Only the 8% of the construction in Istanbul is legally permitted according to the government records (Ercan 18). The majority of construction, regardless of authorization, is unsafe and will be hazardous in the event of an earthquake as shown in the figure 3-26, which a taken after the Yalova Earthquake in 1999. Therefore, high-rise constructions should be built to enable an alternative for the residents of the squatter settlements.

Figure 3- 26 A demolished building after the Yalova Earthquake in 1999

2) Population (Earthquake Safe- Scenario 3):

If no action is made towards moving the residents from the danger zones (See Figure 3-27) to these alternatives before the next expected earthquake, the potential numbers of homeless people will be about 4.5 million people out of fifteen million people (Ercan 15). Whether that many people can potentially be relocated to high-rise buildings in non-earthquake zones could be difficult.

Figure 3-27 Squatter Settlements

3) Government (Earthquake Safe- Scenario 3):

For high-rise constructions, the approximate cost for a 4.3 person family will be 20 thousand dollars (Ercan 22). The government should provide people with mortgages for these newly built buildings and it has taken the initiative to make this scenario possible. For a 20 year mortgage, the expected payment will be around 1000 dollars per year (not accounting for the interest rate). The entire construction is expected to be completed in five years.

4) Social Planning (Earthquake Safe- Scenario 3):

Tall buildings will open more green space allowing parks to be built. However, this will also provide space for more parking lots, which will detract from the goal of

social planning. Instead of using the space as parking lots, sufficient space (See Figure 3-28) should be left for homeless people to shelter on in case of a disaster (See Figure 3-29).

Figure 3-28 A 3D Projection of High-rise Construction with Green Space Available

Figure 3-29 Space is an important factor on where to place the shelters

5) Physical & Land Use Planning (Earthquake Safe- Scenario 3):

The typical high-rise constructions do not reflect physical or land use planning. They lack both human scale and sense of place (See Figure 3-30), although high rise constructions enable green space and parks. Ideally, land use and physical planning can be accomplished by building to imitate plateau elevation.

Figure 3-30 Lacks Human Scale and Sense of Place

6) Cover expenses of displaced (Earthquake Safe- Scenario 3):

The Turkish Republic started the mandatory earthquake insurance program for all residents of Turkey in 1999 after the devastating Kocaeli earthquake when almost more than forty thousand people lost their lives. The basic goals of this mandatory earthquake insurance are:

- To fully insure all the buildings in the coverage area with a reasonable monthly payment.
- To distribute the monetary risk, that will result from the earthquake damages, to the reinsurance and capital markets by utilizing the insurance program internationally.
- To reduce the government's monetary debt which will result from the earthquakes.
- To use the insurance system as a tool for safe and sound constructions.
- To elicit the collected long term sources in order to compensate for the earthquake damages.
- To have better community insurance consciousness.

(http://www.dask.gov.tr/bilgi/sss.htm)

c) Objective 3: Infrastructure (Scenario 3)

Nature should definitely be taken into account when building the infrastructure. In this scenario, the infrastructure could be more substantial due to a possibility of higher densities within the city.

1) Establish Emergency Responses (Infrastructure - Scenario 3):

City streets in newly built high-rise complexes must meet the maximum size standards for an emergency team to be able to respond efficiently (See Figure 3-31). However, in the events of an emergency, high rise construction will shed their walls. Therefore, residents must be informed regarding this issue.

Figure 3-31 Establish Maximum High-rise Construction Standards

2) Government (Infrastructure - Scenario 3):

High capacity infrastructures must be planned and eventually approved by the government. The population near high-rise complexes will be dense. Therefore, the government should build subways to increase the capabilities of mass transportation.

3) Social/ Physical (Infrastructure - Scenario 3):

As stated before, in the first scenario, the social and physical planning must allow for reasonable environmental analysis that would harmoniously fit nature into city planning as a friendly tool to accomplish our objectives. From bridges to roads, the planning should consider alternative passageways that can be useful in the event of an emergency. The best health facilities and shelters must be built with possible space around them in order to make a sufficient social plan.

D) SCENARIO 4: MOVE INHABITANTS TO CANAKKALE

Turkey is made of two peninsulas which provides the opportunity for commercialization based on transportation and shipping. Moving some of the inhabitants of Istanbul to any sea coast city would be reasonable as long as the infrastructure for commercialization is provided.

Canakkale is the ideal city since it shares similar geographical features. Istanbul and Canakkale both have straits connecting to the Sea of Marmara and both have lands in Asia and Europe. This geography enables moving some of inhabitants from Istanbul to Canakkale and will provide similar economic opportunities.

Figure 3-32 A Suitable Location for Moving the Inhabitants of Istanbul

Ideally, businessmen in need of access to the Aegean Sea can move their companies to Canakkale. The government will have to provide incentive for institutions to relocate. Once the job market developed, the residents of Istanbul will follow it and move into Canakkale.

a) Objective 1: Preserve History (Scenario 4)

Dense construction in historical sites presents a unique problem of its own. The historical sites must be sustained to preserve the cultural heritage of Istanbul. In order to protect the cultural assets, the municipality of Istanbul must limit, enforce, and regulate the construction at these historic sites and their surroundings.

The picture below shows the malformed settlement, historic buildings, and high-rise construction mixed together, forming an ugly urban site. This figure clearly depicts the unharmonious nature of unplanned development. Therefore, construction should not be allowed near historic sites, and architecturally incompatible buildings must be eliminated, unlike the cacophonic construction shown on Figure 3-33:

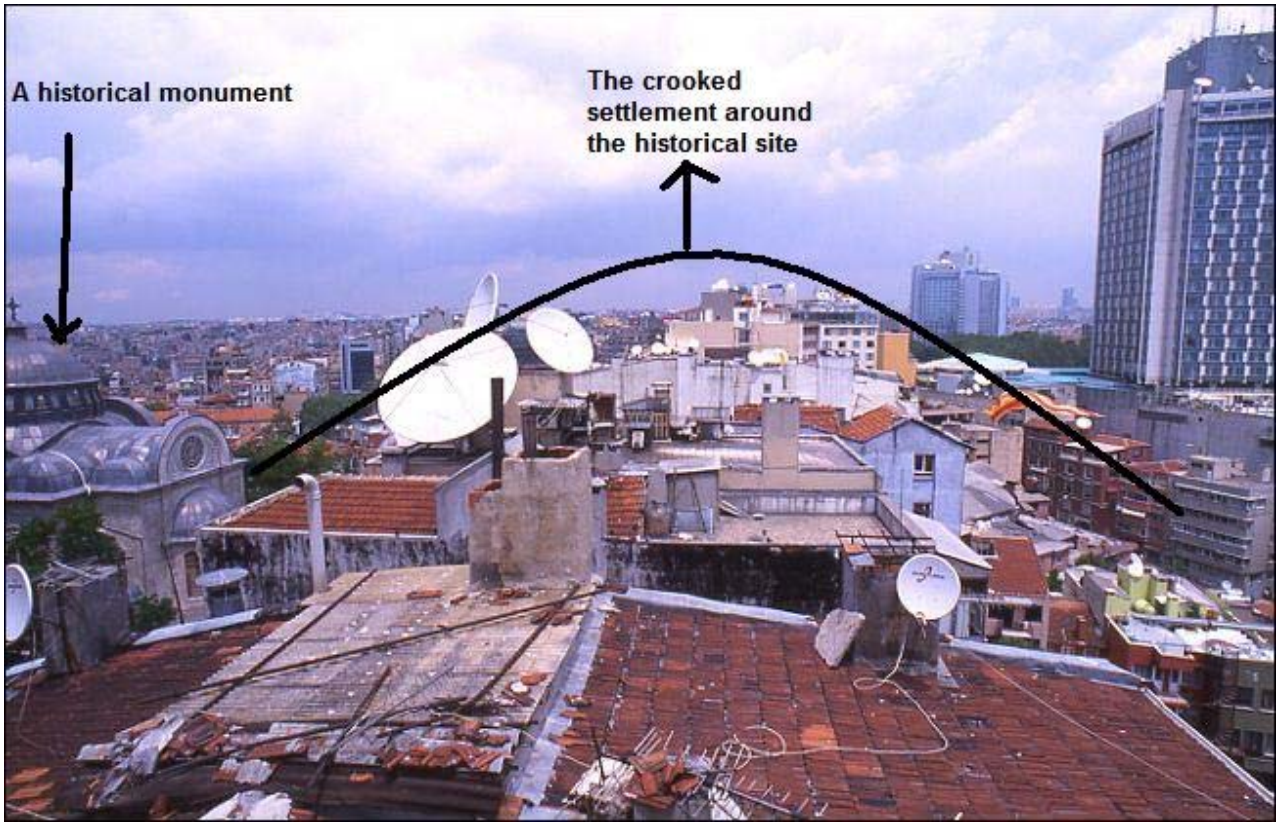


Figure 3-33 Cacaphonic Dense Constructions near a Historic Site

1) Population (Preserve History- Scenario 4):

In order to have Istanbul identified as a prestigious historic city, the historic sites must be cleared of construction or overcrowding population. Badly planned developments must be eliminated and only the monumental buildings should be kept. As a result, an estimated 90% of the residents at the historic sites must be moved to Canakkale and the rest of the people can remain to help support the cultural values. The figure 3-34 shows the assumed 2006 population in relation to 1997 and 2000 population data attained from Municipality of Istanbul website:

Istanbul	Population			Density		1997->2000	2006 Assumed	
Towns	1997	2000	Area(mile²)	1997	2000	Change %	Population	Density
Beyoglu	231826	234964	3.47	66714	67617	1.34	240000	69066
Eminönü	65246	55548	3.09	21123	17984	-17.46	60000	19425
Fatih	432590	407991	5.02	86185	81284	-6.03	415000	82680
Üsküdar	472124	496402	17.76	26583	27949	4.89	530000	29841
Total	1201786	1194905	29.34	40955	40721	-0.58	1245000	42428

Figure 3-34 Population and Density Table for the Major Historical Towns in Istanbul

Cannakale has a low population density. Figure 3-35 indicates the 1990 and 2000 census of Canakkale:

Canakkale	Population			Density	
Towns	1990	2000	Area(mile²)	1990	2000
Main Town	81435	104205	366.41	222	284
Ayvacik	30534	30502	337.45	90	90
Bayramic	31949	32314	492.28	65	66
Biga	75513	77169	513.90	147	150
Bozcaada	1903	2427	13.90	137	175
Can	51713	52929	664.87	78	80
Eceabat	9671	9929	189.19	51	52
Ezine	34234	35301	183.01	187	193
Gelibolu	40020	46226	311.20	129	149
Gokceada	7948	8875	107.72	74	82
Lapseki	24545	26034	368.73	67	71
Yenice	42798	39064	527.80	81	74
Total	432263	464975	4076.47	106	114

Figure 3-35 Table of low population towns in Canakkale.

2) Construction (Preserve History- Scenario 4):

75% of the buildings in Istanbul are not structurally sound or authorized. They must be torn down, leaving only harmonious historic monuments and assets (Ercan 3). Residents moving to the newly developed towns in Canakkale should be provided with buildings that are constructed to be unique, attractive, to human scale, and structurally sound.

Historical sites are surrounded by cacophonous buildings that are architecturally conflicting. The elaborate architecture typical of Turkey has diminished over the last 50 years. The building shown in Figure 3-36 depicts the undesired architecture as a result of unplanned constructions. Furthermore, the mosque seen in the middle of the figure reflects its state of isolation, as if the technology and new constructions - such as the factory, shopping center and other buildings - have taken over of its monumental importance.

Figure 3-36 Undesired Architecture due to Unplanned Constructions

3) Government (Preserve History- Scenario 4):

Historical sites have been a tourist attraction earning large profits for the country. The government should protect this lucrative business and history. Furthermore, it can gain a global reputation again by restricting construction near historic sites. The traffic which has always been troubling Istanbul over the past few decades presents another problem. Moving the residents to Canakkale will both boost tourism and make the city's traffic more comfortable. Figure 3-37 shows on the Galata Tower, a historical monument in the middle of overcrowding settlement:

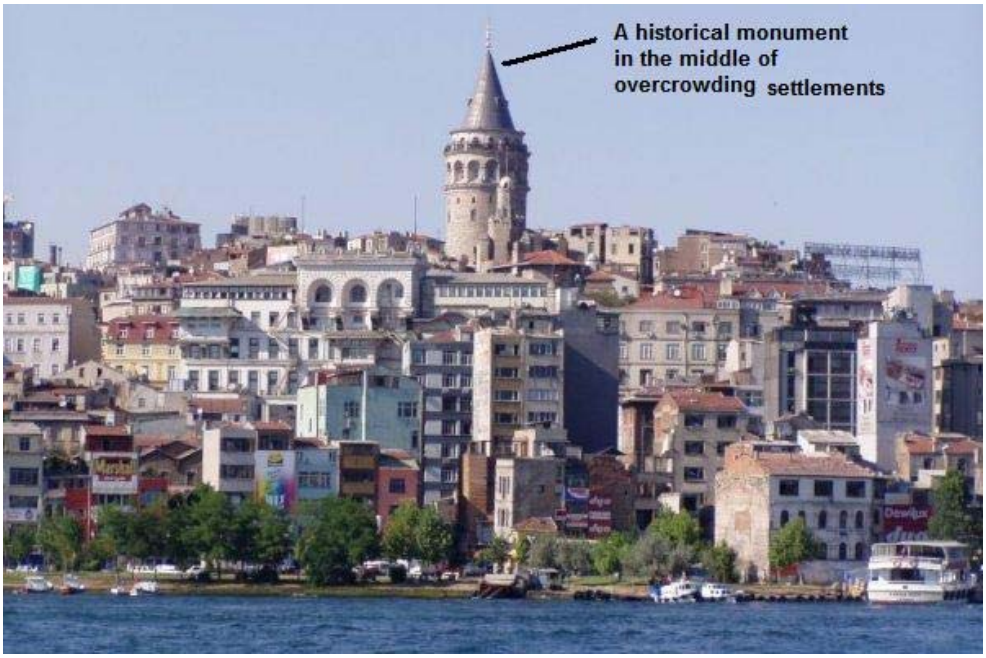


Figure 3-37 Overcrowding Settlements around the Galata Tower in Beyoglu, Istanbul

To give a reason or motivation for people to move to Canakkale, the government will have to provide investors to investors to move as well as providing them with adequate infrastructure and other necessary needs. Therefore, the factories and companies could be built to provide people with jobs, causing migration from Istanbul to Canakkale. The government must have the support and the commitment of institutions at all levels (local, provincial, and national) to enforce and apply laws that will help moving

inhabitants to Canakkale. There must be policy to cover the expenses of the displaced residents and should provide them with shelters if needed. The government must form agencies and governmental institutions that can implement rules for reducing the population, and form better social, physical, and land use planning.

4) Social Planning (Preserve History- Scenario 4):

The concept of "built vs. natural environment" is an important concept to be considered in historical sites of Istanbul. History should integrate into nature. If unauthorized, unplanned or cacophonic buildings around or near the historic sites are not removed, the importance of cultural heritage and prestigious monuments can be lost.

Figure 3-38 Elimination of unauthorized and undesirable buildings around historical sites will reintegrate the history with nature

The historical sites are not just important monuments for Turkish culture but for the whole world as well. If the historic sites are easier to access and more attractive, then they can be marketed and more people will want to see them. Tourists (Figure 3-41 and 3-42) will bring revenue to the Turkish economy. Figures 3-39 and 3-40 show the foreign

travel into Turkey as well as into Istanbul and indicate that there is a potential for a larger tourism industry:

Comparison of Foreign Excursionists by Provinces of Entry and Years in 2002-2004

Provinces of Entry and Means of Transport				Years			% Share			Rate Of Change (%)	
				2002	2003	2004	2002	2003	2004	2003/02	2004/03
İSTANBUL	Karaköy (D)	DENiZ	Sea	102 880	182 050	145 734	0.22	0.26	0.21	76.95	-19.95
Turkey	**Totoal**			466 201	688 602	690 846	100.00	100.00	100.00	47.70	0.33

Figure 3-39 Comparison of Foreign Excursionists by Provinces of Entry and Years in 2002-2004

Distribution of Foreigners Departing from Turkey by Provinces of Exit and Means of Transport-2004

	Means of Transport					
Provinces	Air	Land	Train	Sea	Total	%Share
İSTANBUL	3 344 795			188 248	3 533 043	20.57
Turkey-Total	12 510 459	3 453 963	59 612	1 152 755	17 176 789	100.00

Figure 3-40 Distribution of Foreigners Departing from Turkey (2004)

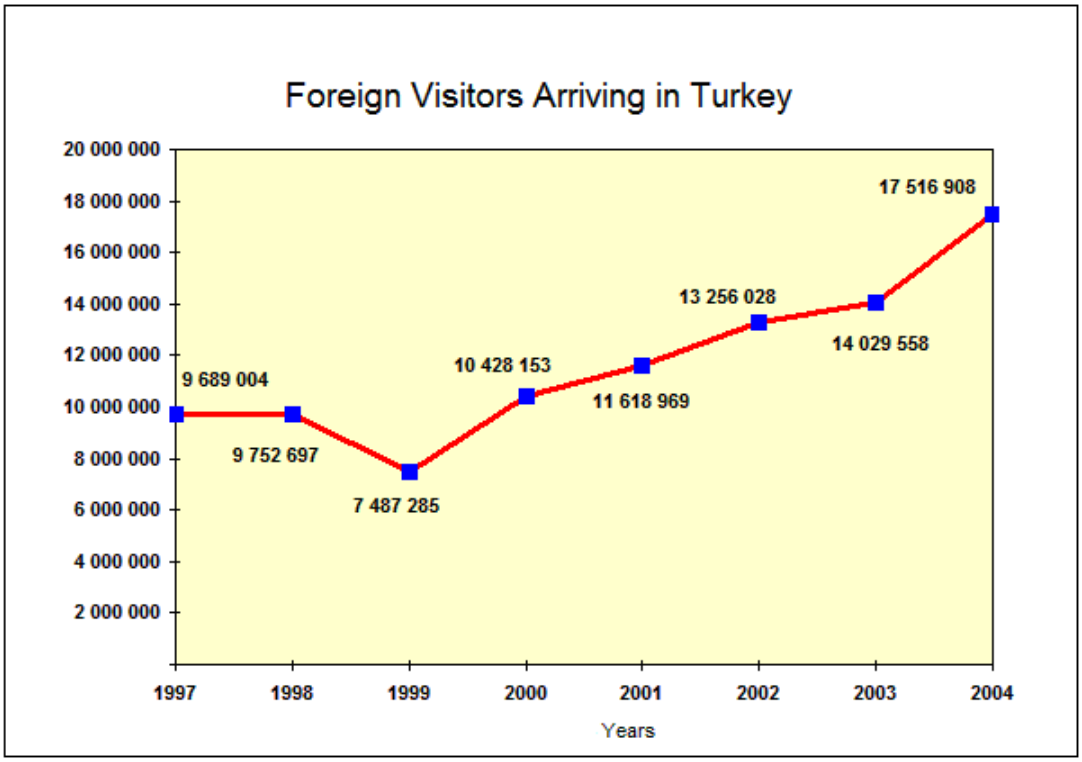


Figure 3-41 The Graph of Foreign Visits to Turkey

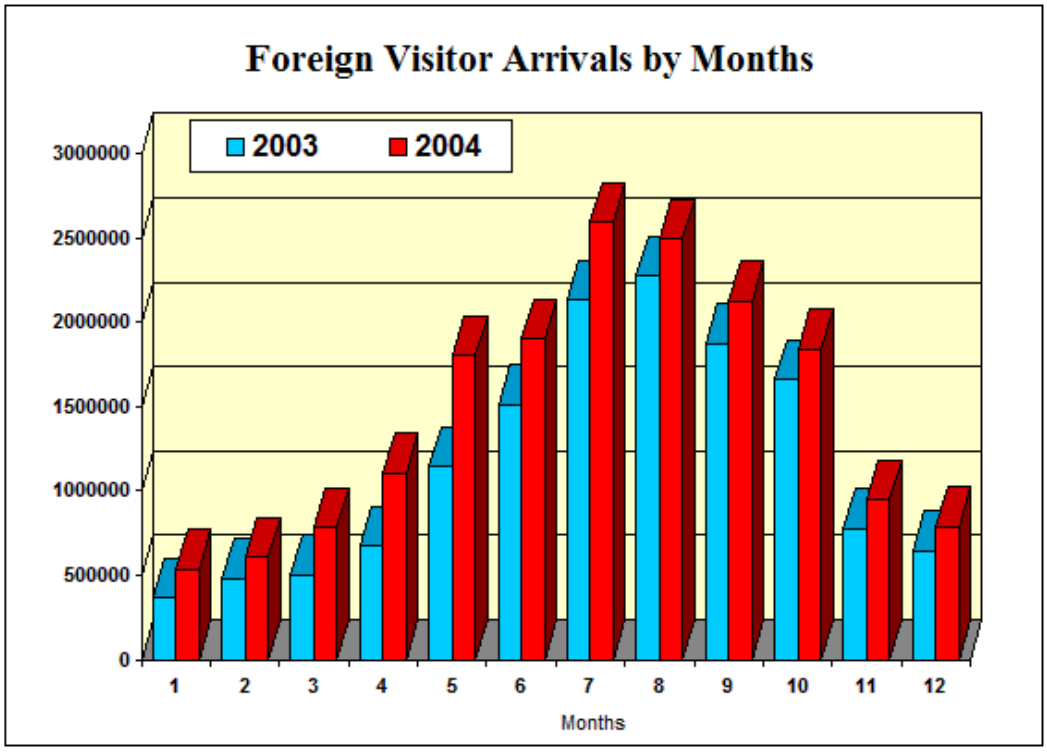


Figure 3-42 The graph of foreign arrivals to Turkeyby months

5) Physical Planning (Preserve History- Scenario 4):

The physical planning must be encouraged more towards multidimensional buildings and alternative passageways in order to preserve the monumentality of historic buildings provide more tourist accommodations in Istanbul and have a good sense of community in Canakkale.

Figure 3- 43 Alternative Passageways

6) Land Use Planning (Preserve History- Scenario 4):

When moving the population, human needs must be satisfied. The newly formed towns in Canakkale must have a cultural center for people's leisure times. Community needs such as schools, hospitals and grocery stores must be met. The allowable zoning laws must be enforced by the governmental agencies in order to have easy access to cultural heritage.

b) Objective 2: Earthquake & Tsunami safe (Scenario 4)

Earthquakes and tsunami are likely to occur in the near future, and it will take everyone's efforts to minimize the damages that will arise from them.

1) **Construction (Earthquake & Tsunami safe- Scenario 4):**

The buildings in Istanbul must be inspected for earthquake resistance. Since 75% of the buildings are structurally very weak, then at least 75% of the residents of these buildings must be moved to Canakkale. Also, the regions likely to be hit by a tsunami should be evacuated immediately for the safety of people. Figure 3-44 shows the towns of Istanbul and their populations that will be directly affected by earthquake and tsunami:

Istanbul	Population			Density		1997->2000	2006 Assumed	
Towns	1997	2000	Area(mile²)	1997	2000	Change %	Population	Density
Avcilar	214621	235113	15.06	14253	15614	8.72	290000	19259
Bakirköy	222336	208223	12.36	17995	16853	-6.78	210000	16997
Eminönü	65246	55548	3.09	21123	17984	-17.46	60000	19425
Fatih	432590	407991	5.02	86185	81284	-6.03	415000	82680
Kadiköy	699379	661953	15.44	45285	42861	-5.65	670000	43382
Kartal	362175	407034	13.13	27589	31006	11.02	475000	36184
Maltepe	335539	358231	43.63	7691	8211	6.33	400000	9168
Pendik	339759	382936	61.00	5569	6277	11.28	470000	7704
Üsküdar	472124	496402	17.76	26583	27949	4.89	530000	29841
Zeytinburnu	228786	244063	4.63	49379	52677	6.26	280000	60433
Total	3372555	3457494	191.12	17646	18091	2.46	3800000	19883

Figure 3-44 Population and Density Table of Towns That Are Going to be Extremely Affected by Earthquakes and Tsunamis in Istanbul

2) Population (Earthquake & Tsunami safe- Scenario 4):

The population of the cities that will be highly impacted by a tsunami (Figure 3-45, 3-46, and 3-47) must be moved to safe parts of Canakkale. The earthquake will also cause lots of devastation. Thus, it is important to make sure the population in danger zones are relatively low (none where tsunami is severe and 25% of population where

earthquake will be felt the most; “gecekondu” (squatter) residents are in need of an alternative solution.

Figure 3-45 Map of overpopulated regions in Istanbul

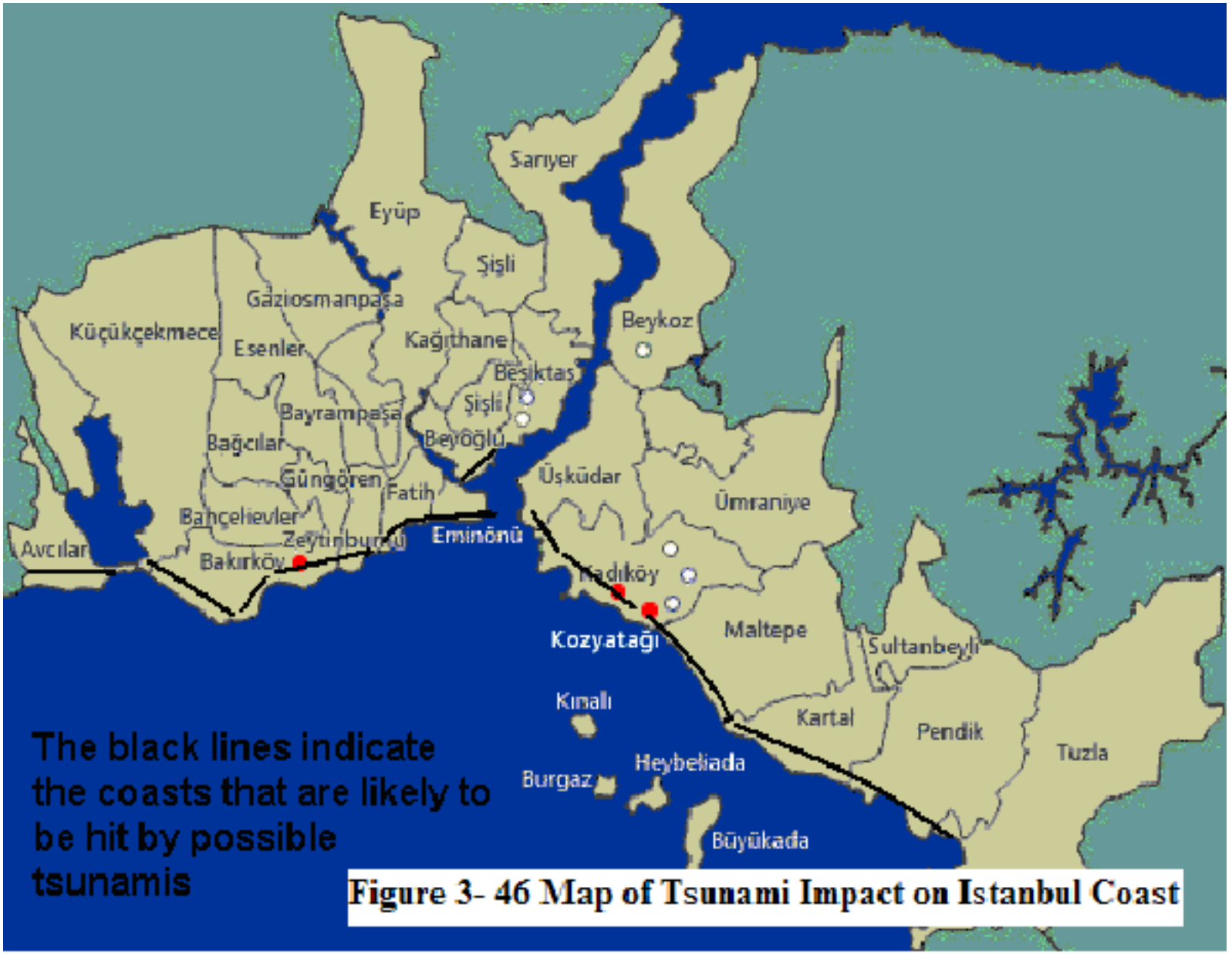


Figure 3- 46 Map of Tsunami Impact on Istanbul Coast

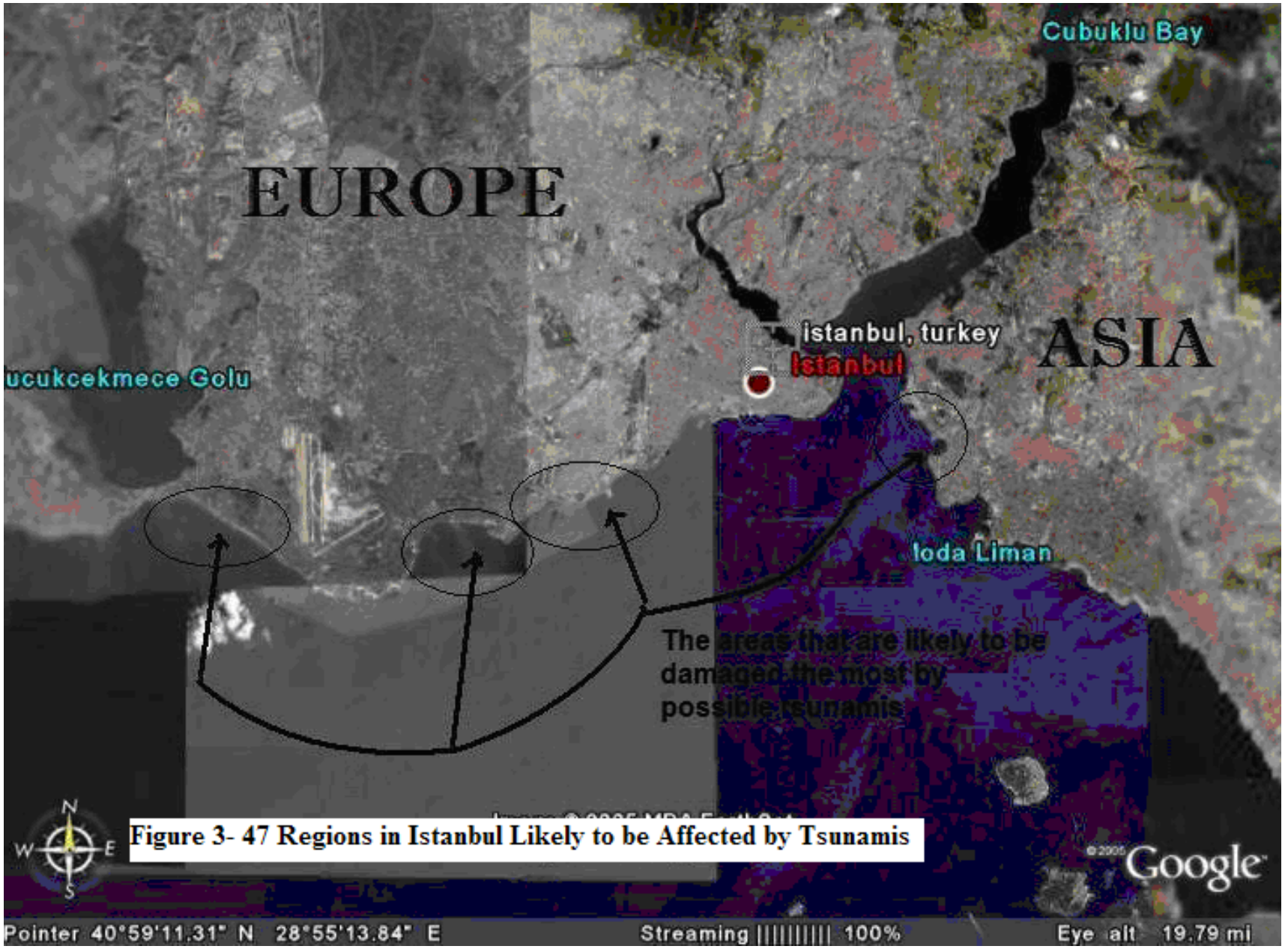


Figure 3- 47 Regions in Istanbul Likely to be Affected by Tsunamis

3) Government (Earthquake & Tsunami safe- Scenario 4):

In order to improve planning in Istanbul, many governmental and non-governmental organizations and institutions have recognized the need to have an Earthquake Master Plan. This Plan was mainly motivated by a request from the Metropolitan Municipality of Istanbul to a group of four prominent Istanbul universities which worked on earthquake preparedness studies of Istanbul. This Plan emphasized reducing the impact of earthquake disasters as well as responding to and coping with their consequences. Moving residents to Canakkale, which has structurally sound lands, will reduce the impact of an earthquake on the population. The government will have to make all the institutions in Istanbul committed to this kind of responsibility and gradually encourage people to move to Canakkale.

4) Social Planning (Earthquake & Tsunami safe- Scenario 4):

Health services and shelters before and after the disaster will be demanded and must be ready. For this need, voluntary organizations, government, and the community should prepare for emergency shelter constructions so that the Istanbul community will be ready for natural disasters. Fewer shelters will be necessary once a large part of the population has moved to Canakkale (See Figure 3-48).

Figure 3-48 Shelters after a Natural Disaster

5) Physical Planning (Earthquake & Tsunami safe- Scenario 4):

Alternative passageways in urban areas are required during emergency situations. Currently, Istanbul is lacking these passageways. Therefore, eliminating the usage of squatter buildings by moving the inhabitants will reduce the need to redesign the city for earthquake preparedness. Figure 3-49 shows the type of house complexes that are likely to be built in Canakkale:

Figure 3- 49 A preferable Example of an Apartment Complex.

6) Land use Planning (Earthquake & Tsunami safe- Scenario 4):

In Cannakele, local communities should participate in the management of their apartment complexes. To fulfill people's expectations, the residential areas should be within walking distance to the center of the town so that there will be a minimal need for a car or a transportation system. Development and design policies should be enacted so that the engineers will not form ugly shaped buildings and streets. The community should make their voices heard and, in return, zoning policies of the government should be firmly enforced to develop a well thought-out land use plan. Unfortunately, this is unlikely to happen. Rather, an ugly building like shown in figure 3-50 seems to be the

“ideal” solution for residential buildings according to many professors, builders and investors in Turkey:

Figure 3- 50 A 3D Projection of an Apartment Complex with Parking Lots and Parks

7) Cover expenses of displaced (Earthquake & Tsunami safe- Scenario 4):

Displaced people are usually the major problem in earthquake disaster situations. This is why the community should use social planning as means of being prepared. Also, the government should start saving funds from now on to help the displaced. Earthquake insurance may help individuals to receive payments for the damages done to their houses. Moving people to Canakkale will reduce the need for disaster funds. Furthermore, Canakkale can be used as an evacuation area when an earthquake occurs.

c) Objective 3: Infrastructure (Scenario 4)

The condition of infrastructure of Istanbul is a major and a serious troubling problem. It needs to be completely rebuilt or at least reduced to fewer deficiencies. Istanbul has many problems like the water shortages or electricity outages. The capacity of the infrastructure can not handle the population living in Istanbul due to its increase of population from 500000 to 14 million people over the past 50 years.

Constructing Canakkale's infrastructure will not be as complicated compare as repairing Istanbul's because Canakkale's will mostly be built from the beginning (See Figure 3-51). It will be easier to design streets with wider roads, bigger pipes and sewage systems all of which can not be built without the complex problems in Istanbul. In Istanbul would also be very costly to do such infrastructure construction and probably would not completely cover the city. As a result, emphasizing Canakkale's infrastructure work is more favorable since it will attract more people and industries around these populated locations and will not have any infrastructure deficiencies. When industrial development starts taking place in Canakkale, it will create jobs which in return will attract even more people, lessening the population in Istanbul and mitigating some of the problems in the city.

Figure 3- 51 Planning the Pipe Sizes Alleviates Future Infrastrucutral Problems

1) Population (Infrastructure- Scenario 4):

Population, very dense in many towns of Istanbul, should be moved to solve on the urban issues of Istanbul's towns. To enable the capacity of Istanbul's infrastructure to be constructed, areas of high densities in the following towns must be reduced:

Istanbul	Population			Density		1997->2000	2006 Assumed	
Towns	1997	2000	Area(mile²)	1997	2000	Change %	Population	Density
Bagcilar	487896	559694	8.11	23233	26652	14.72	650000	30952
Bahçelievler	442877	472649	6.18	27680	29541	6.72	530000	33125
Bayrampasa	240427	246646	2.70	34347	35235	2.59	250000	35714
Besiktas	202783	191776	8.11	9656	9132	-5.43	200000	9524
Beyoglu	231826	234964	3.47	25758	26107	1.35	240000	26667
Esenler	344428	394423	15.06	8831	10113	14.52	425000	10897
Fatih	432590	407991	5.02	33276	31384	-5.69	415000	31923
Güngören	273915	271874	3.09	34239	33984	-0.75	275000	34375
Kadiköy	699379	661953	15.44	17484	16549	-5.35	670000	16750
Kagithane	317238	345574	5.41	22660	24684	8.93	400000	28571
Kartal	362175	407034	13.13	10652	11972	12.39	475000	13971
Üsküdar	472124	496402	17.76	10264	10791	5.14	530000	11522
Zeytinburnu	228786	244063	4.63	19066	20339	6.68	280000	23333
Total	4736444	4935043	108.11	16916	17625	0.04	5340000	19071

Figure 3-52 Population and Density Table of Very Dense Towns in Istanbul.

2) Establish Emergency Responses (Infrastructure- Scenario 4):

The narrow streets, a serious problem, are not sufficient streets to handle the amount of vehicles in Istanbul and cause traffic jam for a very long time. These roads should just be for pedestrian use so the fire trucks, ambulances and other emergency response teams can have access to the houses on very narrow streets. Otherwise, the people will not be able to receive the immediate help needed in case of a fire, or a devastating event, due to a lack of planning as it happened in the past (See Figure 3-53).

Figure 3- 53 The Width of street roads are critical for emergency response timing.

3) Government (Infrastructure- Scenario 4):

Istanbul needs a better infrastructure layout so that the residents of Istanbul can have access to the utilities provided by Istanbul Municipality. There are many infrastructure deficiencies because the infrastructure's capacity is not large enough for the population in Istanbul (See Figure 3-54). If more than 50% of the population is moved to other locations, than the infrastructure could be sufficient for the rest of the town and there would not be a need to fix as many issues in the city.

Figure 3- 54 A better functioning infrastructure for Istanbul is necessary to reduce problems related to water and heat system.

4) Social & Physical Planning (Infrastructure- Scenario 4):

The road system in Istanbul cannot support the traffic. Moving inhabitants to Canakkale will help the infrastructure of Istanbul. The road ways should be examined and, if narrow, it should be given a parking ban. Istanbul must also have better sewage systems to end the environmental problems caused by poor designs. The city must be analyzed to see if it has any other important environmental problems. The city must determine if water flows are controllable and where the sewer water goes to in order to prevent contamination in water reserves. There must be better waste water plants constructed. Adequate environmental tests and implementations must be done to form nature friendly communities.

Figure 3- 55 Better road systems Needed to Address Istanbul's Traffic Problems.

The newly made towns must have central focus and the proposed multifunctional human scale buildings must be served by an infrastructure that will handle the 50 year storms. These new towns must be dense. Mass transportation must be implemented within the city and from city to city. A sufficient infrastructure will attract governmental and non governmental institutions, and allow the constructions of factories to settle to these places. Thus, the new residents will have jobs, a sense of community and a good quality of life.

Scenario 4 Results:

Almost 5 million residents of Istanbul based on the figure below must be moved to Canakkele. About an area of 99 km^2 from Canakkale will be needed for this project. The towns that are mainly affected are listed below along with their assumed 2006 populations. The population movement from Istanbul to Canakkale for each town is presented on the last column of Figure 3-56:

Towns	Preserve History (90%)	Earthquake Safe (75%)	Infrastructure (50%)	Istanbul -> Canakkale Population	
Avcilar		X		290000	217500

Bagcilar			X	650000	325000
Bahçelievler			X	530000	265000
Bakirköy		X		210000	157500
Bayrampasa			X	250000	125000
Besiktas			X	200000	100000
Beyoglu	X		X	240000	216000
Eminönü	X	X		60000	54000
Esenler			X	425000	382500
Fatih	X	X	X	415000	373500
Güngören			X	275000	137500
Kadiköy		X	X	670000	502500
Kagithane			X	400000	200000
Kartal		X	X	475000	356250
Maltepe		X		400000	300000
Pendik		X		470000	352500
Üsküdar	X	X	X	530000	477000
Zeytinburnu		X	X	280000	210000
Total	4X	10X	13X	6770000	4751750

Figure 3- 56 Table showing the number of people needed to move to Canakkale from specific towns in Istanbul.

BEFORE AND AFTER AN EARTHQUAKE (IQP)	**Alternative Objective Matrix**	**Figure 3-57**		
Reduce the impact of a future tsunami & earthquake while developing urban planning in Istanbul				
	Alt1	Alt2	Alt3	Alt4
Objectives	Do nothing- (Majority)	Reinforce;	Highrise	Move inhabited to other cities
Preserve History		systematic teardown/build		
Construction	no integration btwn.	Harmony btwn const and history	Min.const. in historic sites	Min const. near historic sites
	past/present	Well maintained historic sites	No higrise near historical sites	Redevelopment in other cities
	Stays same	Teardown unstable buildings	Historical sites low density area	
Population	No changes	Only tourist allowance	Touristic attraction	Population decrease in historic sites
				Only tourist allowance
Government	Easy way to get out?	Guidelines on how to rebuild	Gov. policy; zoning? Appropriate?	Income to the government
		New gov. policy towards const. $	$	Forming new gov. policy $
				Cover expenses of Displaced
Social Planning	Cont. of problems:	Built vs natural env.:	Built vs natural env.:	Built vs natural env.
	Needs unsatisfied	Surrounding the city with green	Tall buildings with greenspace	Integrate history and nature?
	Poverty	war on poverty	war on poverty	war on poverty
		health, shelter, space	health, shelter, space	health, shelter, space
		satisfy "common needs"	satisfy "common needs"	satisfy "common needs"
Physical Planning	No specif planning	Human Scale around history	Misporportional	Monumental
		Eloborate Architectural Buildings	Multistory buildings in dif. Sizes	Multidimensional buildings
				Alternative Passageways
Land Use Planning	Dissatisfaction but	Forming a sense of community	No higrise near historical sites	Eloborate Architectural Buildings
	not much action	Human needs satisfied		Potential Human needs satisfied
	Alt4	Alt2	Alt3	Alt1
	Do nothing- (Majority)	Reinforce;	Highrise	Move inhabited part to safezone
Earthqauke safe		systematic teardown/build		
Construction	Many unsafe buildings	Stable buildings &planned	Stable buildings	Stable buildings in other cities
			Preserve greenspace	
Population	Chaos	Everyone feels secure	Everyone feels secure	Reduces chaos if any
Government	No changes:(	Istanbul Master Plan:	Ideal planning in terms of costs	Strategic planning implemented:
		Steps to take in planning	clean up city	industrialization spread across Turkey
		clean up city		Formation of regulated U.P. cities
				clean up city
Social Planning	Earthquake resistant?:	Health/Shelter/space bef. disaster	Health/Shelter/space bef. disaster	Health, Shelter, space before disaster
	Probably not	Health/Shelter/space aft. disaster	Health/Shelter/space aft. disaster	Health, Shelter, space after disaster
		Human Needs? Common Good?	Human Needs? Common Good?	Human Needs? Common Goods?
Physical Planning	Bad development	Multidimensional buildings	Multistory buildings in dif. Sizes	Multidimensional buildings
		Alternative Passageways/Human Scale	No Human Scale->Misporportional	Alternative Passageways/Human Scale
Land Use Planning	No Design	Community Design	Community Design	Community Design
		Development Policies: zoning	Development Policies: zoning	Development Policies:zoning
Cover expenses		Earthquake insurance	Earthquake insurance	Earthquake insurance
of displaced	Alt4	Alt2	Alt3	Alt1
	Do nothing- (Majority)	Reinforce;	Highrise	Move inhabited part to safezone
Infrastructure		systematic teardown/build		
Population	Build according to the max # possible	Build according to the max # possible	Build according to the max # possible	Build according to the max # possible
establish emergency	No adequate planning.	Water supplies, shelters, bathrooms, food	Water supplies, shelters, bathrooms, food	Water supplies, shelters, bathrooms, fo
responses		Emergency ways planned. Hospitals	Emergency ways planned. Hospitals	Emergency ways planned. Hospitals
Government		Plan a reliable and adequate infrastructure	Plan a reliable and adequate infrastructure	Plan a reliable and adequate infrastructu
Social/Physical		Adequate infrastruce according to this plan	Adequate infrastruce according to this plan	Adequate infrastruce according to this p
/Landuse Planning				

6) BEST ALTERNATIVE

The best alternative will be determined from the four scenarios by comparing and contrasting them in terms of time, money, and quality of life.

A) TIME:

Time will be one of the most important factors for the comparing and contrasting process. The time it takes to implement varies, depending on how politics, planning, and resources affect the completion of out objectives. The amount of time for constructing different buildings is listed below:

- 4 months for a 5 story building
- 6 months for a 5 to 10 story building
- 8 months for a 10 or more story building (Hergunsel, T. 2006)

For all of the scenarios except the "Do nothing" scenario, the construction should not take more than a year, but neither the planning nor the infrastructure construction is included in this time frame. Planning can vary on how much effort is put in and how complex the project becomes. On the other hand, if the government cannot gather the money needed, then both the construction and planning processes may take much more time than it should and may never be completed, leading to unnecessary debts and other kinds of problems. In addition, the whole project must be designed for use in the long term. It would be a waste, money and time, if the project was done for short term utilization, because the time to plan and complete such a project is enormous.

When all acting factors are considered, constructing 5 story buildings is much more ideal than the other choices, because it will be easier and faster to build. These buildings would be the proper option for the "Moving inhabitants" or "Reinforce teardown and rebuild" scenarios.

B) MONEY:

An important aspect for every major project is the evaluation of financial schemes and resources needed for all the activities in any scenario. The key factor for every major project is money, as it is for this problem. There are two tasks for financing a project such as this. The first is the specific task of funding the capital requirement. This requirement needs to be a one-time financing only, like a technical investigation and strengthening project for a specific public building, a specific scientific study, etc. The other task is a permanent one that needs continuous financing and requires a partially or totally unpredictable capital amount at the outset, whether it is a project to strengthen and re-locate private residential buildings in a city or a project to develop new earthquake-resistant housing sites.

Specific tasks and permanent tasks should be considered separately. Most of the standard project needs, or capital, for the specific tasks can be received from local sources like the Municipality, Treasury, and Private sector, by the use of temporary or permanent partnerships, and international sources like World Bank, European Development Bank and other financial institutions. For the permanent tasks only some of the credit can be obtained, and they can be financed in a sustainable method only through long-term financial models that rely on the market system. Some of the credit can be gathered from the municipality budget, government budget, and even new monetary sources. One of these new sources could be the transferring of properties from non-useful possession to government possession in order to either liquidate the assets into cash or use it more efficiently generating more financial credit.

When estimating all the credits needed for the tasks, the government must obtain at least $25 billion before starting any kind of construction and planning. One simple solution for this fiscal problem could be to take out a huge loan from the global banks. Before taking out any loans, the cost of buildings and planning of everything should be calculated as approximately as possible. Also mortgage systems should be devised for the low income families.

The amount of money it will take to construct different buildings is listed below:

- $500/ m^2 for a 5 story building
- $600 to $650/$m^2$ for a 5 to 10 story building
- $750/$m^2$ for a 10 or more story building (Hergunsel, T. 2006)

Five story buildings do not have lots of structural concerns when it comes to wind load and earthquake forces. For buildings more than 5 stories, the wind and the earthquake forces will be more severe and will need to be taken into account when the structural design occurs. Since more stories will mean more cost as the height of the building increases, the better option is to build 5 story buildings. These human scale buildings will be the appropriate choice for the "Moving inhabitance" and "Reinforce, teardown and rebuild" scenarios.

C) QUALITY OF LIFE:

In order to preserve the quality of life, each scenario must comply with a certain number of ideal density rules for urban areas. Each scenario should fulfill the required uses for the average urban density of a $1km^2$ area; 50% of the area must be used for parks, hospitals, schools, and governmental buildings; 10% must be used for roads that are adequate for mass transportation and emergency exit responses. The rest of the area would be limited to the allowable construction site. If twice the amount of the allowable

construction site, which is 800000m^2, is to be built on this 1km^2 area, assuming that the average household occupies about 100m^2 of space, then 8000 residences will be allowed to be built. If there are 4 persons per household, the resulting density will be 91395 people per/$mile^2$. Moreover the urban development will only take place in the non historic towns.

1km^2=1000000m^2
50% Park, Governmental Building, Hospital, School=500000m^2
10% Road= 100000m^2
40% Allowable Construction Site= 400000m^2
Use the double the amount of the allowable construction site=800000m^2
Area per household= 100m^2
Number of residences=800000m^2/100m^2= 8000
Persons per household=4
Population density=32000people/km^2
1.609km=1mile
Population density= (1.609km/mile) ^{2}) (32000people/km^2) =91395people/$mile^2$ (Hergunsel, T. 2006)

Istanbul must have safe, structurally sound buildings that will alleviate the human casualties that will arise from a natural disaster. Additionally, by involving this community, many of the construction problems for the increasing population of the social, physical and land use planning will be resolved. Furthermore, community involvement and safety must be established to ensure quality of life in Istanbul.

Quality of life is a broad definition which tries to improve the sense of community while acting in an environmentally friendly manner. Entertainment facilities must be built that allows for leisure. Economic well being must be established in order to enable adequate planning. All the constructions must have environmentally friendly infrastructure and buildings. Health and social well being must be maximized to improve the quality of life by increasing the availability of health centers and socialization sites

for the community. Housing must be implemented with sense of community and nature in mind. Population must be stabilized. There should never again be a tremendous increase in Istanbul's population density that causes the infrastructure to function poorly or not at all in some cases. Lastly, mass transportation must be used to in order to reduce traffic, decrease pollution density, and increase quality of life. The figure 2-2 below shows the elements needed for the quality of life looking from the construction, population, social/physical/land planning, and coverage for the displaced expenses perspectives.

Quality of Life vs	Methods of Change	Figure 2-2		
	Construction	Population (Pop.)	Social/ Physcial /Land Planning (S/P/L Planning)	Cover expenses of displaced
People and Place	strong buildings?			
	less human cusalties ?	Pop. vs Improvement in the community?	Do the plans serve the community sufficiently?	Will the expenses be covered?
	priotories for improvement in the local area?			Who will cover it? And How?
Community involvement & safety	Stronger buildings?	Is population well maintained?	Safe buildings meeting the requirements of the plans?	Development of new communities?
Culture for Leisure	strong entertainment/sprots facilities?	Does entertainment increase population?	Built entertainment facilities accoring to the plans?	Initiative to entertain after earthquake?
Economic Well-being	Improvement of safe construction?	Is there a possibility of increase in pop.?	Economic well being enables these types of planning	Funding of new jobs?
Education	Inform the community on making the buildings stronger?	Is Population stable?	Enough education to realize these plans?	
Environment	Environmental friendly construction?	Does Pop. appreciate the env. they live in?	How effecitive is env. factored in for S/P/L planning?	Clean up the destroyed parts? How?
Health-social well-being	Construction for the community?	H. Social well being increase relatively?	Can S/P/L Planning improve the health social well being?	
	Availability of health centers during a disaster?			
Housing	House const. harmonious with community and nature?	Housing increases as Pop. increases?	Are houses S/P/L Planned?	Earthquake insurance?
Transport and Access	Useful streets?	Masstransportation?	Is the transportation system S/P/L Planned	Will the community be liable for it?

In summary, the differences between the four scenarios are the main construction types used in different locations. There will be no constructions for "Do nothing" scenario. The "Reinforce, Systematic Teardown, and Rebuild" scenario involves human scale five story constructions within Istanbul boundaries except in historic sites. High-rise constructions will take place within Istanbul boundaries except in historic sites. They will be 10 to 15 stories tall constructions. The last scenario moves many inhabitants to Canakkale. The constructions will be human scale buildings as well.

The human scale buildings are four to five story buildings. It enables a person to relate him or herself to a building and not feel lost at the same time. Planning becomes easier and quality of life increases.

All the scenarios will have quality of life. However, the two scenarios "Moving inhabitants to Canakkale" or "Reinforcing Istanbul" scenarios are most appropriate since they have human scale buildings. Therefore, the choice must be made between "Moving the city" and "Reinforcing" scenarios. According to the survey done with 100 random residents of Istanbul, 76% decided on reinforcing Istanbul. Therefore, it is not ideal to move the inhabitants to another city, since the residents are hesitant, want to remain in Istanbul and enjoy the historical heritage with the idea of staying in Istanbul. Remaining in Istanbul is the critical point that will separate scenario 2, "Reinforce/rebuild", from scenario 4, "Moving Inhabitance". Hence, the quality of life can be achieved better with the choice of scenario 2, reinforcing Istanbul, must be picked.

Scenarios	Time (construction)	Cost	Quality of Life
1- Do nothing- (Majority)	None	None	Poor and will become worse
2- Reinforce/Rebuild	4 months	$\$500/ m^2$	Better (human scale & preference of the inhabitants)
3- High-rise	8 months	$\$750/m^2$	Fair (no human scale)
4- Move inhabited to other cities	4 months	$\$500/ m^2$	Good (human scale & not preferred by the inhabitants)

Figure 2-3 Overall results for the best alternative

7) CONCLUSION

- Historic cities must be preserved from any new construction in order to preserve cultural heritage.
- No buildings should be permitted within half a mile radius of the historic sites in order for archeological excavations to take place.
- The buildings where tsunami will most likely hit need to be relocated to new towns in the Black Sea Coast of Istanbul.
- The weak buildings in Istanbul must be determined and the necessary ones must be reinforced without further delay.
- Human scale constructions with a density of 91395people/mile^2 must be initiated.
- Istanbul must see ways to move industrialization away from Istanbul within at least 50 mile radius.
- Every six months the prime minister, governor of Istanbul and the mayor must be presented with a report showing some progress.
- The infrastructure must be consistent with the development of the area.
- Mass transportation must be implemented with adequate roadways, streets and highways systems.
- Environmental concerns must be eliminated by constructing technologically advanced waste water treatment facilities.
- Newly constructed human scale must also meet green building standards to be environmentally friendly.
- Politics must not affect the decision making on this emergency plan.

- Important emergency decisions must be the first priority on government and community's list.
- The money needed to survive the kind of disaster Istanbul is predicting must be obtained from the country's sources by the government.

8) APPENDIX

A) Interviews

a) English Version of Interviews:

1) INTERVIEW WITH DANYAL HERGUNSEL:

Mehmet: Now, we are answering questions about our IQP with Mr. Danyal.

Danyal: I graduated from the Metallurgy Department of Istanbul Technical University in 1975.

Mehmet: Do you know any information regarding earthquakes and tsunamis?

Danyal: Yes.

Mehmet: Have you ever experienced a tsunami or an earthquake?

Danyal: My first earthquake experience was in Adapazari in 1968. Later on in 1970, we experienced the Bam Earthquake and felt many other smaller earthquakes afterwards. However the biggest earthquake I felt was in Istanbul. As you can remember, 40000 people lost their lives in the Marmara region.

Mehmet: So what is your knowledge on the expected earthquake in Istanbul and what does u know about the fault lines?

Danyal: As you know, Istanbul lies on Northern Anatolia Fault line and it is said that this fault lines is an extension of the Los Angeles fault line. It is said that at some of the faults, the stresses are yet to be released and large amounts of potential energies are stored. The biggest problem is whether these faults are going to break as one or break in many parts. If it is broken as one, it is thought that the magnitude of the earthquake will be above 7.5. Hopefully, this wont be the case. If it is broken in many parts, the magnitude will be around 6. Unfortunately, Istanbul is not even ready for a 6.0

magnitude earthquake. Many of the buildings are not structurally sound. In the New Construction Policy, new laws concerning this issue were passed but it can not be predicted how much the 25 to 30 year old buildings will be damaged. Unfortunately, Turkey's economy can especially not handle a rebuilding plan for Istanbul. It is said that rebuilding the city would be very costly. People are getting their houses checked depending on their economic standing and I do not know how safe this process is.

Mehmet: Allright, what did you do on this issue? Have you done any work on your own house or check the environment and other buildings around you?

Danyal: There are emergency headquarters. Every local authority are preventing our work. On the other hand those emergency headquarters in Istanbul became legitimate organizations from the streets. We don't know how the earthquake will meet us. Our building is 67 years old and we pulled out its plan papers, and realized that we have knowledge on how resistant our building is to earthquakes. We are trying to take precautions in our houses. I am living in an apartment on the 5th floor and trying to form thick blocks with books and such near the corners. Since the kitchens and the bathrooms have stronger corners, one of my emergency options is to shelter in those stronger corners. It seems like there is no other solution for our case.

Mehmet: How is the planning for the Istanbul supposed to be?

Danyal: First of all there is a fault line starting out from the south of the islands concerning Istanbul. The weak buildings, especially the ones on the direction of this fault line, must be cleared out. The buildings in Maltepe, Kadikoy, Idealtepe, Pendik, Avcilar, Buyukcekmece, Kucukcekmece, Mimarsinan and Sivrili must either be retrofitted or

evacuated and cleared out. After that, with the modern urban planning ideas, it would be better to build high-rise buildings on strong lands on the north of Istanbul in my opinion.

Mehmet: Do you think Istanbul should be moved to another location? If yes, where? For example should it be moved to Canakkale? It is very hard for the 15 million-population in Istanbul to live together since there is already many problems concerning every aspect of life.

Danyal: No, the Karadeniz side of Istanbul is available and favorable since it is far away from the earthquake area. Its land is also strong and suitable to move the city there. A third bridge could be built near Sariyer. There is also the squatter settlement problem in Istanbul. There are two to three story high buildings with very low quality labor and material. These buildings need to be cleared out and build high-rise buildings instead.

Mehmet: Now… One of the subjects our professor talks is that the reason for population increase for every population growing city is usually either because of the economy or industrial buildings in the strategic areas attracting more immigrants since there are more jobs openings. Is the real reason for these migrations the industry in these areas since there are already many industrial activities going on?

Danyal: Obviously, 60 percent of Turkey's industry is located in Istanbul.

Mehmet: Ok, but why?

Danyal: The reason is this: Because there is not much of an infrastructure throughout Istanbul. Because when people come to Istanbul, they can find a job in the food sector with many establishments of the factories happening. Also driver and restaurant related jobs are not always too hard to find. All kinds of work are being done since Istanbul is a

big tourist attraction, with a lot of shopping and many hotels. Because there are possibilities of finding any kind of job, many people are migrating.

Mehmet: Allright, are all these things as a result of Istanbul's strategic geography?

Danyal: It is as a result of the trading.

Mehmet: Are the forming of these buildings as a result of Istanbul's geography?

Danyal: No, no.

Mehmet: My professor is telling us that most of the time, the forming towns or further development of these towns is mainly due to geographical reasons.

Danyal: Personally I do not agree on this for Istanbul. The reason for Istanbul to be 15 million in population is that the city is seen as a "golden city". Istanbul changed a lot and in time people constructed buildings without authorization. Later the government made these buildings authorized and gave its residents the titles with the use of politics. As a result of this political change, many people became famous, but these lands are actually governments. If all the political turmoil over this land title matters were put aside, then instead of these two story buildings, there would be five to seven story buildings and there would not be as many jobs as now. So it can be seen as the political parties provoked this situation with residents receiving titles on authorized lands.

Mehmet: You have said that 60 percent of Turkey's industry and most of its revenue is in Istanbul. For instance, we are trying to move people to the Karadeniz side of Istanbul. How do we do this so that we can also move the economy to another area as well?

Danyal: For the movement of these people there also must be an infrastructure ready before hand. Health related, education and all other needs must be satisfied, also health

and educational institutions, roads and job sectors must be provided. If all these needs are met, then moving people will not be such a big problem.

Mehmet: Could you give more details on your emphasis for the job sectors? For example, how can we relocate the commerce to a farther location? Because as you already know as well as everybody that Istanbul's positioning is very important for its trading and commerce purposes.

Danyal: All the four fundamental elements, land, sea, air and raildroads, intersects at the point where Istanbul itself starts disbursing.

Mehmet: Yes, but do you think Karadeniz's sea connection will be as useful if we actually carry these elements to the Karadeniz side?

Danyal: They are gathering organizational information and trying to make the region convincing by planning to invest more. For instance, in some cities like Samsun, Maras, Coruma and Eskisehir some regions are being prepared to stimulate people to move in. In these regions, the government is helping out people who want to start a business but this seems not enough. The increase encouragement for people to move in these regions, most importantly there has to be an adequate infrastructure. Unfortunately, Turkey's budget for these regions is not able to handle since Turkey has both huge debts and only 5-10 percent of the budget could be given out for this kind of project. There is a fast increase in population here in Istanbul and this increase is preventing Turkey from progressing in a way, but nowadays there is a slight decrease in population showing a possibility for Istanbul to be in a better situation.

Mehmet: What do you blame the population increase on?

Danyal: Because there is no birth control and no education especially on the east side of Turkey, the population is increasing. I think the biggest problem for Turkey is the education. Average education level for these people is no more than elementary and most of the girls are getting married too soon just after the elementary school usually. I am member for one of the protective foundations on this issue and have done its presidency before. We are working on it as much as we can. We are trying to increase the mandatory education to the 12^{th} grade.

Mehmet: Is there a mandatory education level?

Danyal: It is 5 years of education, but we are trying to make 8 years, especially in the east of Turkey people don't want to send their daughters to school. The biggest reasons for families to have 10, 20 children are family revenue and no education.

Mehmet: How do you think Turkey's economy and other related issues are going to be affected?

Danyal: I think the Turkey will be devastated. It will be a major disaster for our country. Turkey wil not be able to recover for a long time and it will make Turkey go 20 years as much as civilization and technology is concerned.

Mehmet: Ok, do you think is there enough investigation in Istanbul for this matter and are the people being informed about what kind of activities? We talked about this before. For example there are some kind of investigation done by TUBITAK and the government, but do you think all this is enough?

Danyal: In my opinion, it is not enough. An extensive master plan is needed and a lot of expenditures must be made. If the unauthorized buildings in Istanbul are checked, retrofitted, torn down and rebuild, it could be very better maybe. There aren't only

hundreds of these unauthorized buildings, there is thousands of it. Because of this I do not think what is being done is adequate.

Mehmet: First of all, what do you think is the most logical way to decrease the population of Istanbul? Is it to tear down these buildings and move its residents to either to the Karadeniz side or to Canakkale, or is it opening more space and have more greener environment by building high-rise buildings?

Danyal: We have to apply all these plans to paperwork and we should construct new apartment complexes resistant to earthquakes to have more green space and to open up the roads in Istanbul. The roads especially will be a big problem after an earthquake. We also need to move the universities, hospitals, the industry and the commerce to the rest of Anatolia, but first, infrastructure is needed for the buildings. We should not forget to create a harmonious planning with the environment as well. I think this is very essential. We should build high-rise and sky-scrapers, and also move some buildings to other locations with the whole plan involved.

Mehmet: Is there any there any thing else you would like say?

Danyal: Istanbul is a very significant and an important cultural city for the world as well as for Turkey. For living through many empires and many religions, and having a geographically strategic position with a Bosporus connecting both the Asian and European continents makes Istanbul a *world city*. The heritage and assets from all kinds of different cultures and religions do not just belong to Turkey. It belongs to all humanity and it needs to be protected for other generations too.

Mehmet: Thank you very much.

Danyal: Thank you.

2) INTERVIEW WITH HALIL GOKCEN

Mehmet: Could you please introduce us yourself?

Halil: Majored in electric engineering and graduated from the Marmara University in Istanbul in 2002.

Mehmet: Could you please shortly tell us your knowledge about Istanbul and the possible earthquake?

Halil: I don't have a broad knowledge on it but it is only general.

Mehmet: Have you experienced an earthquake before?

Halil: I saw the collapsed building after the earthquake on August 17th and I did not feel its vibrations at all but I also experienced the earthquake on November 6th in Istanbul and I felt it more than I could. At the moment of the earthquake, we were in the university buildings. Everybody was pretty calm and I followed what others did.

Mehmet: What kind of impressions did you have after the earthquake?

Halil: Because I was living in Avcilar, some of the houses were collapsed and the 12 story-high building that I was staying in had some cracks but there was not much of a heavy damage on the building.

Mehmet: Were you prepared enough to know what to do in the moment of an earthquake back then?

Halil: No, everybody acted together as anybody would have guessed and I followed whatever they did. People had all kinds of different reaction and most of them reacted pretty unconsciously and were moving with their instincts.

Mehmet: Do you have any kind of education on the possible earthquake in Istanbul? Have you taken any precautions?

Halil: In my opinion either there will be earthquake in the future or not people should be educated about earthquakes? In this matted the biggest duty is on the media and educational institutions. The education also will have to be from a long term prospective look. According to my observations, after all these earthquakes there still was not any kind short-term education given or brochures distributed in the schools.

Mehmet: What kind of damage do you expect after the possible earthquake?

There will be a lot of damage. Hopefully Allah will not send us such a great disaster. The community should do whatever necessary and the government, and municipality must make sure all the necessary measures taken and the people are informed on this matter.

Mehmet: What kind of actions and measure should be taken in order to decrease the Istanbul's population and how will the population affected due to the possible earthquake in your opinion? What kind of earthquake prevention plan should be arranged?

Halil: In my opinion, Istanbul is seen as *the* city or the place to immigrate to and this is because of the economic reasons. If the fundamental economy building blocks of the industry is moved outside of Istanbul and provoke, and convince people somehow to move to more open locations with better city planning, we could work out solutions to this problem.

3) INTERVIEW WITH TAMER HERGUNSEL

Mehmet: Do you know any information regarding earthquakes and tsunamis?

Tamer: It would not be right for me to say that an earthquake is possible if we don't look at other earthquakes that happened and have some idea on how we should look at it. In 1999, an earthquake 60-70 miles near the regions of Yalova, Golcuk, Tutunciftlik, Derince and Yarimca caused heavy financial damages and casualties. The buildings near the coast lines were under water after the earthquake. The sea moved further into the land. The building which belonged to a relative of mine and in which I lived most of my young years in Halidere was tragically collapsed. The sea backfills for the building was all lost. The road between the house and sea was also gone. The water was all up to the house on the land. Most of the strong looking cement buildings were collapsed and the old wooden buildings were less damaged. When I was walking in the earthquake affected sited, I saw some very strong looking buildings collapsed and some old buildings not damaged. When I visited a relative in Adapazari, one of the most devastated regions, I realized the buildings on one side of the street were standings and the other side was completely collapsed. Some of the buildings collapsed only due to the weak land it was on and some old buildings survived the disaster due to the strong land it was on. Moreover I visited the heavily devastated places near the fault line in Duzce. There was a dike in the ground and the ground was split apart. One side of the land was directed towards the west and other to the east. There was about 1-1.5 meter slipping on the land. Your uncle Ahmet had just bought an incomplete house and he asked me my opinion. No matter how good the cement ingredients were put in the walls, the column cross-sections were small. These column cross-sections were not big enough for this kind of earthquake

region. I told him that I will send a friend of mine to calculate the column strengths and not to do any thing else for the house. He listened to me and completed the house accepting the suggestions of my technician friend. When I visited Duzce after the earthquake, most of the houses around your uncle's new house were collapsed and its residents sheltered in his house. When they asked your uncle where he got the idea of increasing the size of column cross-sections, he said that he asked someone who knows. Your uncle told him to come to his place to take a shower, shave and get himself together. His friend who had been building houses replied and said that your uncle was a baker not an engineer. He also told him that his buildings should have been stronger than your uncle's house since your uncle was only a baker who would not know about how to build. His friend had been staying in camps because all the houses he built were collapsed. The reasons for high story buildings to collapse are because the connections between the columns and beams breaks and the reasons for this break are 1) lack of steel 2) lack of good quality concrete 3) concrete is not compressed enough 4) lack of steel workmanship knowledge 5) technicians do not check very well while the cement pouring process 6) in Turkey they even grease the burned casting wood so the wood is used more. While they grease it up, they mistakenly grease the steel to causing steel not to stick to the ground very well. This makes it very unstable in the moment of an earthquake.

Mehmet: What do you know about Istanbul's infrastructure?

Tamer: It is very difficult to fix the infrastructure problems in Istanbul. There are a lot of historic monuments and assets. Anywhere you excavate or dig you, you might find valuable magnificent monuments from the Roman, Ottoman or Byzantine Empires. So it is very difficult to do any underground work in Istanbul. It is very hard to get a sewage

tunnel system done for the infrastructure. Some place should just be left for archeological excavations and discoveries. The rest of the buildings without any historical importance should be cleared out to open more space making the city more like a museum for the next generations. The residential buildings hotels should be built away from the archeological sites.

Mehmet: What are your thoughts about the buildings in Istanbul?

Tamer: Unfortunately 80 percent of the buildings in Istanbul are completely unauthorized. In the constructing process of most of these unauthorized buildings there was no engineering knowledge or any kind of expertise involved. The high story buildings constructed with the "general method" are in great danger when earthquakes occur. Most of these buildings must be demolished. Most of these buildings were also constructed close to the river banks on weak and slippery land because these regions were never inspected by the government or any engineer. For the other 20 percent of the buildings in Istanbul, they also are in some kind of danger since 1) unknowing people constructed these buildings 2) not enough technical control or attention 3) lack of material 4) less use of steel and concrete in the buildings constructed before 1960 was calculated after the earthquake investigations 5) most of the buildings in Istanbul was made of unwashed sea sand most of the sand has mussel shells in it. The buildings constructed even with authorization are likely to be damaged by the earthquake because of these reasons. For example, I saw the earthquake devastation in Adapazari in 1966 and my father saw the devastation in 1941. In 1980, a couple rich friends from Adapazari offered me partnership on building the commerce headquarters. I didn't want a part of it since I knew the construction site was an earthquake region. They told me they would

build it strong and I told them that I don't trust the strength of the land and we don't have the technology to make it strong enough to resist earthquakes. In 1999, most of the buildings constructed after 1966 were collapsed. Most of the buildings my rich friends built were also collapsed including their own houses and the commerce headquarters which they built. After the earthquake, they decide to build the commerce headquarters to a different location with a strong land.

Mehmet: What kind of precautions should be taken in order to protect the historical heritage and assets against *the* possible earthquake in Istanbul?

Tamer: The grounding the historical buildings are on and the land around it must be strengthened. The necessary measures must be taken for the buildings as well. The unneeded buildings with no historical significance around the historical buildings must be cleared out.

Mehmet: Where and how should the possible New Istanbul erected because of the expected major earthquake?

Tamer: There is enough strong land for the new city between Marmara Sea and Black Sea. First thing to move must be hospitals and schools. The residential sites must be planned carefully. Some of the universities must be moved to stronger lands. For example Istanbul Technical University was moved to Ayazaga. KOC University campus was built outside of the city. Yeditepe University built its campuses on Kayisdagi which has a strong land. With the use of technology new residential sites are starting to be built on stronger lands and people are trying to buy houses built on strong land. Some fancy residential sites built on weak grounds before are starting to lose its illustrious look losing customers. For the less priced sites on stronger land, it started to gain value.

Mehmet: What is the government's role on rebuilding Istanbul?

Tamer: First, the government has to stop the unauthorized buildings. The strong land for the new residential sites should be determined and public works planning should be carefully figured out. It is government duty to move the important public buildings to the strong lands, and demolish unsafe, unnecessary buildings and rebuild on better sites in order to prevent the loss of lives from any earthquake. The weak buildings should be reinforced and retrofitted with the use of technology or rebuilt on stronger lands.

Mehmet: What do you think about how the humans needs will be satisfied for the survivors after the expected earthquake and tsunami?

Tamer: Unfortunately it is a very big problem. Because the streets near the downtown are very narrow, the collapsed buildings will completely block the roads and any emergency unit. The studies done on this issue are not enough in Turkey. Even the emergency kits are stolen by the thief when put in the buildings before and after disasters. As a result there will not be any emergency kits around in the time of a disaster. The emergency units and civil population must be educated on disasters. Better institutions must be established in order to direct and help people. Unfortunately, there are not enough search and rescue units and the ones that exist do not have adequate education. The government must start organizing, establishing and education better emergency units and institutions.

Mehmet: What kind of additional infrastructure problems do you think Istanbul will face after the expected earthquake?

Tamer: The infrastructure in Turkey is not even sufficient enough today. In winter the snow piles up just 5 centimeters in Istanbul and the life becomes paralyzed. When a big earthquake occurs in small cities, a scary chaos comes out and if you compare Istanbul to

these cities, you don't even want to imagine the extent of damage in such a disaster. But the worst incident that happens in disasters is when robbers and looters stealing from whatever is left and whatever they can get their hands on. In 1939, after the earthquake in Erzincan, a friend of my grandfather shot and killed a man who was trying to cut someone's arm under the wreckage so that he could get the bracelets out. This was a very bitter memory that I documented.

Mehmet: What do you think are the reasons for the population increase in Istanbul?

Tamer: Generally, it is due to unemployment in Turkey. In the rural areas, agriculture and farming are not seen important. The land per family is not proportional and lands are subdivided into many regions which in turn reduces the economic productivityr. For farming and agriculture, farming and agriculture production for small businesses usually family businesses is very hard. Therefore, the small production businesses along with the residents of the villages feel the need to move into urban places.

People were satisfied with bread and onion before. Nowadays, people's needs and demands increased. Everyone would like to have better living standards. Therefore, people either go to cities or abroad. Istanbul is one of these cities. At this point in time. Over the past fifty years, 5 million Turk migrated to Germany. Especially, when the residents of small villages migrating abroad returned to their hometowns in their yearly vacations, they talk about the prosperity of the city they live in with some exaggeration. People that listen to these stories either migrate to cities or to Europe, especially over the last 50 years.

b) Turkish Version of Interviews

1) Danyal Hergunsel ile Soylesi:

Mehmet: Şimdi IQP projesinde Danyal Bey'le birlikte soruları cevaplıyoruz.

Danyal: İTÜ'den metoroloji bölümünden

Malzeme yüksek bölümünden 1975'te mezun oldum.

Mehmet: Birinci sorumuz depremlerle ve tusunami ile ilgili bilginiz var mı ?

Danyal: Evet

Mehmet: Deprem yada tusunami yaşadınız mı ?

Danyal: 1968 yılında Adapazarı'nda ilk depremimi yaşadım. Daha sonra 1970'de Bam depremini, daha sonra küçük depremleri yaşadık. Ama en büyük depremi İstanbul'da yaşadık, hatırlarsınız ki Marmara bölgesinde 40 bin insan hayatını kaybetmişti.

Mehmet: Peki İstanbul'da olacak deprem hakkında bilgileriniz neler ve fay hatları ile ilgili bilgileriniz nelerdir ?

Danyal: Bildiğiniz gibi İstanbul Kuzey Anadolu fay hattı üzerinde ve **bu fay hattının aynı zamanda dünyada dolaşan Los Angelas'a kadar gelen fayın bir uzantısı olduğu soyleniyor?** Burada Marmara Deniz'i içerisinde kırılmamış bir sürü fayın olduğu ve enerji birikimi olduğu söyleniyor. Buradaki en büyük sorun bunların tek parça mı yoksa çok parça mı olarak kırılacağı önemli oluyor. Tek parça halinde kırılırsa eğer şiddetinin yedi buçuğun üzerinde olacağı söyleniyor. Inşallah böyle değildir. Çok parçalı olursa bu şiddetin 6 civarlarında olacağı söyleniyor. Maalesef İstanbul 6 şiddetindeki bir depreme de hazır değildir. Ve bir çok yapı maalesef imar olarak dayanıklı olarak yapılmamış. Yeni imar yönetmeliğinde bu yasalar yapıldı ama 225 30 senelik yapılarda ne gibi hasar olacağı ve ne gibi zarar olacağı öngörülememektedir. Türkiye'nin maalesef bugünkü

imkanları şehri yeni baştan özellikle inşa etmeye yeterli değildir. Çok büyük para gerektiği söyleniyor. Insanlar kendi imkanlarıyla evlerini kontrol ettiriyorlar, bunun da ne kadar sağlıklı olduğu hakkında bir bilgim yok.

Mehmet: Peki siz bu konuda ne yapmaya çalıştınız ; yaşadığınız ev olsun ya da yaşadığınız çevre olsun ne tür bir faaliyet oluyor ?

Danyal: Acil durum merkezleri var. Her belediye yerel yönetimler önümüze çıkıyor. Ama o acil durum merkezlerinde İstanbul dar sokaklardan teşekkül olmuş. Ne gibi şekilde ve nasıl yakalanacağımız belli değil. Evimiz 67 yılında yapılmış ve planlarını çıkarttık ve ne kadar dayanıklı olup olmadığı konusunda fazla bir bilgimiz yok.Evimizde tedbir almaya çalışıyoruz. Apartman dairesinde oturuyorum. 5. katta. Buna uygun olarak kalın kitaplıklar, köşeler yaratmaya çalışıyorum ve bu köşelerde, mutfak tezgahlarında, banyo tezgahlarında, bunlar daha dayanıklı olduğu için buralara sığınmak gibi acil ilk yarıdım önlemleri. Bunun dışında ise çok fazla birşey yapmak mümkün gözükmüyor.

Mehmet: İstanbul'da yapılması gereken planlama nasıl olmalı ?

Danyal: Bir defa depreme dayanıklı olmayan yapılar bilhassa deprem fay hattı istikametinde adaların güneyinden başlayacağı söyleniyor. Adaların güneyinden gireceğine göre işte Maltepeydi, Kadıköy'ün deniz taraflarıydı, İdealtepe'ydi, Pendik'ti, daha sonra Avcılar, Büyükçekmece, Küüçükçekmece, Mimarsnan ve Silivri hatları üzerine şiddetli bir şekilde buradaki eski yapıların kuvvetlendirilmesi veya acilen erkedilmesi gerekiyor.

Ondan sonra da yeni şehircilik anlayışına göre şehrin kuzey taraflarında pilot bölgeler yapılıp yeni tekniklerin çok katlı çelik kontstrüksiyona ya da zeminlerin yapının betonarmenin birleştiği yapının daha iyiolacağını düşünüyorum.

Mehmet: Peki sizce İstanbul taşınmalı mı, taşınmalı ise nereye taşınmalı ? Örneğin Çanakkale'ye mi taşınmalı ? İstanbul'da yaşayan 15 milyon insanın bir arada yaşaması çok zor, yaşasa bişe bir çok problemin olması söz konusu şu anda olduğu gibi.

Danyal: Yoo Karadeniz kısmı İstanbul'un müsait, depremden oldukça uzakta olan bir bölge. Alt yapısı zemin etüdlerinin yapıldığı daha uygun. Şehir o tarafa doğru taşınabilir. Bir üçüncü köprü yapılabilir Sarıyer taraflarına ama oralarda, İstanbul'un bir de gecekondu sorunu var. 2 katlı 3 katlı ama kalitesiz malzemeyle yapılmış. Bunların yıkılıp yüksek katlı ama çelik konstrüksiyon yapılara dönüştürülmesi lazım.

Mehmet: Şimdi bizim profesorun dediği konulardan bir tanesi her gelişen populasyonu artan bir ilin artma nedeni genellikle ya ekonomi açısından kaynaklanır ya da ordaki ticaret fazla arttığından ya da oranın coğrafi önem olduğundan göç alıyor. Simdi İstanbul'un göç alma nedeni ordaki ticaretin, orda baya ticaret var, ticaretleşme var ?

Danyal: Tabii Türkiye'nin %60'I oranında ticareti İstanbul'da.

Mehmet: Peki neden İtanbul?

Danyal: Sebep şu: Çünkü insanlar Anadolu'da alt yapıları yok. İstanbul'a geldiğinde servis sektründen çalışabiliyorlar, bir srü fabrikalar İstanbul çevresinde yoğunlaşmış. Burada iş bulabiliyorlar. Şöförlük yapabiliyorlar,kapıcılık yapabiliyor, lokantada çalışıyor. Her türlü işi yapıyorlar. Çünkü İstanbul aynı zamanda tarihi bir kent, turizm açısından çok önemli. Otelcilik yoğun, alışveriş yoğun. Burada iş bulma imkanı yoğun olduğu için insanlar buraya geliyor.

Mehmet: Peki İstanbul'daki bütün saydığınız şeyler coğrafi açıdan mı*

Danyal: Ticari açıdan.

Mehmet: Bu yapıların oluşması coğrafi açıdan mı?

Danyal: Hayır hayır.

Mehmet: Profesörüm diyorki her zaman yerlerin çoğu zaman oluşmasında daha ileri gitmesinde daha çok coğrafi bir nedeni vardır.

Danyal: Ben buna şahsen İstanbul konusunda katılmıyorum. İstanbul'un 15 milyona yakın gelmesinin tek nedeni taşı toprağı altın denmesindendir. Istanbul çok değişti, zamanında devlet arsalarına illegal bir şekilde ev yaptılar, sonra devlet bunlara politik olarak tapu verdi ve böylece bir sürü insan zengin oldu, halbuki burası devletin arazisi,, devlet kontrol etseydi ve bir alan getirseydi, siyasi partiler buraya politik açıdan bakmayıpta iki katlı yerine 5 katlı ya da 7 katlı bina yaptırmasaydılar bu insanlar bu kadar iş bulamazlardı.Biraz da siyasi partiler buraya teşvik ettiler.

Mehmet : Peki İstanbul'da dediniz Türkiye'nin % 60 ekonomisi, geliri İstanbul'da. Biz mesela insanları Karadenize taşımaya çalışıyoruz. Bunu nasıl yaparız da ekonomiyi bir yerden bir yere taşıyabiliriz.

Danyal : Bunun için taşınacak yerin altyapısını yapmak lazım. Insanların sağlık barın ma, eğitim ve çalışma imkanlarını temin edebilmek lazım, ancak o şekilde insanlar güzel uygunntler yaratmak lazım, okullar kurmak lazım, hastaneler kurmak lazım, yollarını yapmak lazım, insanların çalışabilecekleri iş sahaları oluşturmak lazım, bunlar yapılırsa gerçekleşir.

Mehmet : Peki çalışma konusunda biraz detaylı olabilir misiniz ? Mesela değişik iş yerlerini İstanbul'un yakınından daha uzak yerlere nasıl taşıyabiliriz. Çünkü bildiğimiz gibi İstanbul'un bulunduğu mevki taşımacılık açısından güzel bir mevki.

Danyal : Çünkü hem kara hem deniz hem hava hem de demir yolu dört tane temel yol İstanbul'da kesişiyor, ordan dağılıyor.

Mehmet: Çouk rahat bir şekilde yapabiliriz. Peki bunu Karadeniz'e götürürsek Karadeniz'in denizi de kullanışlı?

Danyal: Organize bilgiler yaratıyorlar, teşvik veriyorlar, daha teşvik bir bölge kuruyorlar. Mesela işte Samsun'a, Maraş'a, Çorum'a, Eskişehir'e teşvik bölgeler kuruluyor, bu bölgelerde iş kurmak isteyenlere devlet imkan sağlıyor ama bu yeterli değil. Bunu daha da arttırmak lazım ama sadece teşvik vermek yeterli değil, oraların alt yapısını da geliştirmek lazım ama maalesef Türkiye burada milli gelir olarak da düşük olduğu için devlet bütçesi borçlu bir ülke iç ve dış borçları çok olan bir ülke, devlet maalesef bu yatırımlar anca % 5-10 pay ayırabiliyor. Burda hızlı nüfus artışı var, bu nüfus artışı da bir çok anlamda Türkiye'nin atılım yapmasını etkiliyor ama bu sıralar nüfus artışı düşmeye başladı ama muhtemel ki ileri zamanlarda daha iyi olmaya başlayacağını düşünüyoruz.

Mehmet: Nüfus artışını peki nereye bağlıyorsunuz?

Danyal: Nüfus artışını doğum kontrolü yapılmıyor, bir ikincisi de özellikle batı bölgesinde değil Türkiye'nin doğu bölgesinde insanlar eğitim olayında oldukça geriler. Türkiye'nin en büyük sorunun'nun eğitim sorunu olduğunu düşünüyorum, bunların ortalama eğitim orani ilkokul seviyesinde bile değil, özellikle kızlar çok erken evleniyorlar, ilk okuldan sonra. Bu konuda bende bir vakfın kurucusuyum ve zamanında daha önce başka bir vakfın genel müdürlüğünü de aptım. Bu konuda çalışıyoruz. Mecburi eğitimi 12 seneye çıkartmak istiyoruz.

Mehmet: Şu anda mecburi eğitim var mı ?

Danyal: Beş sene ama 8 seneye çıktı, özellikle doğu bölgesinde aileler kız çocuklarını göndermek istemiyorlar. Batıdaki nüfus artışımız Türkiyenin batısında Avrupa ortalamasının belki de altında, çok .ok ailede 10 çocuk, 20 çocuk ve aile gelir seviyeleri çok düşükve eğitimsizlikten kaynaklanıyor.

Mehmet: Peki İstanbul'da olacak deprem sonucunda sizin görüşleriniz Tükiye'nin ekonomik konusundan ve diğer konularından nasıl etkileneceğini düşşünüyorsunuz ?

Danyal: Çok olumsuz etkileneceğini düşünüyorum, Türkiye için çok büyük felaket olur. Türkiye uzun seneler kendisini toparalayamaz çünkü İstanbul TC'nin aynı zamanda kalbi, burada olabilecek herhangi bir felaket Türkiye'yi 20 belki daha fazla sene geri götürür.

Mehmet: Peki sizce İstanbul'da yeterli araştırma yapılıyor mu ve insanların bu konularda bilgileri var mı, ne türlü faaliyetler var önceden de konustuk fakat mesela değişik araştırmalar var İTÜ olsun Tübitak olsun, devletinde çalışmaları var, bunlar yeterli mi ?

Danyal: Bence yeterli değil, çok büyük bir masterplan yapmak lazım, büyük paralar sarfetmek lazım, belki İstanbul'da hala ruhsatsız bina sayısı çok fazla, bu binaların ya kuvvetlendirilmesi, ya yıkılması ve yeniden bir plan dahilinde gözden geçirilmesi lazım. Birkaç tane değil bu şekilde yüzbinlerce bina var o yüzden bu konuda alınan önlemlerin yeterli olduğunu zannetmiyorum.

Mehmet: Sizce öncelikle bu gibi binaların yyıkılıp yeniden yapılması mı yoksa insanları başka bir yerlere mi olanakları salayığ Karadeniz olsun, Çanakkale olsun

başka bir yerlere götürmek mi İstanbul'un popülasyonunu alçaltıp daha değişik gökdelenler mi ve yeşil alan bırakmak mı daha mantıklı olur ?

Danyal: Blgesel olarak hepsini bir arada tatbik etmek lazım bir kısım gecekondu gibi ama daha doğrusu gecekondu kalmadı kotu yapılar var depreme dayanaklı uydu kentler yapıp bol yeşil alanlar oluşturmak lazım İstanbul'un yolları da dar gelecek depremde bu da çok büyük bir sıkıntı oluşturabilecek şehirdeki üniversiteleri Anadolu'ya taşımak lazım bir çok hastaneyi Anadolu'ya taşımak lazım ama bunlar içinde alt yapılar kurmak lazım bir çok sanayi ve ticaret merkezini de taşımak lazım ama dediğim gibi İstanbul'da belli oluşmuş bugüne kadar taşınacak yerlerde de bu alt yapıyı tekrar kurmak lazım bu söylemiş olduğumuz herşeyi bir harmoni icçnde uyum içinde yapmak lazım diye düşünüyorum yani hem gökdelen yapmak lazım hem bir kısmını taşımak lazım.

Mehmet: Başka bir diyeceğiniz düşündüğünüz başka bir bilgi ve söyleyecekleriniz var mı ?

Danyal: Var çünkü İstannbul hem dünya için hem YÇ icin çok önemli olup dünya tarihinde önemli bir yere sahip olmaktadır. Gerek Boğaz'ı ile gerek doğu-batı, gerek Asya ve Avrupa arasında bir köprü olmasıyla birleşme noktasında olması, bir çok imparatorluğa ev sahipliği yapması, bir çok kültürlerin ve dinlerin bir arada olması ve bir çok önemli merkezi bir arada tutması İstanbul'u bir dünya şehri yapıyorö Bu kültür bütün dünyaya ait olup sadece bizim TC 'ye ait değildir. Ama aynı zamanda insanlığa sunmak lazım, bunun içinde İstanbul'u çok iyi korumak lazım.

Mehmet: Çok çok teşekkürler.

Danyal: Ben teşekkür ederim.

2) Halil Gokcen ile Soylesi:

Mehmet: Kendinizi tanitirmisiniz ?

Halil: 2002elektronik mezunuyum. İstanbul'da Marmara Üniversitesi'nde okudum.

Mehmet: Kisaca istanbul ve depremi konusunda neler biliyorsunuz ?

Halil: :Çok geniş bir bilgim yok, olan bilgim genel kültür civarındadır.

Mehmet: Herhangi bir deprem tecrübeniz var mıdır ?

Halil: 17 ağustos depremi sonrası yıkılan bazı evleri gördüm. Ama tam olarak bu depremi hissermedim. Ama 6 Kasım'da olan deprem olduğunda İstanbul'daydım ve bu depremi fazlaca hissettim. Deprem anında üniversitedeydik. Herkes derin kanlıydı ve ben de insanların yaptıklarını yaptım.

Mehmet: Deprem sonrasında ne gibi izlenimleriniz oldu?

Halil: Ben avcılar'da kaldığım için, Avcılar'da bazı evlerde yıkılmalar oldu, benim kaldığım 12 katlı binada çatlaklar meydana geldi ama çok büyük bir hasar olmadı.

Mehmet: Deprem anında yapılacaklara daha önceden hazırlıklı mıydınız?

Halil: Hayır, genel olarak insanlar topluca hareket etti ve ben onlar ne yaptıysa onları yaptım. İnsanlar çok çeşitli şekilde tepkiler verdi, insanların çoğu bilinçsiz ve içgüdüleri ile hareket ediyorlar.

Mehmet: İstanbul'da olabilecek deprem konusunda herhangi bir eğitim var mı? Herhangi bir önlem alındı mı?

Halil: Bence deprem olsun olmasın her insanın deprem konusunda bilinçlendirilmesi lazım. Bu konuda en büyük görev medyaya ve eğitim kurumlarına düşüyor. Yapılacak eğitimin depremden depreme değil, orta ve uzun vade de eğitim verilmesi lazım. Benim gözlemlerime göre olan depremlerden sonra okulumuzda broşür ve kısa eğitimler verildi.

Mehmet: Olabilecek depremde hasar ne boyutta olacaktır?

Halil: Çok fazla olacaktır. Allah bu şekilde bir depremi göstermesin. Bireyler yapacaklarını yapmalı ve belediyelerin ve devletin öngörüleri yapp gerekli önlemlerin gerçekleştirilmesi için alt yapıların atılması gerekmektedir.

Mehmet: İstanbul nüfusunun azaltılması için ne gibi önlemler alınmalıdır ve bu nüfusun olabilecek depremden etkilenmeleri sizce neler olacaktır. Sizce en iyi deprem önlem planı nedir?

Halil: Benim şahsi görüşüm, İstanbul devamlı göç alan bir yer ve bunun en önemli nedeni ekonomik nedenlerdir. Ekonomik temel yapı taşlarını İstanbul'un dışına çıkartırsak ve insanları daha geniş alanlara güzel planlamalar yaparak yarleştirirsek bu sorunu halledebiliriz.

3) Tamer Hergunsel ile Soylesi:

Mehmet: Istanbuldaki olabilicek Tsunami ve Depremle ilgili bilgileriniz nelerdir?

Tamer: Olabilecek konusunda konusmam mumkun diilde olmuslar hakkinda konusursak olabilecek hakkinndada fakir sahibi olabiliriz. 1999 depreminde Istanbul merkezine 60-70 mil mesafede olan Yalova Golcuk Tutunciftlik Derince Yarimca gibi bolgelerde cok buyuk mali hasar ve insan kayiplari meydana geldi. Deniz kiyisi olan kesitlerde deniz doldurularak yapilmis alanlardaki binalar denizen altinda kaldi. Deniz karaya dogru ilerlemis oldu. Gencligimin bir bolumunu gecirdigim Halidere'deki (Golcuk Yalova arasi) yazlik yerlesim yeri) bir yakin akrabamin denize sifir evi bu trajik olayda yikildi. Deniz dolgulari kayboldu. Evle deniz arasindaki sonradan yapilmis olan sahil yolu sular altinda kalmis. Sular evin oldugu yere kadar gelmis.

Bir cok yerde saglam gorunen betonharme binalar yikilmis, eski ahsap yapilar daha az hasar gormustu. Zelzele bolgesinde dolatigimda gordugum, bazi yerlerdeki cok saglam gozuken binalarin yikildigi hemen yanlarindada cok eski binalarin da saglam durdugunu gozlemledim. Hatta depremde en buyuk zarar goren sehirlerden, Adapazarindaki bir akrabami ziyarete gittigimde sokagin sol tarafindaki binalara hic birsey olmamis, sag tarafindaki binalarin ise tamamen yikilmis oldugunu gozlemledim. Hatta ziyarate gittigim akrabamin evi saglam kalmisti fakat kapisinin onunde duran arabasi yolun karsi tarafindaki yikilan binalardan gelen molozun altinda kalmisti. Buralardan anlasilan su: Binalarin oturdugu arazi zemininin binalarin cinsine bakmadan olayi etkiledigini goruyoruz. Yani bazi yerlerde zeminden dolayi hasar goruyor bazi yerlerdede daha zayif eski binalar zemininden dolayi hasar gormemis olabiliyor. Hatta zelzeleden buyuk hasar goren Duzcede fay hattinin oldugu yere goturduler. Yerde bi hendek vardi. Toprak yarilmisti. Topragin bi tarafi batiya giderken digger tarafi doguya gitmis. Yaklasik 1-1.5 metre kayma vardi.

Akrabalardan Ahmet Enisten bir tane kaba insaati bitmis bir bahceli villa almis. Fikrimi sordu. Her ne kadar harci, betonu deniz kumu degilde dere kumu kullanilmis ve dere cakillari kullanildigi betonun saglam olmasina ragmen kolon kesitleri kucuktu. Burasi zelzele bolgesi, burada bu kolonlar yeterli olmiyabilir. Hesaplar yeniden yapilsin dedim. Bizim sirketten bir arkadas yolliyim kolon kesitlerini hesaplasin ve simdilik hic birsey yapma dedim. Oda lafimizi dinledi. Gonderdigimiz teknik arkadasin tavsiylerine uyarak kolonlari buyulterek insaatini tamamladi. Zelzeleden sonra ziyarete gittigimde duzcedeki evlerin buyuk bir kismi yikilmis oldugundan akrabamin evi dahil, hepsi o yazlik eve siginmislardi. Sadece bir kac bardak kirildigini soylediler. Baskaca binada bir hasar yok

idi. Ve ev sahibi arkadas firincidir. Depremden 1 1 bucuk ay sonra yuzlerce ev yapmis bir arkadasini sac sakal icinde kirpas icinde goruyor. Cadirda kaliyorlarmis. Gel bize bir dus yap tras ol diyor. Banyo yaptiktan sonra arkadasi bu buyukteki kolonlari biz 5 katli binalara bu buyuklukte kolon koymuyoruz. Nerden aklina geldi bu kadar buyuklukte kolon koymak diye soruyor. Firincinin cevabi da ben bilmiyordum sordum. Bilenin tavsiyesini gore yaptim fakat insaatcilik sizing mesleginiz yeterli buyuklukte kolon yapmazsan yaptigin butun evler yikildigi icin kendi evin dahil zelzeleden sonra firincinin evinde banyo yaparsin. Aslinda senin evinin benim evimden saglam olmasi lazim. Insaat yapmak senin isin.

Zelzelede zarar gormus cok katli binalar kolon ve kiris baglanti yerlerlerinin kopmasindan binalar yikilmakta bunun sebebide 1) eksik demir kullanimi 2) kaliteli beton kullanilmamisi 3) betonun iyi sikistirilmamasi 4) demir isciligini yapanlarin yeterli bilgi sahibi olmamasi 5) teknik elemanlarin beton dokumu esnasinda demir baglantilarinin dikkatli control edilmemesi 6) turkiyede kalip tahtalari fazla kullanilsin diye yanik yaglan tahtalari yaglarlar. Bu arada tahtalari yaglarken yanlislikla demirleride yagladiklari icin, ve bu demirlerin betonu tutmadigi icin oda zelzele agninda beton demiri tutmuyor.

Mehmet:Istanbulun alt yapisi konusunda ne yapilmalidir?

Tamer: Istanbulda alt yapi icin oldukca zor bi kent. Istanbulda oldukca tarihi eser var. Kazilan heryerde istanbulun bir cok yerde Roma, Bizans, Osmali eserleri cikmaktadir. Onun icin istanbulda yerin altinda calismak oldukca guc bi is. Kanalizasyon, tunnel gibi alt yapi islerini yapabilmek oldukca zor. Bunun icin mumkun mertebe istanbulda kazi isleri arkeologlara birakilmali. Tarihi kisimda mumkun mertebe yeni bir insaat

yapilmamali. Mevcut binalardanda tarihi degeri olmiyanlari yikarak bir acik hava muzesi gibi gelecek nesillere miras olarak birakilmali. Yapilacak olan yeni yerlesimler mumkun mertebe arkelojik sit alaninin disina yapilmali.

Mehmet: Istanbuldaki binalar hakkindaki dusunuceleriniz?

Tamer: Istanbuldaki binalarin malesef 80%'i tamamen control disi yapilmis kacak yapilardir. Bunlarin cogunda muhendislik calismalari yapilmamistir. Geleneksek methodla yapilmis cok katli binalar deprem aninda cok buyuk bir tehlike gostermektedir. Bunlarin cogu malesef yikilacaktir. Ayrica bu binalarin cogu dere yataklarinda kaygan bolgelerde zemininin saglam olmadiigi bolgelerde tamamen devlet denetiminden veya teknik eleman denetiminden uzak yapilmis oldugu icin buyuk hasarak gorecekleri herkes tarafindan tahmin edilmektedir.

Ayrica kurallara gore yapildigi dusunulen diger 20%lik bolumde buyuk bir tehlike arz etmektedir cunku binalar 1) bilgisiz kisiler tarafindan yapilmistir 2) yeterli teknik kontrolleri yapilmamistir 3) eksik malzeme kullanilmistir 4) 1960 senesinden once yapilmis olan binalarda o gunku deprem hesaplarindaki kullanilan demir ve beton daha az hesaplanmistir. 4) Istanbuldaki binalarin cogunda yikanmamis tuzlu deniz kumu kullanilmistir. Arti bide iclerinde cok fazla midye kabugu vardir. Kurallara gore yapilmis binlarda soylenen nedenlerden dolayi depremde buyuk hasar goreceklerdir. Mesela, 1966Adapazari zelzelesindeki yikimi gordum. 1941 senesindeki yikimida babam gormus. 1980de adapazarinin zenginlerinden bir iki arkadasim beraberce is merkezi yapmami onerdi. Bende burasi zelzele bolgesi bulasmak istemem dedim. Saglam yapariz dediler. Zemine guvenemiyorum dedim. Bizde henuz o yeterli teknoloji yok dedim. 1999 zelzelesinden sonra malesef 66dan sonra yapilmis binalarinda buyuk

bir kismi yikilmis. Kendi is yerleride dahil olmak uzere, zengin arkadaslarinda yaptiklari cogu bina yikildi.Daha sonrada Adapazarinin yerini degistirmeye karar verip merkezi cevredeki saglam zemine tasidilar.

Mehmet: Olabilecek depremde Istanbul'un sahip oldugu tarihi yapilarinin korunmasi icin ne gibi tedbirler alinmalidir?

Tamer: Tarihi binalarin zeminleri saglamlastirilarak binalarin istedigi gerekli teknik tedbirler alinmali. Cevresindeki gereksiz luzumsuz tarihi degeri olmayan binalarda ortadan kaldirilmalidir.

Mehmet: Istanbulda olabilecek depremden sonra kurulmasi muhtemel yeni Istanbul'un nerede ve nasil kurulmasini istersiniz?

Tamer: Istanbulun Marmara Karadeniz arasinda tasinabilecigi saglam zeminli yeterli arazi vardir. Oncelikle okullar ve hastaneler buralara tasinmalidir. Planli bir sekilde yeni yerlesim yerleri yapilmalidir. Bazi universteler sehir disinda saglam zeminli alanlara tasinmaktadir. ITU ayazaga ya tasindi. KOC universtesi sehir disinda kampusunu yapti. Yeditepe universteside saglam zeminli Kayisdagina kampuslerini kurdu. Buna benzer bir cok yerlesim yerleride son teknolojiye gore saglam zeminle alanlarda yapilmaktadir. Ve insanlarda artik ev alirken saglam zemine yapilmis semtlerde ev almaya calismaktadir. Daha once yerlesme acisindan moda olan bazi semtler zeminlerinin saglam olmadigi gerekcesiyle eski degerlerini yitirmistir. Ornegin yesilyurt ve yesilkoy taraflari. Buna karsilik umraniye gibi saglam zeminli olup degerli olmiyan yerleri buyuk deger kazanmistir.

Mehmet: Istanbul'un yeniden yapilandirilmasinda devletin rolü ne olmalidir?

Tamer: Devletin oncelikle kacak yapilanmayi engellemesi lazim. Saglam zeminli yeni yerlesim bolgelerini tespit edip alt yapilarinin ve imar planlarini duzgun bir sekilde yapmasi gerekmektedir. Mumkun mertebe sehrin bilhassa merkezi ve tarihi bolgelerindeki yeni yapilanmalari ilgilenmesi bilhassa devlet yatirimlarini hastane, okul, devlet daireleri gibi bu yeni tespit edilen alanlara tasimasi ve olabilecek deprem durumunda sagliksiz binalardaki yikimdan dolayi olacak insan zaiyatini azaltmak devletin esas gorevi olmalidir. Saglam olmayan binalari yeni teknolojiye gore saglam zeminli alanlara tasimasi gerekmektedir.

Mehmet: Olabilcek bir depremde ve tsunamide Istanbulda yasayacak insanlarin ihtiyaclarinin nasil karsilanacagi konusunda ne dusunuyorsunuz?

Tamer: Malesef cok buyuk bir problem. Cunku sehir merkezinde sokaklar cok dar olup, binalarin yikilmasi durumunda kurtarma calismalarini yapacak vasitalarin ambulans, itfaiye vs cok zordur. Turkiyedede bu konuda yapilmis calismalar cok yetersizdir. Gostermelik olarak bazi yerlere yapilmis icinde kazma kurek balta yatak, bahtaniye ilk yardim malzemeleri mazemeler bulunan binanlar hirsizlar tarafindan devamli soyulmakta, bir ihtiyac halinde gerekli malzemeler bulunamiyacaktir. Yardim calismalarina istirak edecek personelin yetistirilmesi, sivil toplum kuruluslarinin cok iyi yonlendirilmesi ve egitilmesi gerekmektedir. Turkiyede malesef yeterli arama ve kurtarma faliyetlerine katilicak egitilmis eleman sayisi cok azdir. Devletin bu konuda bilgi ve beceresi olan ekipler yetistirmesi ve bunlari organize etmesi gerekmektedir.

Mehmet: Altyapi sorunlarinin olabilecek deprem sonrasi etkileri sizce ne olacaktir?

Tamer: Turkiyede zaten nufusa gore mevcut altyapi yeterli degildir. 5 cm kar yagdigi zaman bile Istanbulda hayat felc olmaktadir. Buyuk bir zelzele oldugu zaman kucuk

sehirlerde bile korkunc bir kargasa yasanmakta istanbulda olabilecek bir zelzelenin sonrasinda olabilecekleri dusunmek bile insani malesef cok uzmektedir. Tabi afetlerin en kotu tarafi kotu niyetli insanlarin bu aci zamanlarda yaptigi soygunlar talanlar yagmalar acinin uzerine tuz biber ekmektedir ve insanliga sigmiyacak olaylarla karsilasilmasi supriz degildir. 1939 Erzincan zelzelesinde yedek subayligini yapan dedemin bir arkadasi enkaz kaldirma icin yardimci olurlarken elindeki bilezikleri enkazin disinda vucudu ise altinda kalan bir kadinin kolunu kesmeye calisan bir talanciyi vurarak oldurdugunu anlatmasi aci bir hatira olarak bellegimdedir.

Mehmet: Istanbul'un nufusunun her gecen gun cogalmasinin sebepleri neler olabilir?

Tamer: Turkiyedeki genel issizlik. Tarima ve hayvanciliga yeterince onem verilmemesi, Turkiyede aile basina dusen arazilerin dengesiz olmasi ve arazilerinde cok parcali olmasi ekonomik verimliligi dusurmektedir. Tarim ve hayvancilik urunlerinin maliyetleri kucuk ureticiler acisindan rekabeti zor olmaktadir. Dolayisiyla kucuk ureticiler, koylerde yasiyan insanlar gecim zorlugu ile buyuk sehirlere goc etmektedirler.

Eskiden insanlar sogan ekmekle gecinirdi. Ancak su an insanlar ihtiyaclari ve talepleri artti. Herkes kendine daha iyi hayat sartlari istiyor. Bunun icin yurt disina yada sehirlere goc ediyorlar. Istanbulda bunlardan en cazibe yerlerinden bitanesi. Su anda avrupada 5 milyon insan vardir. Son 50 senede buyuk cogunlugu Almanyaya olmak uzere avrupaya calismak icin goc eden insan sayisi 5 milyon civarindadir. Ozellikle ufak koylerden yurt disina calismaya gidenler, senelik izinlerinde koylerine dondukleri zaman oradaki refahi birazda ballandirarak anlattiklari icin goce tesvik etmektedirler. Onlari gorenlerde

sehirleri yada Avrupanin yollarini aramakta son 50 senede sehirlere goc bu nedenle buyuk oranda artmistir.

B) SURVEY:

Brief information about yourself (age, education): _____

Did you ever experience an earthquake or a tsunami before? Yes/No/Heard about it

Pleas answer the following questions below according to the following degrees.

1= very little 2= little 3= fair 4= well 5= very well

1. What is your knowledge on earthquakes and tsunamis? _____

2. How much do you think you know about *the* possible earthquake in Istanbul and where the fault lines are? _____

3. How sensitive do you think the building and the area you are living in against possible earthquakes and tsunamis? _____

4. How prepared do you feel against *the* possible earthquake in Istanbul (Example: emergency-kit or emergency plan)? _____

5. Do you have any knowledge about possible tsunami waves which could be created by the fault lines in the Marmara Sea? _____

6. How safe do you feel and what kind of precautions do you think are being taken in Istanbul? _____

7. How much do you believe that the necessary preparations will be made against *the* possible earthquake in the following years? _____

8. How well do you approach to the idea of relocating of some of the population in Istanbul in order to decrease it? _____

9. How strong do you think the communication network is against *the* possible earthquake and possible tsunamis? _____

10. Do you have any knowledge about the Earthquake Insurance? _____

11. Are you against the idea of relocating the industrial areas of Istanbul? What kind of an effect would it have on you? _____

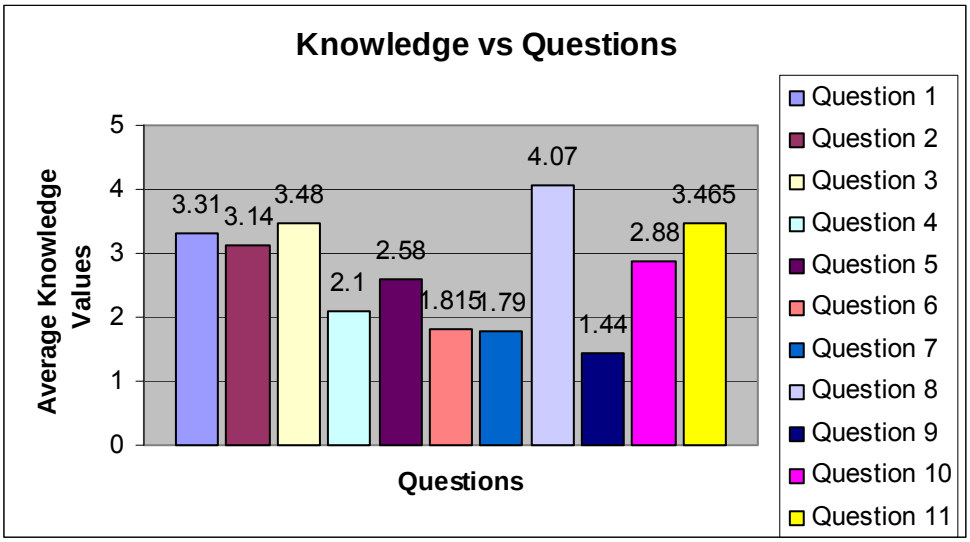
In your opinion, which scenario is likely to minimize the damages the most from *the* possible earthquake in Istanbul from the choices below?

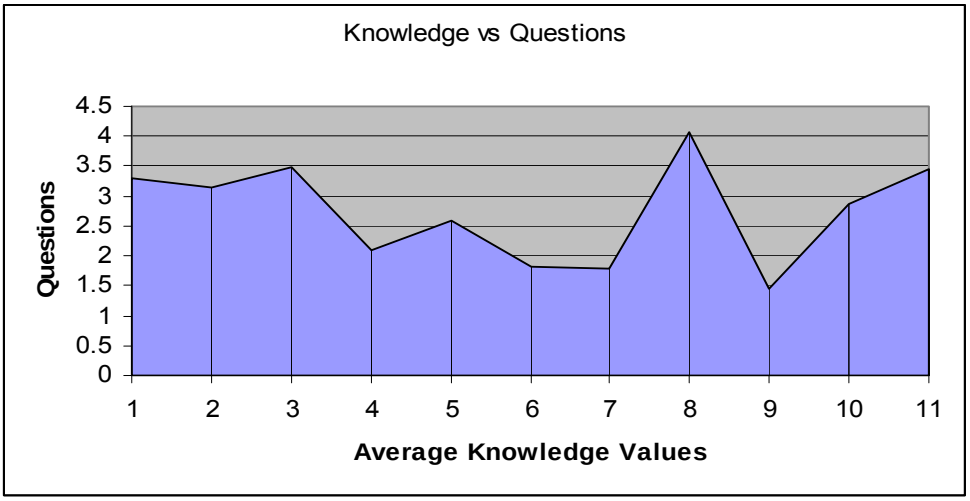
a) Move the inhabited to other cities.

b) Reinforce buildings throughout Istanbul; systematic teardown/build.

c) Build high-rise buildings, saving space and the environment.

d) Do nothing.





- Area of knowledge is 35.755. The total area possible is 50. Therefore, there is a 71.51% of knowledge in a survey of 100 random people when asked questions about Istanbul.
- Results of Question1: There is an average knowledge of 3.31. There is a fair knowledge on earthquakes and Tsunamis.
- Results of Question2: There is an average knowledge of 3.14. There is a fair knowledge about the possible earthquakes in Istanbul and where the fault lines are.
- Results of Question3: There is an average knowledge of 3.48. There is some kind of good sense of how sensitive the buildings and areas that the residents of Istanbul living about possible earthquakes and tsunamis.
- Results of Question4: There is an average knowledge of 2.1. Istanbul is poorly prepared for a possible earthquake.
- Results of Question5: There is an average knowledge of 2.58. The residents of Istanbul do not have adequate knowledge about possible tsunami waves which could be created by the fault lines in the Marmara Sea

- Results of Question6: There is an average knowledge of 1.815. The precautions are taken poorly in Istanbul.
- Results of Question7: There is an average knowledge of 1.79. The residents of Istanbul believe that the necessary preparations are very poor against the possible earthquakes in the following years.
- Results of Question8: There is an average knowledge of 4.07. The residents believe that the idea of decreasing the population in Istanbul is a very good idea.
- Results of Question9: There is an average knowledge of 1.44. The communication network is awefully poor against the possible earthquakes and tsunamis.
- Results of Question10: There is an average knowledge of 2.88. There is a fair knowledge about Earthquake Insurance.
- Results of Question11: There is an average knowledge of 3.465. Relocating the industrial areas of Istanbul does not a major effect on the residents of Istanbul.

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B) Figures

Figure1-1
http://images.google.com/images?q=%20turkiye%20haritasi&ie=utf-8&oe=utf-8&client=firefox-a&rls=org.mozilla:en-US:official&sa=N&tab=wi

Figure 1-2
http://images.google.com/images?q=%20turkiye%20haritasi&ie=utf-8&oe=utf-8&client=firefox-a&rls=org.mozilla:en-US:official&sa=N&tab=wi

Figure 1-3
Google Earth

Figure 1-4
http://images.google.com/images?q=gaziosmanpasa&svnum=10&hl=en&lr=&rls=GGLG,GGLG:2005-26,GGLG:en&start=20&sa=N

Figure 1-5
http://images.google.com/images?hl=en&rls=GGLG,GGLG:2005-26,GGLG:en&q=constantinople&spell=1&sa=N&tab=wi

Figure1-6
http://www.34tr.com/data/thumbnails/11/Old%20Not%20Used%20Map.jpg

Figure 1-7
http://images.google.com/images?svnum=10&hl=en&rls=GGLG,GGLG:2005-26,GGLG:en&q=la+ville+et+le+port+de+constantinople&spell=1

Figure 1-8
http://images.google.com/images?svnum=10&hl=en&rls=GGLG,GGLG:2005-26,GGLG:en&q=nationalgeographic+istanbul+pictures&spell=1

Figure 1-10

http://www.ozanhouses.com/Dansk/Istanbul/Fotoalbum_Istanbul/Street1.jpg

Figure1-11
http://www.kotuvepis.com/ist/eskiistanbul1.htm

Figure1-12
http://www.34tr.com/index.php?template=Blue%20Mosque

Figure1-13
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Figure 1-14
http://images.google.com/images?q=gaziosmanpasa&svnum=10&hl=en&lr=&rls=GGLG,GGLG:2005-26,GGLG:en&start=20&sa=N

Figure 1-15
http://images.google.com/images?hl=en&rls=GGLG,GGLG:2005-26,GGLG:en&q=constantinople&spell=1&sa=N&tab=wi

Figure 1-16
http://images.google.com/images?q=major+tectonic+plates+of+the+world&svnum=10&hl=en&lr=&rls=GGLG,GGLG:2005-26,GGLG:en&start=20&sa=N

Figure 1-17
http://images.google.com/images?svnum=10&hl=en&lr=&rls=GGLG%2CGGLG%3A2005-26%2CGGLG%3Aen&q=++world++Fault+Lines

Figure 1-18
http://images.google.com/images?svnum=10&hl=en&lr=&rls=GGLG%2CGGLG%3A2005-26%2CGGLG%3Aen&q=+++active+fault++map+of+turkey++

Figure 1-19
http://images.google.com/images?svnum=10&hl=en&rls=GGLG,GGLG:2005-26,GGLG:en&q=major+earthquake+in+turkey++&spell=1

Figure 1-20
http://www.deprem.gov.tr/haber.htm

Figure 1-22
http://images.google.com/images?svnum=10&hl=en&lr=&rls=GGLG%2CGGLG%3A2005-26%2CGGLG%3Aen&q=+Major+Earthquake++in+turkey

Figure 1-23
http://images.google.com/images?svnum=10&hl=en&lr=&rls=GGLG%2CGGLG%3A2005-26%2CGGLG%3Aen&q=+Fault+lines++turkey

Figure 1-24
http://images.google.com/images?q=++Marmara+Sea&svnum=10&hl=en&lr=&rls=GGLG,GGLG:2005-26,GGLG:en&start=20&sa=N

Figure 1-25
http://www.angelfire.com/de2/zelzele/tablo1.html)

Figure 1-28
http://images.google.com/images?q=what+the+tsunami+is&svnum=10&hl=en&lr=&rls=GGLG,GGLG:2005-26,GGLG:en&start=60&sa=N

Figure 1-29
http://images.google.com/images?sourceid=navclient&ie=UTF-8&rls=GGLG,GGLG:2005-26,GGLG:en&q=%20Formation%20of%20a%20Tsunami&sa=N&tab=wi

Figure 1-30
http://modersmal.skolutveckling.se/turkiska/nilgun/Tsunami/tsunami22.gif

Figure 1-33
Google Earth

Figure 1-34
Google Earth

Figure 1-35
Google Earth

Figure 1-36
Google Earth

Figure 1-37
Google Earth

Figure 2-1
Matrix

Figure 2-2
http://images.google.com/images?svnum=10&hl=en&lr=&rls=GGLG%2CGGLG%3A2005-26%2CGGLG%3Aen&q=istanbul+map+

Figure 2-3
http://www.google.com/search?sourceid=navclient&ie=UTF-8&rls=GGLG,GGLG:2005-26,GGLG:en&q=map+of+turkey

Figure 2-4
http://images.google.com/images?hl=en&rls=GGLG,GGLG:2005-26,GGLG:en&q=map%20of%20canakkale&spell=1&sa=N&tab=wi

Figure 3-1

http://images.google.com/images?q=remparts&ie=utf-8&oe=utf-8&client=firefox-a&rls=org.mozilla:en-US:official&sa=N&tab=wi

Figure 3-2
Google Earth

Figure3-3
http://www.universes-in-universe.de/car/istanbul/ort/e-istanbul-06.htm

Figure 3-4
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Figure 3-5
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Figure3-6
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Figure 3-7
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Figure 3-8
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Figure 3-9
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Figure 3-10
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Figure 3-11
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Figure 3-15
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Figure 3-16
Google Earth

Figure 3-17
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Matrix