

Landslide, Earthquake & Flood Hazard Risks of Izmir Metropolitan City, A Case: Altindag Landslide Areas

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Abstract—Urban disaster risks and vulnerabilities are great problems for Turkey. The annual loss of life and property through disaster in the world's major metropolitan areas is increasing. Urban concentrations of the poor and less-informed in environmentally fragile locations suffer the impact of disaster disproportionately. Gecekondu (squatter) developments will compound the inherent risks associated with high-density environments, in appropriate technologies, and inadequate infrastructure.

On the other hand, there are many geological disadvantages such as sitting on top of active tectonic plate boundaries, and why having avalanche, flood, and landslide and drought prone areas in Turkey. However, this natural formation is inevitable; the only way to survive in such a harsh geography is to be aware of importance of these natural events and to take political and physical measures.

The main aim of this research is to bring up the magnitude of natural hazard risks in Izmir built-up zone, not being taken into consideration adequately. Because the dimensions of the peril are not taken seriously enough, the natural hazard risks, which are commonly well known, are not considered important or they are being forgotten after some time passes. Within this research, the magnitude of natural hazard risks for Izmir is being presented in the scope of concrete and local researches over Izmir risky areas.

Keywords—Earthquake, Flood, Landslide, Natural Hazard Planning.

I. INTRODUCTION

NATURAL hazards are natural events. The earth is a highly dynamic planet, and most of the natural events show a wide range of variation through the time energy and material of environmental process. The extreme natural events are not considered hazards unless they cause death or damage to humans. A severe earthquake in a remote, unpopulated region is an extreme natural event of interest to seismologists, and no more [1].

Hazard is an ever-present, unavoidable part of life. The fact is that such events are not unexpected. As urban growth in hazardous areas continues and as buildings is constructed carelessly, the devastating potential of floods, earthquakes, landslides, and rock falls etc. increases at the same time, advances in mapping hazardous areas, assessing population vulnerabilities, and designing to withstand destructive forces have created new opportunities for reducing losses.

The main reason of perception and location is to do with

establishing good pre-disaster and post disaster strategies and programs. It is indispensable to take measures integrally and locally against diversifying natural hazards, specific variations of which are regional and country- wide. Especially in countries having a risky geographical and geological structure, like Turkey, a concept of perception and measures against natural hazard are unavoidable.

There are serious natural hazard risks in Izmir, which is a metropolis and third largest city of Turkey. Flood, earthquake, landslide and rock fall hazards have damaged to Izmir built up zone many times in the past. Especially, earthquake risk increases the hazard probability. But the competent authority cannot take main measures and precautions.

II. TOPOGRAPHIC AND GEOLOGIC RISKS

A. Topographic situation and master Plan in Built-up Zone

Izmir survived as a big city throughout its history of 5000 years and has been frequently renovated under geopolitical and geological influences. Izmir has been greatly affected by some disasters such as earthquakes, fires, epidemics and etc. Thus many edifices that would reflect historical background of the city did not survive until today and present remains are generally few and known only by experts and the neighboring people [2].

Izmir forms an interesting situation in terms of land-use and urban settlements (see Fig. 1). Most of the urban area is situated on the arable or agricultural land. Indeed the residential area is found on the southern edge of the Menemen deltaic plain, the Bornova plain and piedmont of Inciralti-Narlidere- Güzelbahce. The squatter and public social housing developments are built on the land composed of andesitic mass.

Population increases and its development pressure son rural areas were inevitable problems for Izmir. Urban housing supply could not meet the demand, the housing policies could not be integrated with that of urban land and the housing subsidies could not help to serve low-income groups.

Natural environmental features of Izmir increase its natural hazard risks. Izmir has topography slopes that surround the city shape. Further more, soil geology is unsuitable for to settle down in built up area. On the other hand natural hazard

risks increase because of the spread of the illegal urban settlements and the build feeble building types.

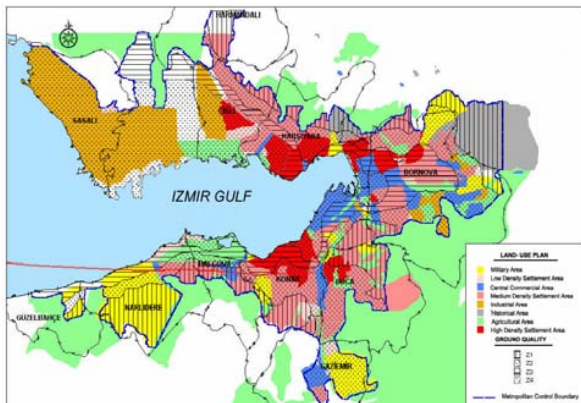


Fig. 1 Master Plan in 2005 of Izmir Metropolitan Area

B. Geologic Situation in Built-up Zone

Soil character in and around Izmir is continuously changing at the expense of agricultural land and natural environment. Fertile irritable land is changing into settlement areas or express roads, factories; storage houses are constructed upon them. Some very specific types of agricultural products such as; artichokes, sultana grapes, olives and tangerines are now inhabited and lost from production point of view (see Fig. 2-3).

All these are the results of uncontrolled urbanization and planning practices undermining the ecological and agricultural objectives under the pressure of unacceptable escrowing of the city.

On top of the productivity and agricultural products reducing due to this unduly used land, concrete covered surfaces affect the climate, water and airborne pollutants degrade the soil properties and even sometimes the soil it is used as a raw material in industrial production and used out.

Under all these pressures soil structures are affected badly, slope stability and sliding properties are changing and resistances of the soil against such pressures are diminishing. This causes lowering of the soil classes and takes away the withstanding capacity of the soil against environmental pressures. Continuing deforestation and tree cutting left open the soils to severe erosion. The severe flood that occurred on 4th November 1995 at the outskirts of Yamanlar Mountain and the flow of soil material together with it is an indication of this.

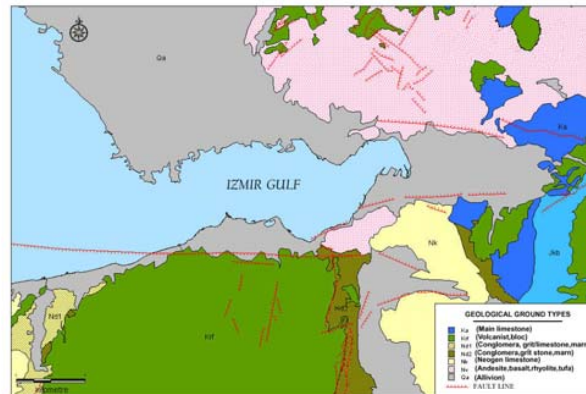


Fig. 2 Geological Map and Fault Lines of Izmir Metropolitan Area

III. EARTHQUAKE AND FLOOD HAZARD RISKS

A. Earthquake Risks in Izmir Built up Zone

Izmir is one of the seismically active parts of the Aegean Plate. It shows a very complex, active, move and rapidly changing tectonic pattern due to the relative motions of surrounding tectonic plates. According to history readers, earthquakes have been the most damaging natural disasters that have affected the Izmir built up area. There have been at least 20 disastrous earthquakes with magnitudes greater six reported, which are in literature. For example, readers documented that historical cities in and around Izmir were destroyed in AD. 17, 47, 105 and 178 [3].

In the last century three damaging earthquakes occurred in Izmir and its surroundings: 1928 Torbali, 1949 Karaburun and 1992 Seferihisar earthquakes mostly affected the southern part of Izmir. Izmir built up zone belongs to the first-degree hazard zone in the official Earthquake Hazard Rationalization Map of Turkey (see Table I).

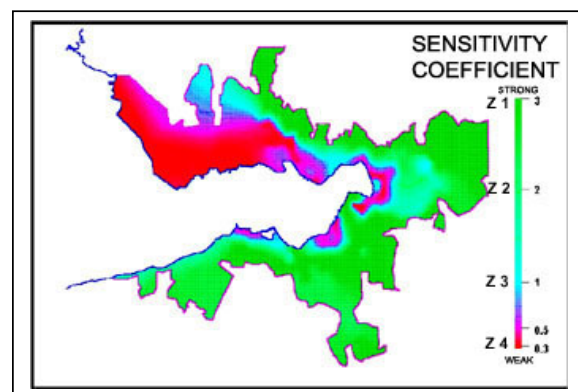


Fig. 3 Earthquake Sensitivity Coefficient Value of Izmir Metropolitan Area

TABLE I
EARTHQUAKE HAZARD RATIONALIZATION OF TURKEY

No	City Area	Date	P. (km)	Ms	H. Dam	M. Dam	L. Dam	# of D.
1	Izmir-Torbalı	1928	10	7.0	2100			50
2	Izmir-Dikili	1939	10	7.1	1235			60
3	Izmir-Karaburun	1949	10	7.0	824		946	1
4	Izmir-Karaburun	1969	16	5.6	443			
5	Izmir	1974	31	5.2	47	2610	2800	2
6	Izmir	1977		4.8	11			
7	Izmir	1977	24	5.3	40			
8	Izmir-Foça	1979		5.9	22			
	Izmir	1992	27	5.2			150	
	Izmir-Urla	2003	35	5.4	35	200	650	
	Izmir-Urla	2005	18	5.9	250	510	2760	
	Izmir-Urla	2005	16	5.9	250	510	2760	

P. (km): Proth (km), H. Dam.: Heavy Damage, M. Dam.: Medium Damage, L. Dam.: Light Damage, # of Death: Number of Death.

The Izmir area takes place at the west part of the Gediz Graben system and contains several morphologically prominent active normal faults with approximately east-west strike. Moreover, the NE-SW and NW-SE trending faults, whose kinematics characteristics differentiate, form north to south, take major roles on the tectonic regime of the region. Even though there is no evidence on the active faults that could create a high earthquake activity except Gediz Graben, both historical and instrumental seismic activity is rather dense between Karaburun–Chios, Izmir Bay-Lesbos and Doganbey-Samos axes [4].

According to RADIUS project group researches (2001), the soil characters in Izmir Metropolitan Areas separate four different parts. This soil codes which are named Z1-Z2-Z3-Z4 symbols, show to be influence with earthquake affect (Z4: the most weakly soil character, Z1: the most strongly soil character).

B. Flood Risks in Izmir Built up Zone

Flash floods associated with intense rainstorm have occurred many times in the Aegean and Mediterranean coasts of Turkey in the past, and the magnitude of these types of intense storms has risen in recent years.

A group of rainstorms swept through the Aegean and Mediterranean coast of Turkey during 3rd–5th November 1995 and led to devastating flash floods. Settlements along the Aegean coast suffered the greatest damage from the flood. The flood associated with the heavy rains claimed the lives of 67 people and caused more than 50 million dollars of residential and commercial property damage in Izmir. Cars,

bridges and buildings were swept away by the raging floodwaters of creeks, which had burst their banks. In this disaster, 322 buildings were destroyed completely, nearly 10.000 houses suffered major damage as a result of the flooding in the city. Damage from the flood was greatest in the Karsiyaka district, which is the major commercial and residential centre of the city.

Topography, geomorphology, land-use and urbanization are three main factors that have considerable impact on downstream extension of the flood and aggravated the consequences of the flood to a great extent in area. Topography and geomorphology can play a large role in the structure. The main topographic and geomorphic features of the area are Yamanlar Mountain and Yamanlar expression, Upper Karsiyaka plain, and Lower Karsiyaka plain. The Plain is formed by fine-grained alluvial deposits brought by the water table in the area is very high. The Karsiyaka district, which is the commercial centre of the city, is located in the plain and it suffered the greatest damage from the flood [5].

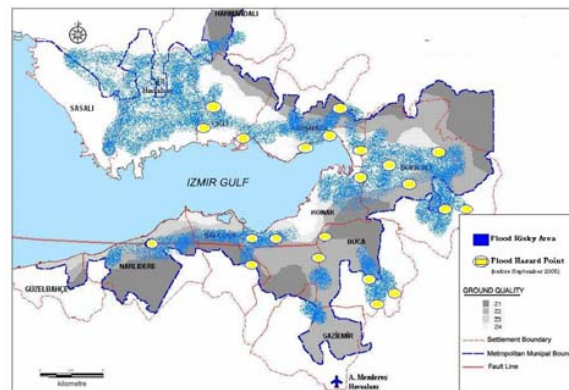


Fig. 4 Flood Risks Areas of Izmir Metropolitan Area

The main issue of the flood in Izmir however can be explained best by the uncontrolled urbanization factors. The population of the city has been rising steadily and already exceeded 2 million people due to migration from other parts of the county. In order to absorb the increasing population new settlements were constructed in the Karsiyaka and Yamanlar district. In between 1987 and 1995, 50.000 new buildings were constructed in the Karsiyaka district. As a result of the increased construction activities in the parts of the Yamanlar and Karsiyaka district, more soil became vulnerable to the storm runoff due to the excavation (see Table II and Fig. 4).

The other important problem about flood hazards was stream position for Izmir built up zone. Poor quality of streams and bridges that most of all caused floods were seen in 1995's disaster. Especially, Büyük Cigli, Bostanlı, Yamanlar, Ali Bey and Narlıdere streams affected physical damage in built up zone.

TABLE II
MAJOR FLOODS IN İZMİR CITY

No	City	County	Village	H. Dam	M. Dam	L. Dam	Non Damage
1	İzmir	Çiğli	8	77	13	28	170
2	İzmir	Narlıdere	8	25	9	30	29
3	İzmir	Karşıyaka	18	208	126	427	1047
4	İzmir	Konak	2	0	1	11	50
5	İzmir	Güzelbahçe	1	5	8	7	138
6	İzmir	Balçova	1	0	3	3	7
7	İzmir	Bornova	2	0	0	1	45
8	İzmir	Menemen	8	14	23	33	47
9	İzmir	Urla	4	0	5	3	13
Total				329	188	543	1546

H. Dam.: Heavy Damage, M. Dam.: Medium Damage, L. Dam.: Light Damage

IV. LANDSLIDE HAZARD RISKS AND ALTINDAG CASE AREA

A. Landslide and Roc Ffall Hazards in İzmir Built up Zone

In İzmir built up area, landslides are at two different regions, first of all can be seen in the bed of Kocacay stream, Karagol and Yamanlar village and their surroundings in north of İzmir Gulf. The other one is the Cretaceous detritics in the South of İzmir Gulf out cop in the South line of Balçova-Güzelbahçe [6].

Similar to the landslide events, the rock fall events were evaluated using the Disaster Working reports registration data. Much report were not taken into consideration because of their occurring dates are not known exactly. 17 rock fall events were recorded from the Disaster Working İzmir City Head Office reports between 1950 and 1998.

Landslide and rock fall areas are around the metropolitan city, especially, squatter areas are risky regions about them. In İzmir built up area, there are 15 different rock fall and landslide areas that are around the city [7] (see Table III, Fig. 5).

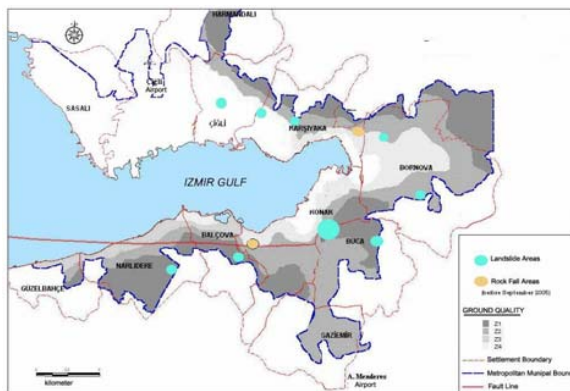


Fig. 5 Landslide and Rock fall areas of İzmir Metropolitan Area

TABLE III
MAJOR LANDSLIDES & ROCK FALLS AREAS IN İZMİR CITY

No	Region	Damage Buildings	Natural Hazards type
1	Cigli- guzeltepe	440	Landslide
2	Cigli- Ornekkoy	18	Rock fall
3	Karsiyaka- Ornekkoy	50	Rock fall
4	Bayrakli- Cicekkoy	20	Rock fall
5	Buca- Sakarya	44	Rock fall
6	Konak- Kocakapi	28	Rock fall
7	Konak- Gurcesme	10	Landslide
8	Asansor	54	Rock fall
9	Kadifekale	3162	Landslide
10	Altindag- Merkez	62	Landslide
11	Altindag- Kuyu	11	Landslide
12	Altindag- Camdibi	13	Landslide
13	Hakimiyeti Milliye	64	Landslide
14	Narlidere- Narkent	800	Landslide

Landslides that are in the İzmir built up zone are studied as key study subject in this study. Moreover, three landslide areas which are in Altindag landslide areas, will explained together with habitants who lived in there.

Altindag landslide district which is in the east of Gürçeşme, in the west of Merkez district, in the north of Buca skirts of Kalabak Hills and in the south of Bornova, was occurred because of the fault of Kadifekale- Altindag line. Altindag district is a very famous area about landslide risky areas in İzmir Metropolitan zone. There are three different landslide area in Altindag districts; Merkez- Zafer Area, Su Deposu area and Camdibi area.

In Altindag- Merkez district, characteristic silt and muddy debris flows were more common and clayey and silty materials are dominant there. An active silt- mudflow in central district of Altindag is having approximately circular shape at depth of 1- 2 m. And slope angles of 10° noted. The active landslide line of fossil landslide can be seen in the area of Altindag district, at the south of Kancesme ridge located by the mini football field, Central district, and their surroundings have the characteristics of active landslide.

Additionally, a new soil flow in Camdibi district has occurred by the excavation in the toe of the slope wash unit. In Camdibi region, the type of soil is dangerous and risky about landslide for people.

Three different types of data, which were related with built environment, land ownership and social environment, were collected in Altindag landslide areas. These analyses showed us different results, which were economically- social and legally different, in landslide areas of Altindag district [8].

TABLE IV

SITE ANALYSIS OF LANDSLIDE AREAS IN ALTINDAG CASE IN IZMIR CITY

Built Environment Analysis	Social Environment Analysis	Land Ownership Analysis
<ul style="list-style-type: none"> Land- Use Plan Ages of Buildings Qualities of Buildings Storey Numbers of Buildings Building Areas) In construction Iron Proportion Damage level of Buildings Suggested Precaution 	<ul style="list-style-type: none"> Household Density Household Ages Household Educations Household Occupations Household Numbers Household Incomes Household, House/ Car Ownership 	<ul style="list-style-type: none"> Cadastral Plan Legal Status of Building Legal Status of Plot Land- Building Ownership Pattern Changing Process of Land Ownership Pattern Period of Residence Comparison of Development Plan with Existing land use Plan

TABLE V

SITE ANALYSIS OF LANDSLIDE AREAS IN DIFFERENT REGIONS OF ALTINDAG

ALTINDAG- ZAFER REGION	ALTINDAG- SU DEPOSU REGION	ALTINDAG- ÇAMDIBI REGION
Similarities <ul style="list-style-type: none"> All of landslide areas are defined as "Potential Landslide Areas" by The Ministry of Public Work and Settlement Some families are living in each of these zones. (Zafer: 6 families, 47 people, Su Deposu: 8 families, 84 people, Camdibi: 15 families 75 people) All families are living illegal buildings and any of them have not permissions. The Bornova Municipality does not take whatever measures. 		
Differences <p>According to both Bornova Municipality and Ministry, if the necessary measures, which are to replace technical infrastructure, to change the stream axes to control subterranean water, are taken, the landslide areas are will be suitable for development</p> <p>According to Bornova Municipality; landslide area is not dangerous for buildings and suitable for developments. (DEU shored up to this implementation, 1994) Ministry and Rescue Committees of Altındag District were opposed</p> <p>According to both Bornova Municipality and Ministry; the landslide area is certainly unsuitable for developments. This area should be afforested and should be controlled after heavy rainfall.</p>		
Suggestions <ul style="list-style-type: none"> In Zafer Region, immediately necessary measures should be taken and building constructions should be controlled. In Çamdibi Region; certainly this area is not suitable for development. Therefore all habitants should be transported, until any dangerous hazard will occur. In Su Deposu Region: Detailed researches should be done about landslide occurrence and all authority departments should decide and should declare the results together. Municipalities should not think political attitude about voters. 		

The site study was take place in April-May 2004. The study started by preparation of questionnaires that is containing the social, construction and ownership types of questions. In the second stage, questionnaires were interviewed in all houses of Altındag landslide areas. The photo archive was the most important data about landslide areas in Altındag district. Three site visits were given (May 2000, May 2002 and May 2004) to see the development of landslide areas (see Table IV- V).

B. Built Environment Analysis

Built environment analysis includes buildings and their physical features. Inhabitants were settled in different dates in landslide areas of Altındag, therefore different materials were observed on the buildings.

In this section, lands use plan, building quality, building age, building area, building storey, building structure and damage level of buildings were examined in landslide areas of Altındag- Çamdibi, Sudeposu and Zafer regions. Particularly, building damages and iron proportions in constructions were taken into consideration.

C. Social Environmental Analysis

Habitants, who live in landslide areas of Altındag district and their social structures, were researched in this section. Household surveys were realized for each building in landslide areas, and data were collected about density, ages, household size, education level, and occupation, incomes and houses- car ownership patterns of families in the study areas.

D. Land Ownership Analysis

The other important factor related with settlements in landslide areas is land ownership pattern. In this analysis, cadastral map numbers, plot numbers and areas, title deed numbers and dates, title deed owner names, legality of plots, period of residence, changing process of land ownership's in risky areas were researched in detail.

V. CONCLUSION; PRINCIPLES OF PLANNING PROCESS

The importance of work and readiness for preventing or minimizing natural hazard effects in Turkey, belonging to Developing Country Group, is doubled due to risks increased by its geological and geographical conditions. Turkish Natural hazard Policy, relating internal social and economical conditions, together with foreign relation arrangements, should be examined, and new strategies in law, institution and application fields determined [9].

To minimize natural hazard risks is the planning conception to be concretely discussed. Urban-scaled regional physical plans, land use plans, protection and improvement projects for old construction areas and new techniques should be assured by setting relations with new techniques and natural hazard concept.

Development and Regional Plans: Basic principles for diminishing natural hazard effects consist of balanced allocation of the population, economical operations and avoiding agglomeration in certain regions, creating reliable environments, bearable for living. This is the reason that distorted urbanization should be prevented. In other words, country leveled decisions be taken. National sources should be researched and a relation brought up between economical and physical events. Local physical plans should be supported with regional ones and consolidated. Crowding movements in metropolis, decrease of agricultural fields and constructing

buildings in unfavorable alluvium lands, are facts, which increase natural hazard risks. Consequently, regional geology maps should determine inconvenient and natural hazard risky areas. Regional planning projects, which depend on mentioned regional geology maps, must be compulsory.

Sub- Regional Plans and Metropolitan Plans: Basic problem is that the necessity of making metropolitan plans according to the country and regional plans goes to a dead end from the very beginning, due to a lack of regional plans. Although actual physical development area of metropolitan municipalities, today there is no one responsible and no authoritative organization, which provides coordination between different municipalities and prepares metropolitan physical plans.

Due to shortages in laws, metropolitan municipality being unable to make changes in borders, controls and coordination around border areas cannot be provided, which results in broken, disordered situations. This of course produces uncontrolled and uninspected problems in respect of natural hazard effects. Insufficient organization level of the Ministry of Development and Reconstruction, responsible of making metropolitan plans, is one of reasons of non implementation of this process, too.

Local Implementation Plans: Local Implementation Plan as physical plans are known as basic physical plan in our country. Fixing the areas having natural hazard risky during planning process and limitative regionalization by these plans is quite possible. Compatibility between macro scaled plans, micro scaled plans and physical site can be assured, in order to reach a reliable physical building and structure. Lack of relation between planning levels, missing of new strategies in planning process for preventing natural hazard effects, supervision, are the most important problems in existing physical planning practice.

Notwithstanding physical planning position is interdisciplinary process, it appears as the one not including disciplined application, nor common work of ground mechanical, geologist and earthquake engineer in natural hazard risky areas. Necessary legal procedures should get these common operations compulsory.

In the implementation process of physical plans %40 of the lands are gotten from the landowners without and costs and are used for urban utility services. This constant rate is defined in Development Law and is used in everywhere. However, highly crowded areas taken into consideration, this proportion, regarding a number of users, remains insufficient. Increase of utility portion, proportional to a population density, is proposed by a wide section of people.

As a natural hazard concept and planning are so close one within the other, this brings together a natural hazard sensible plan understanding in plan approach and implementation revisions.

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