

## Natural Disasters in Turkey and Natural Disaster Profile of Bursa

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**Abstract:** *Disasters have always been destructive for humankind throughout history. In respect of its geological and geomorphological structure, Turkey experienced many disasters, both natural and human-instigated or technological disasters in its history. However, it is not possible to say that we are well prepared to disasters. Among disasters, this study touches upon only natural disasters and analyzes natural disasters occurred in Bursa and risk areas. Role of natural disasters in the history of Bursa Province, determination of risk areas for prospective disasters and measures taken were researched and investigated. Various statistical data received from DMEA (Disaster Management and Emergency Authority) and Earthquake Department of DMEA was shown in this study both in tables and by utilizing various programmes required and by mapping using GIS methods. In addition, reports prepared both by Metropolitan Municipality of Bursa and NGOs were also utilised. Natural disaster areas and risk areas in Bursa Province were shown in maps in the study, settlement conditions were also presented. It is seen in this study that rather than earthquakes, landslides and floods have been more effective in Bursa Province. As a consequence, it appeared that Bursa Province is conducive to various natural disasters such as earthquake, landslide, flood, spate, and more importantly, the risk areas were opened to settlement, resulting a significant risk to lives of settlers.*

**Keywords:** *Disaster, Natural Disaster, Bursa, Landslide, Earthquake, Geographic Information System (GIS), Physical Geography Features*

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### 1. INTRODUCTION

Turkey, due to its geological and geomorphological structure, is conducive to natural origin disasters, and to human-instigated disasters in respect of its geopolitical position. Every year, various instigated disasters occur in many places of the world, and thousands of lives and huge amounts of property are being lost as a result of these disasters.

Definition of disaster is not well understood in our country. We are mistaken to define every huge incident as disaster. Although there is not a consensus on the definition, I would like to quote herewith some of the definitions brought to disaster:

Cases where sources allocated for fighting off all natural or unnatural conditions remains inadequate, or capacity of coping with such cases is overwhelming is named as disaster. In other words, events become disaster when sources allocated for coping with emergency cases are inadequate. The term disaster could be used not only for natural events, but also human and technology-instigated events. Effective area of the event is not the primarily important factor to define a case as disaster, but the effects of the event and sufficiency of resources to cope with the case (Güngör, 2014).

Disasters in the broadest sense, are nature, human or technologic instigated events resulting in physical, economic and social loss for human beings, affecting societies by ceasing or suspending normal daily lives and human activities, and impossible for the society affected from the event to cope with and overcome with their own source (Özmen, 2005).

Another definition brought to disaster states “results of natural or human and technology- instigated events that result in physical, economic, social and environmental loss on human beings and human settlements by ceasing or suspending normal life and human activities” (Ergünay, 2006).

Disasters, in respect of their generation, could be examined in three categories as Natural Disasters, Technology Instigated Disasters, and Human Instigated or Human-made Disasters. However, this study deals only on natural disasters, composed of meteorological, geological and hydrological events.

Considering generation and developing consequences, natural disaster could be defined as “natural ground or air motion that suddenly generated or developed over a certain period of time, affecting normal life by disturbing daily routines on settlement and production areas” (Tabban, 2015).

Natural disasters could be seen both at different places at different times, and and at the same place in various types. Magnitude and effect of natural disasters could be different, time of natural disasters could also vary, and in other words, a natural disaster could last longer or shorter in respect of time. They generally stun and shock human beings, cause loss of lives and property. Generally speaking, natural disasters result in huge economic loss can influence economic investments and can result in migration.

Natural Disasters could be categorised as;

- Earthquake
- Landslide
- Tsunami
- Volcanic Eruption
- Flood
- Avalanche
- Storm
- Drought
- Climatic Changes
- Forest Fires
- Tornado
- Rock Fall
- Storms (Hurricane, tornado, typhoon, etc.)
- Air pollution

Natural disasters have been effective throughout centuries and caused large number of lives and billions of property loss. Considering the lack of technological opportunities in the past, loss of lives for human beings in the past has been relatively huge as they were unprepared to cope with natural disasters. In the light of modern proper technological development, more accurate predictions and detections could be made at present. However, negligence and carelessness of human beings cause destructive and devastating results, badly affecting themselves at the consequence.

Natural disasters generally have a big destructive power. Besides the natural event causing disasters, social, political and economic features of the society where the disaster occurs have great importance in the existence of a disaster (Gherardi, 1998; Lomnitz, 1994; Mc Entire, 2001; Short et al, 1998). In this regard, disasters in a social environment occur as a result of association of vulnerability sources and dangers (Wisner et al, 2003). Vulnerability states “the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard” (Wisner et al, 2003).

While natural disasters have such a great destructive power, and such important role in shaping the surface, negligence of human beings for the environment they live has been costly and overwhelming for ages.

## **2. MATERIAL AND METHOD**

First of all, relevant literature review was done. At the outset definition of disaster was investigated, and information and statistical data on disasters in Turkey were collected. Besides, information and statistical data on natural disasters occurred in Bursa Province were collected; all data were transferred into Geographic Information System (GIS) medium by ArcGIS/ArcMap 10 software using Microsoft Excel and Access 2010. Maps obtained both from national and local sources were also used.

## **3. NATURAL DISASTERS IN TURKEY**

Turkey, due to its geological and topographic structure and climatic features, frequently faces natural disasters. Besides loss of lives, natural disasters also bring about significant economic loss for Turkey (Özmen, 2005).

## Natural Disasters in Turkey and Natural Disaster Profile of Bursa

Various natural disasters often occur in Turkey at various times. Earthquakes, floods, landslides, avalanches and rock falls are among the most frequent disasters experienced in Turkey (Ildr, 1995).

Due to its tectonic and geological structure, topography and climatic features, Turkey time to time faced various natural disasters (Table 1). In consideration of probable and potential disasters, such disasters could result in considerable loss of lives, injuries and loss of property. Taking the geological and geomorphological structure of our country into account, earthquakes being in the first place, various disasters such as landslides, floods, overflows, and rock falls are experienced. Besides, forest fires and erosion are among important natural disasters that Turkey face. These disasters also bring about important environmental problems.

Number of people lost their lives in Turkey at natural disasters occurred in the last 70 years is 100.000, number of damaged houses is 600.000, and number of houses affected from earthquakes by some means is around 500.000. 1000 people on average die at earthquakes each year, 2100 injured and 7000 buildings damaged (Keleş, 2002; Erdik, 1999; Kiper, 2001).

**Table1.** *Some of Natural Disasters Occured in Turkey (2000 - 2015)*

Disaster Type	Number of Disasters	Loss of Lives	Injured	Number of Demolished Buildings	Number of Damaged Buildings
Landslide	3.158	17	9	231	4.217
Earthquake	1.007	659	4.258	2.479	90.379
Flood	809	72	47	201	33.295
Avalanche	497	33	28	13	122
Extreme Winter Conditions	619	131	797	0	0
Storm/Typhoon	1.398	172	152	4	883
Fire	1.507	22	34	2	124
<b>Total</b>	<b>8.995</b>	<b>1.106</b>	<b>5.325</b>	<b>2.930</b>	<b>129.020</b>

**Source:** *Republic of Turkey, Prime Ministry Disaster and Emergency Management Authority*

As seen in the above table, natural disasters caused considerable loss of lives and property even in recent history of Turkey. As a result of natural disasters such as earthquakes, landslides, floods, avalanche, extreme winter conditions, storms and fires, over 60.000 people died in Turkey since the beginning of 20<sup>th</sup> Century, 35.000 people injured, over 145.000 buildings demolished, and over 1.350.000 buildings damaged (TR, Prime Ministry Disaster and Emergency Management Authority).

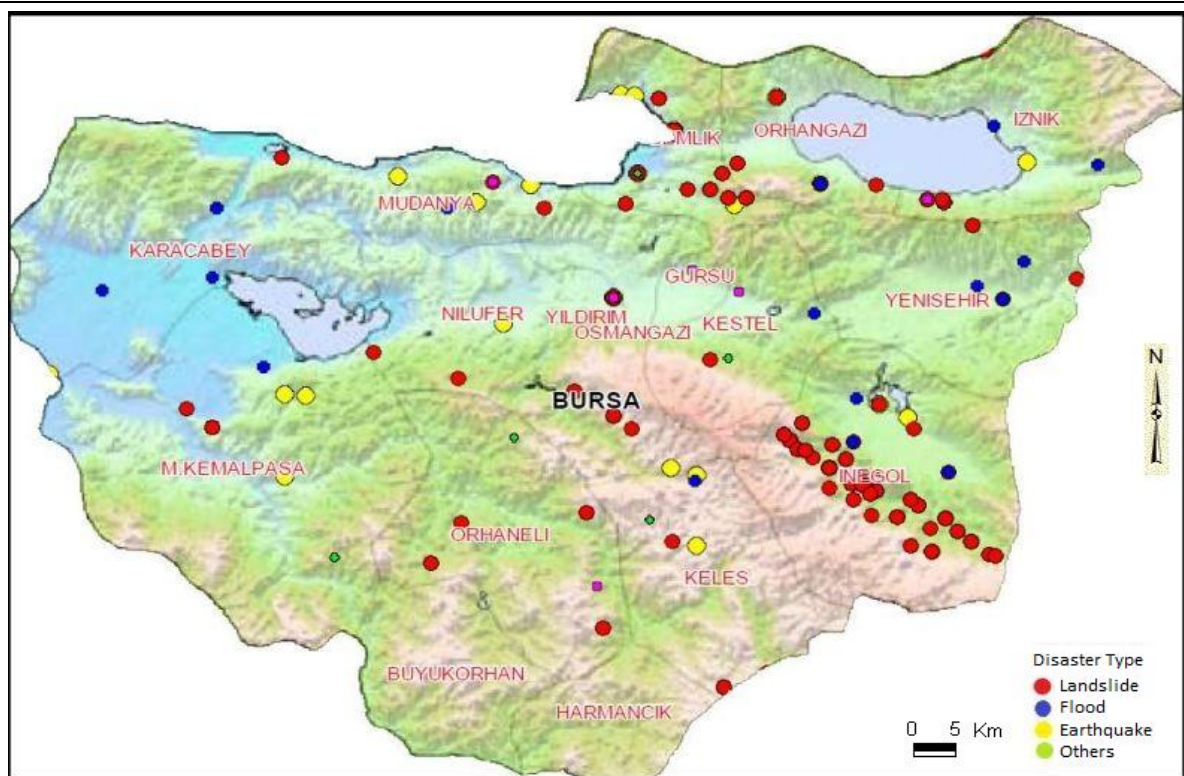
### 4. NATURAL DISASTER PROFILE OF BURSA

Bursa, due to its geopolitical position and geological structure, could experience various natural disasters, notably earthquake, and flood, landslide, overflow, tsunami and rock fall. Natural disasters caused loss of lives and property over the years at different times (Table 2). Most frequently occurred natural disaster in Bursa province has been landslide, followed by flood (Figure 1).

**Table2.** *Some natural disaster types and number of occurrence in Bursa (1900 - 2015)*

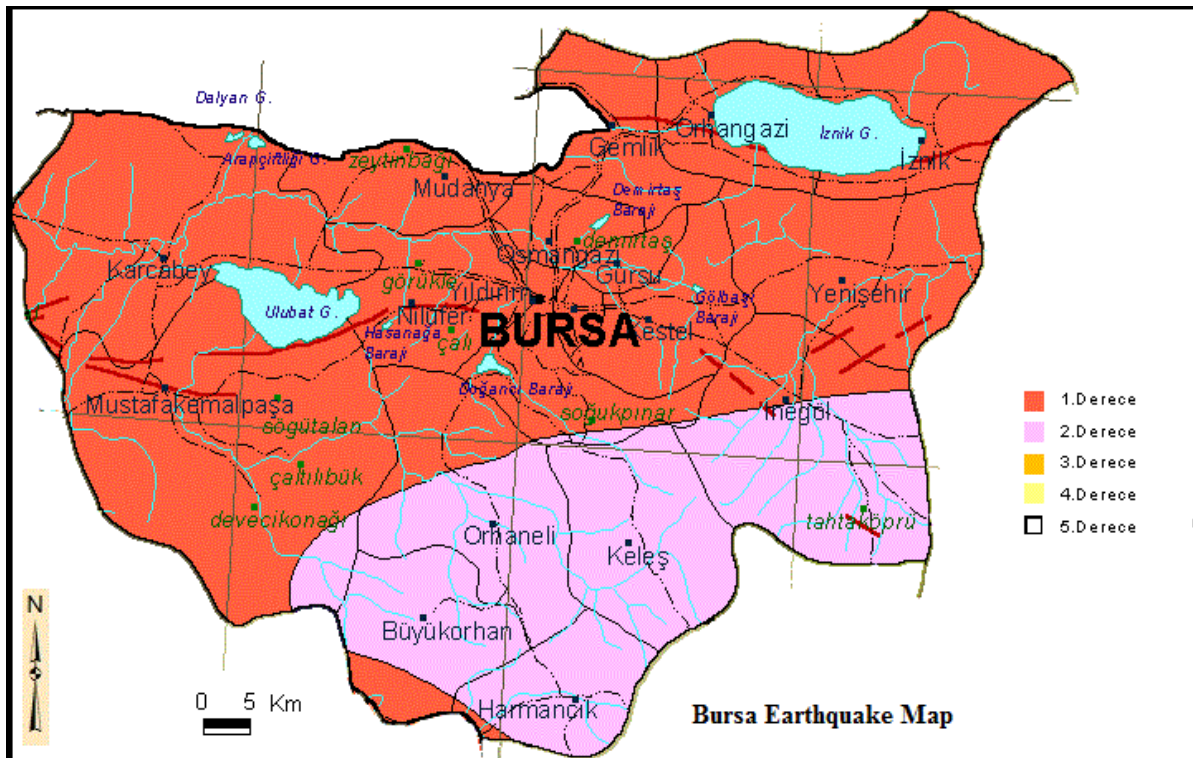
Disaster Type	Number of Occurance
Landslide	313
Earthquake	58
Flood	39
Avalanche	1
Extreme Winter Conditions	17
Storm/Typhoon	29
Fire	61
<b>Total</b>	<b>518</b>

**Source:** *TR, Prime Ministry Disaster and Emergency Management Authority*



**Fig1.** Distribution of natural disasters throughout Bursa Province, 1950 - 2008 (DMEA Bursa Directorate)

Earthquake is the first to come to mind when it is spoken about natural disaster in Bursa. As Bursa is located on Northern Anatolian Fault Zone, the city always faces earthquakes (Figure 1).



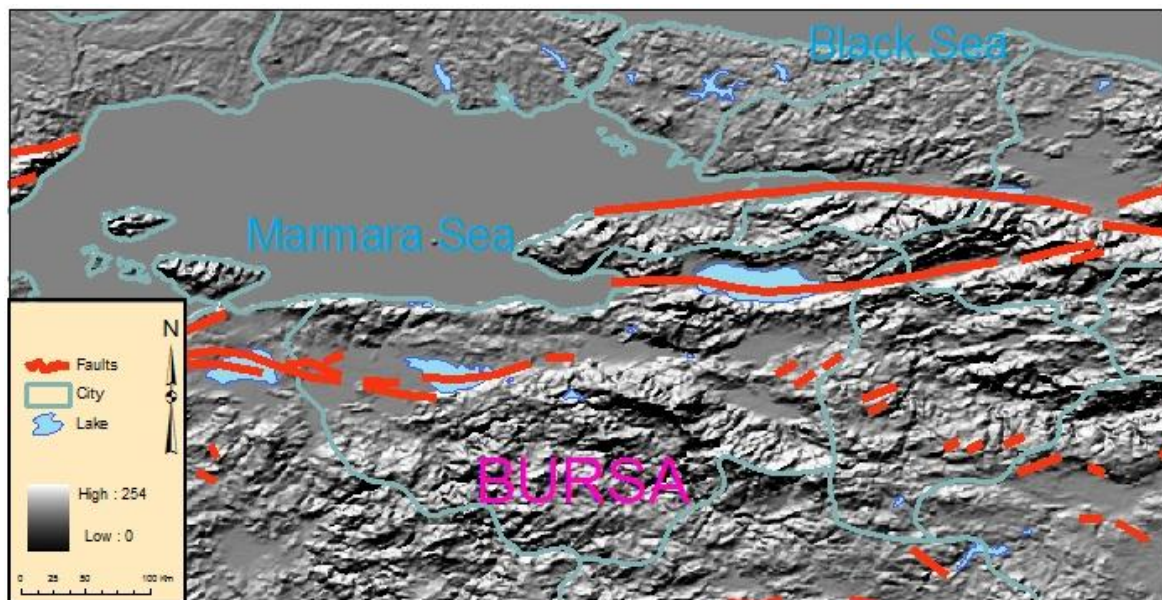
**Fig2.** Earthquake Map of Bursa Province

The first recorded destructive earthquake in history of Bursa occurred in 1855. 9 magnitude earthquake occurred in Bursa-Kemalpaşa on 28.02.1855 caused loss of around 300 lives, and 10 magnitude earthquake occurred on 11.04.1855 caused approximately another 1300 lives. Between 1900 and 2014, 98 earthquakes occurred between magnitudes  $4 \leq M < 10$  (Table 3). The most massive of these earthquakes was on 06.10.1964, occurred in Bursa-Karacabey, with a magnitude of 7, which was the largest scale earthquake after the 10 scale occurred in 1855.

**Table3.** Earthquakes Occured in Bursa (1900 - 2014)

Date	Earthquake Scale	Date	Earthquake Scale	Date	Earthquake Scale	Date	Earthquake Scale
03.07.2014	4,5	19.08.1999	4,1	30.12.1983	4,1	06.09.1970	4
17.08.2013	4,5	19.08.1999	4,5	07.12.1983	4	24.12.1969	4,3
16.08.2011	4	17.08.1999	4,1	23.11.1983	4,1	09.11.1968	4,2
09.03.2011	4	17.08.1999	4,1	15.11.1983	4,4	09.05.1968	4,2
11.06.2010	4,2	17.08.1999	4	03.11.1983	4	06.05.1968	4,3
01.08.2009	4,3	17.08.1999	4,3	02.11.1983	4,6	12.02.1967	4,2
05.10.2008	4,2	17.08.1999	4,3	30.10.1983	4,7	20.11.1964	4,4
12.03.2008	4,2	25.09.1998	4	27.10.1983	4,3	07.10.1964	4,4
28.01.2007	4	07.07.1995	4,1	21.10.1983	5,4	06.10.1964	7
19.12.2006	4	06.04.1994	4	01.02.1983	4,8	06.10.1964	5,4
25.10.2006	4	21.02.1994	4	27.07.1982	4,3	06.08.1959	4,1
24.10.2006	5	25.05.1993	4,1	09.06.1982	4,4	02.04.1959	4,6
20.10.2006	4,8	18.03.1993	4,4	23.05.1982	4,2	03.06.1953	5,3
16.05.2004	4,4	18.03.1993	4,4	20.05.1982	4	15.09.1951	5
09.06.2003	4,5	18.03.1993	4,1	26.12.1981	4,9	13.11.1948	5,6
05.05.2002	4	22.03.1992	4,9	28.08.1981	4,1	09.02.1941	4,6
31.01.2000	4,1	03.03.1991	4,6	08.08.1981	4	02.07.1938	5
29.09.1999	5,2	07.01.1991	4	23.07.1981	4,5	22.10.1905	5,9
18.09.1999	4,6	27.01.1989	4,1	22.07.1981	4	15.04.1905	5,6
09.09.1999	4	01.01.1988	4,5	21.07.1981	4,1	26.05.1903	5,9
31.08.1999	4,4	27.10.1987	4,4	11.01.1979	4,3	13.07.1902	4
22.08.1999	4,1	03.09.1987	4	13.02.1978	4,2	02.12.1900	4,2
20.08.1999	4,5	14.09.1985	4,7	29.05.1976	4	18.06.1900	4,8
19.08.1999	4,1	11.04.1985	4,2	18.01.1974	4		
19.08.1999	5,1	28.10.1984	4,8	28.02.1972	4,1		

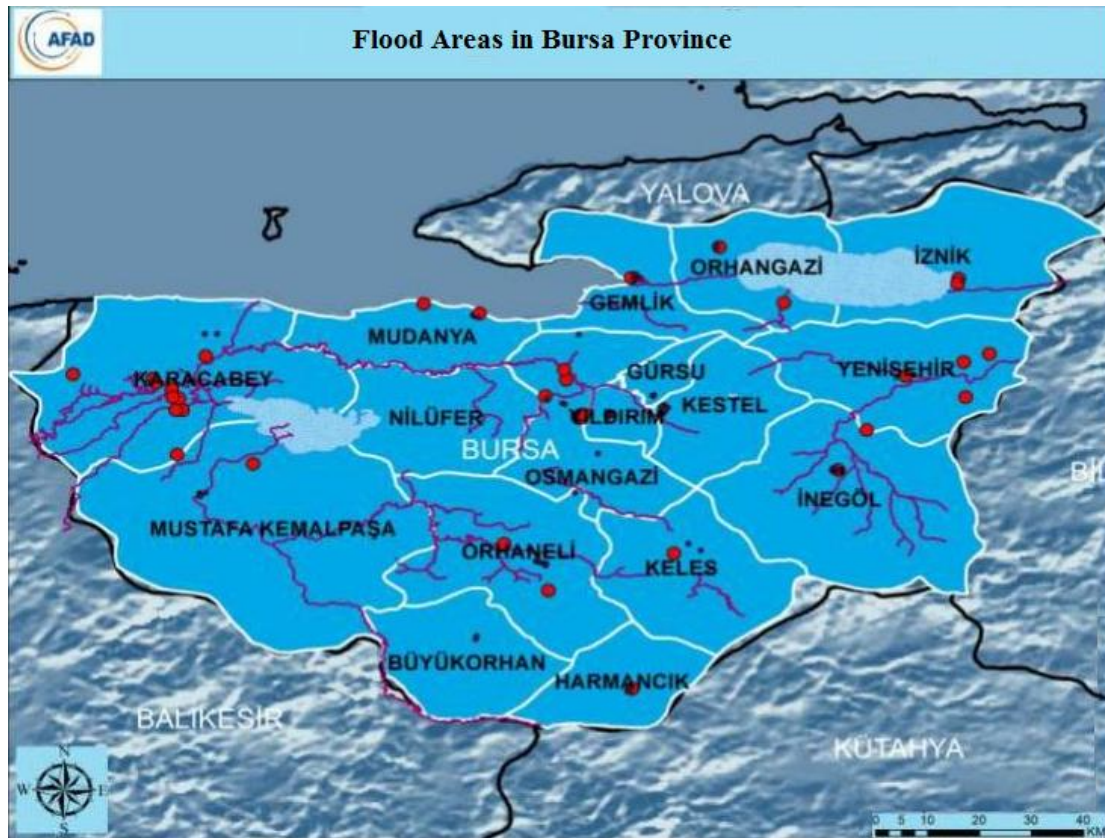
Active fault lines in Bursa province are the main fault line in Marmara Sea, Geyve-İznik-Gemlik fault line, Yenişehir-Bursa-Manyas fault line and other large and small fault lines (Figure 3).



**Fig3.** Active Fault Lines in Bursa

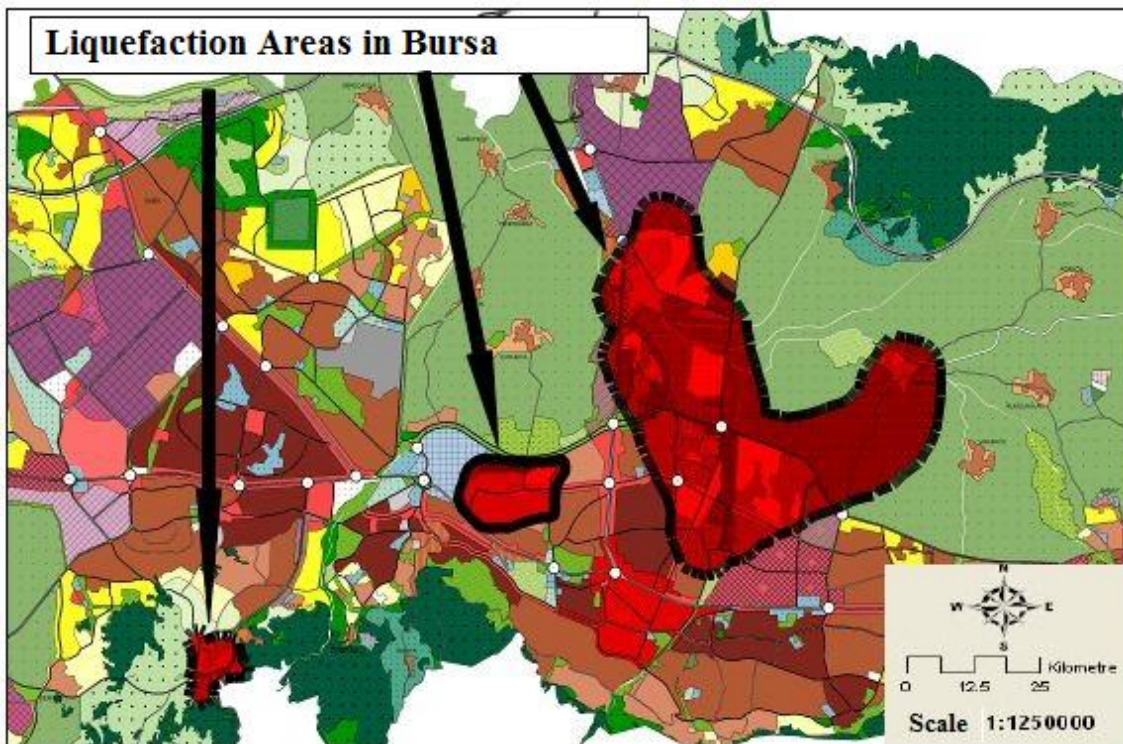
Since the beginning of 20<sup>th</sup> Century to until today, 58 earthquakes occurred in Bursa, over 150.000 buildings were damaged. İznik-Gemlik and Karacabey-Mustafakemalpaşa lines in Bursa are first degree seismic zones; where approximately 200.000 settlers live on the former and 380.000 on the latter.

Another natural disaster occurring in Bursa is flood, which especially became significant after 2010. As a result of unorganised urbanisation and housing on stream beds, more frequent flood events are being experienced in Bursa lately.



**Fig4.** Flood Areas in Bursa Province (Governorship of Bursa, Provincial Disaster and Emergency Directorate)

One person was died in the flood occurred in October 2010. Floods and overflows are occurring more frequently and becoming more effective lately. Unplanned urbanisation and housing on stream beds have a great impact on this. Liquefaction areas in Bursa have also been detected (Figure 5).



**Fig5.** Liquefaction Areas in Bursa (TMMOB, 2008)

Liquefaction is commonly observed especially at sandy, silty and loose grounds with young sediments and where ground water is shallow (up to 20 metres). Liquefaction could vary depending on the shape and size of particles forming the soil, and type of soil. If the earth is composed of round particles,

liquefaction is more likely to occur. As gaps among big size particules in a well graded ground will be filled with fine grains, liquefaction potential will be low at such grounds. Besides, grounds most appropriate to liquefaction are places composed of round, coarse silt and sand size grains. Eventhough not highly sensitive to liquefaction, clayey and cohesive soils loose their resistance to great extent during earthquakes (TMMBO, 2008).

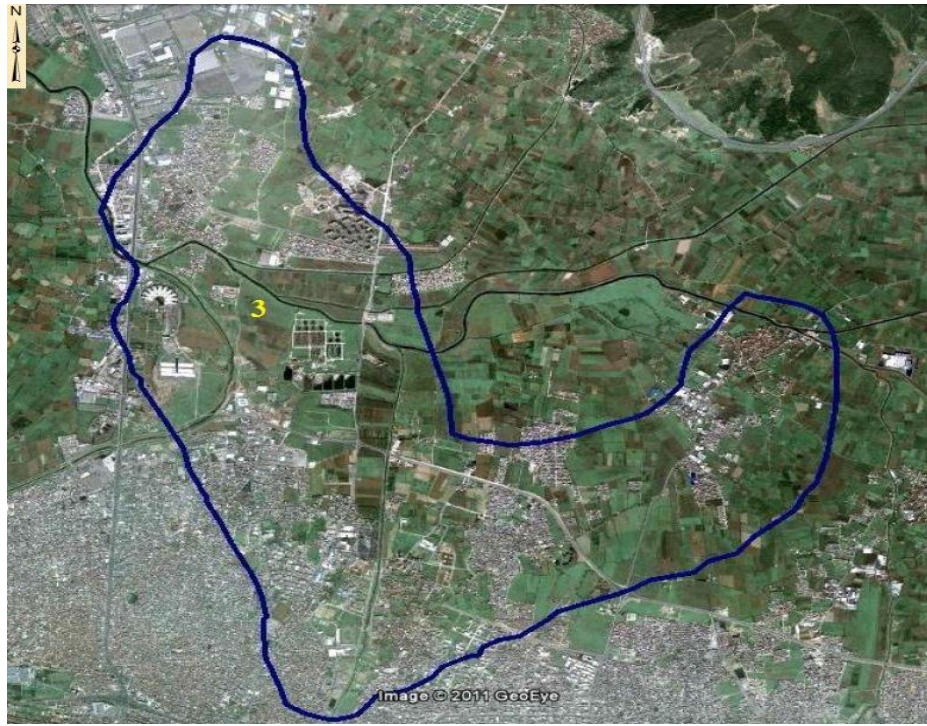
Detected liquefaction areas in Bursa were later zoned for housing. Housing activities continue in these areas identified in 1/25000 scale Master Development Plan. Looking at the master development plan, it will found out that 155.711 settlers are currently living in areas shown in three pieces at above map (Figure 4, 5, 6).



**Fig6.** *Opening Liquefaction Areas to Settlement*



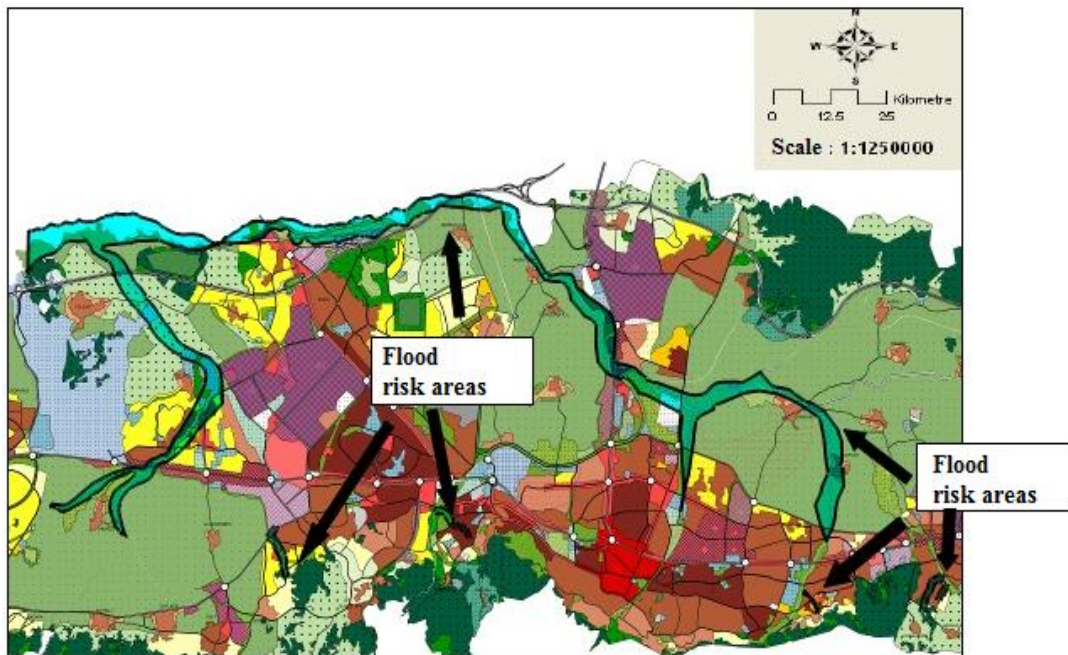
**Fig7.** *Opening Liquefaction Areas to Settlement*



**Fig8.** *Opening Liquefaction Areas to Settlement*

Floods are among important natural disasters that cause huge amounts of loss of lives and property, both in Turkey and in most parts of the World. Destroying natural beauties of river basins as days pass, extensive land use and disturbances of stream beds result in floods even during normal amount of rain for streambeds and basins. In addition, engineering structures constructed over rivers could sometimes be assessed as risk, though previously not evaluated as risk. This factor causes taking various new plans into account while implementing risk management during land use in the vicinity of stream beds (Özdemir, 2007).

Flood areas are identified and shown in Master Development Plan of Bursa (Figure 9). However, it is seen that 1/25000 scale master development plan is not followed and these risk areas were opened for housing. 28.656 settlers currently live in this risk area under vulnerable to flood.

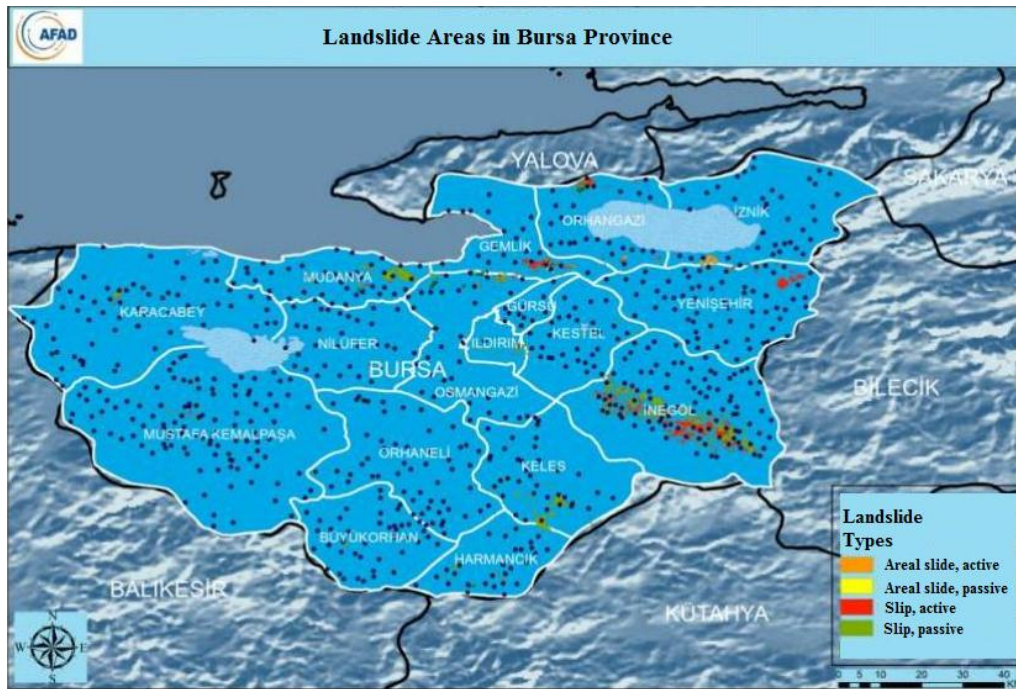


**Fig9.** *Flood risk areas in Bursa Province*

Natural factors such as rainfall, vegetation, geological structure, topography of the land and climatic features are effective in occurrence of landslides. Besides these natural factors, rapid population growth



due to immigration, illegal housing at steep lands, inadequate control at settlement and housing areas and road construction without sufficient ground and soil investigation could also give rise to generation of landslides (Figure 10).



**Fig10.** Landslide Areas in Bursa Province (Governorship of Bursa, Provincial Disaster and Emergency Management Directorate)

There are various parameters and methods in detecting areas vulnerable to landslides. Gökçeoğlu (2001) states that there is not a consensus in selecting factors to be used in detecting landslide risk areas. There are variabilities on maps developed depending on land conditions of study area, and personal evaluations. According to Gökçeoğlu (2001), depending on the land features of study area, factor selection in the literature includes at least three factors; primarily topography, lithology and land use structure. Factor selection at studies requiring details could be done in accordance with land features of the study area. In addition to topography, geology and land use, rivers and roads are taken as individual parameters in this study.

Landslide risk areas in Bursa are located at slopes of Uludağ. Two large 8-storey buildings collapsed at landslide occurred on 23 February 2006 at slope of Uludağ spanning through city centre where named as İntam (Photography 1). This place is still among landslide risk areas.



**Photograph1.** Landslide in Bursa, Intam, 2006

## 5. RESULT

Bursa is vulnerable to natural disasters due to its geological and geomorphological structure. Besides active fault lines, the region came into prominence lately with floods, overflows and landslides. Eventhough risk areas of natural disasters of the province have been detected and identified; such areas are being zoned and developed for housing, which intensifies the risk.

Both areas where active fault lines exist which are likely to produce earthquakes, areas where floods and overflows are effective, and under the threat of landslides are zoned for housing, planning and housing permits are granted, which increases the risk for loss of lives and property in a probable natural disaster to a great extent.

Settlement areas existing active fault lines are not efficiently and effectively checked and control although Bursa experienced destructive earthquakes in its history, and high-rise, multistorey buildings are still being constructed in such areas.

Disturbances of streams beds lately and problems brought by unplanned urbanisation increased rainwash and overflows throughout the province. It is observed that housing permissions are still being granted in areas vulnerable to landslides.

As risk areas throughout Bursa province have been detected and identified, previously prepared master development plan should be followed without any changes, risk areas should not be opened for settlement, and people already settled in such areas should be moved, and eventually, risk areas should be turned into safe zones.

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