

## **CAUSES AND EFFECTS OF FLOOD HAZARDS IN TURKEY**

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### **ABSTRACT**

Human beings have a great capacity to adapt to varying climatic conditions and environments but remain vulnerable to adverse impacts of weather and climate .

Floods are among the most common natural disasters and, in terms of economic damage, the most costly. In addition to the direct impacts of loss of life and property damage, there are indirect impacts such as increased exposure of survivors to other hazards such as contaminated water supplies and landslides, and the disruption of traffic and trade. The indirect impacts are quite numerous and often difficult to quantify.

Flood hazards represented 30% of all water related disasters in Turkey. Between 1955-1995 more than 1,000 people in Turkey lost their lives as a consequence of floods and the economic damage was more than \$650 million during this period.

In assessing the sensitivity and vulnerability of communities to weather and climate hazards, long-term climate records and related sectoral information are of vital importance. Such records are also essential for preparedness planning and response strategies that build resilience for coping with extreme events.

This study examines spatial and temporal distribution of flood hazards that occurred between 1940-2005. It is aimed that the information provided here will help to identify areas which are vulnerable to floods and develop management strategies to reduce adverse impacts of floods.

**Keywords:** causes and effects of floods, climate hazards, spatial and temporal distribution of floods

## INTRODUCTION

Since the start of history the world has been plagued by natural disasters (WMO, 1990a ). Few regions seem to have escaped the impact of one extreme or another; fewer are likely to be free from them in the future.

It is important, of course, to recognize that an extreme natural event only becomes a natural disaster when it has an impact on human settlements and activities. There is a strong social as well as natural science component to natural disasters and while the events themselves cannot be prevented, their disastrous consequences can often be reduced by appropriate advance planning, the preparation of emergency measures on the part of the community at risk.

Floods are one of the most widespread and savage of natural disasters. They can be defined as overflowing by water of the normal confines of a stream or other body of water, or the accumulation of water by drainage over areas which are not normally submerged ( WMO, 1990b ).

On a large river system a flood may take several weeks or a month or more to subside, but in headwater regions and in small river systems a flood may last for only a few hours. These are *flash floods* which are common in mountainous areas and arid regions. The combination of storm surge and river floods is particularly hazardous for low-lying areas.

## DATA AND METHOD

In this study regional distribution of flood hazards that occurred in Turkey between 1940-2005 was examined. For the flood hazards distribution, the records from 237 Principle Climatological Stations records from Turkish State Meteorological Service were used.

It is aimed that the information provided here will help to identify areas which are more vulnerable to flood hazards and develop management strategies to reduce adverse impacts of these hazards.

The spatial distribution of the flood hazards in Turkey was mapped by using Surfer6.0.

## MAIN CAUSES OF FLOOD HAZARDS

### a - Topographic factors

Mainland of Turkey is located in Mediterranean macroclimatic region of subtropical zone. She has a mean elevation of 1100 meters and is surrounded by sea on three sides( Fig.1 ). Due to its complex topographic features, its proximity to water, being in a transition zone for different large scale weather circulations systems, spatially variable climatic features appear to be dominant over the country.

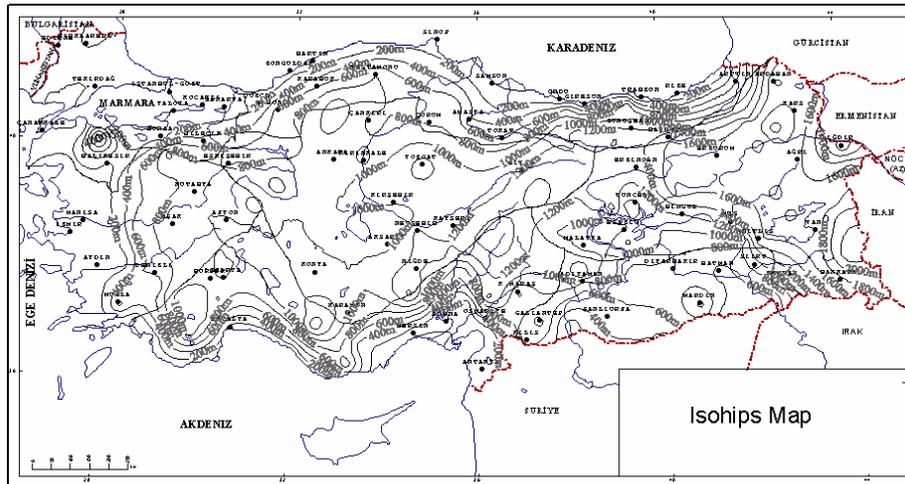


Fig.1: Topographic map of Turkey.

**b – Meteorological factors**

Geographic features of Turkey such as mathematical location being surrounded by seas, higher mountain ranges between the seashore and inland regions and variations in height in short distances play an important role on rainfall quantity ( Fig. 2 ). There are some different regions in Turkey in terms of the rainfall intensity and duration because of these deterministic factors.

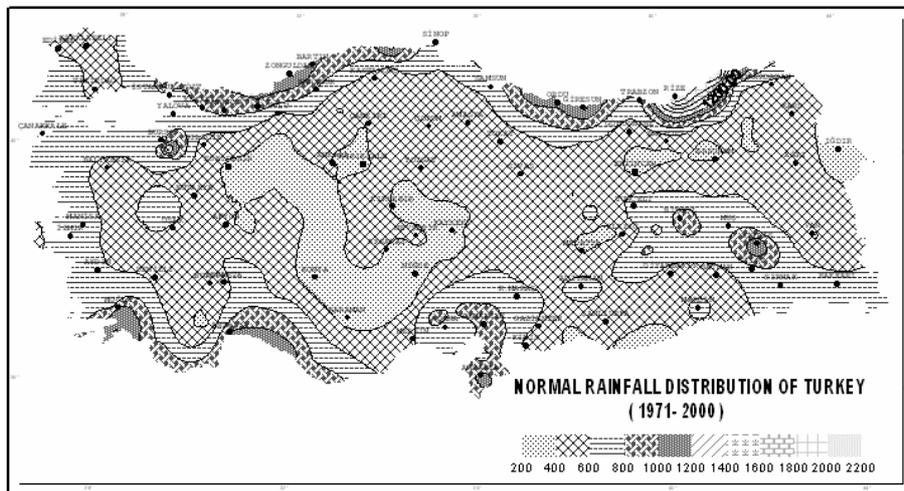


Fig.2: Normal Rainfall Distribution of Turkey ( 1971-2000 )

Different rainfall intensity characteristics between the seasons in Turkey are related to the north-south directed oscillations of the polar front systems and the low

pressure systems. Turkey, in general, is affected by the polar front and the low pressure systems from the end of October to May. (Meteorological Office 1962, 1963). During the frontal systems pass through the country, the short-term weather conditions having warm and cold periods as well as rainy and dry periods occur. Developing phase of the frontal system and the path followed affects the distribution of rainfall intensity and frequency. The polar frontal systems hanging down Mediterranean basin causes air masses to warm and have higher relative humidity. The rainfall intensity also depends on the orographic lifting in western and southern parts of the country occurred by these unstable air masses.

The other system affecting on Turkey in winter is the continental polar air mass. This system extends through Eastern Mediterranean basin. Rain showers occur along the frontal system zone formed by continental polar air mass and the tropical air mass. Moreover, this frontal system causes less intensive rainfalls and snows in the inner parts of the country.

When the warmer conditions occur on the land, the polar front system withdraws to the northern latitudes and the country is affected by the tropical air masses ( Fig. 3 ). As Asor high pressure extends over Europe, the southern part of Turkey is affected by thermic low pressure system. These conditions are the major factors causing decrease in summer rainfall in Turkey (Akyol 1944). The gradient difference between Asor high pressure and Basra low pressure creates an appropriate condition that for the northwesterly wind. Both enhanced humidity of the air masses passing over Black Sea and rise of these air masses along the Northern Anatolian Mountains cause orographic rains. Because of these conditions Black Sea shore has rainy summer seasons. This region also has rains associated with depressions passed over Black Sea in summer. Since the continental polar air mass does not have any effect in summer, the number of rainy days and rainfall intensity increase in the Northeast Anatolia.

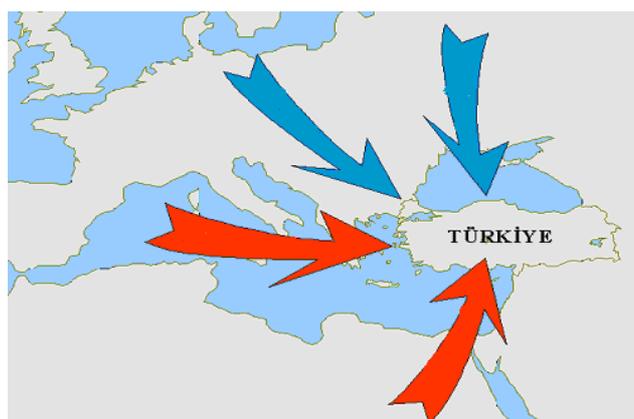


Fig.3: Air masses affecting Turkey

Frontal Mediterranean cyclones associated with the southwesterly air flows create favorable conditions for heavy rainfall and thunderstorms in the southern and western coastal parts of the country in late autumn and early winter. Orographic lifting is also a main cause of heavy rainfall production that intensity of the rainfall is further enhanced when the conditionally unstable and extreme moist air pushed upslope into higher terrain along the Mediterranean coast. During the winter season, she is under the influence of Siberian high pressure centre bringing cold air which produces heavy snow on the mountains while summer seasons it is under the influence of Arabian Gulf high pressure which results in high temperature over the continent. On the other hand, during the transition seasons atmospheric instability prevails producing severe floods across the country.

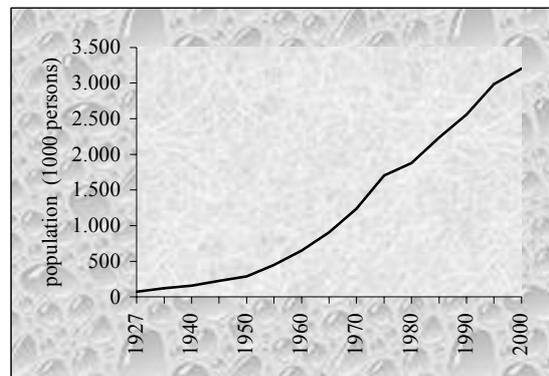


Fig.4: Population growth in Ankara ( Ceylan,2002 )

### c - Other factors

Land-use, particularly wrong and even illegal land-use, is a most important factor in Turkey - as in many other countries - when dealing with natural hazards, especially the flood hazard. During the past 30 years continuous forest cutting to gain new agricultural areas, especially on the steep slopes of the northern Anatolian mountain range, and clear-cutting of shrub-size oaks as burning material in winter has increased the possibility of landslides and debris flows, while at the same time destroying valuable fertile soil and increasing the sediment loads in the river.

The consequences of flooding are strongly influenced by the commercial development and urbanization of many areas around Turkish cities in recent years (Fig.4). In order to absorb the increasing population, new settlements have been built, mostly illegally. The increasing property value has made the flood risk worth taking and has encouraged people to settle in the flood-prone zones despite their known danger. In some instances, the urbanization of certain areas progresses visibly from one month to the next. Parallel to this "explosion" of housing areas there has been a substantial

increase in the construction of asphalt roads, parking lots and pavements in the cities. It should also be noted that insufficient flood control structures and the lack of channel improvements in the creeks have further enhanced the flood damage. The capacity of the storm sewers and flood detention structures in the cities is often inadequate to control large floods. The conveyance capacity of the creeks is greatly reduced during floods by building the walls of houses in the stream beds, constructing roads on the stream beds and throwing garbage and construction material into the creeks.

These factors aggravate the consequences of the floods to a great extent.

### SPATIAL AND TEMPORAL DISTRIBUTION OF FLOOD HAZARDS

Flooding is induced by above factors either in concert or separately. The most dangerous type of flood occurs in coastal regions when orographic and frontal lifting of the saturated air masses causes surface convergence, leading to very intense rainfall.

Flood hazards represented 30 % of all water related disasters in Turkey.

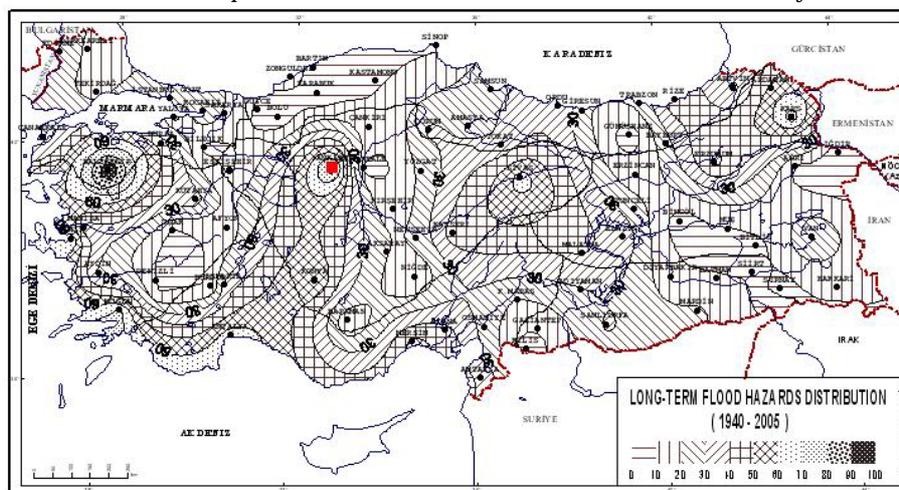


Fig.5 : Long-term flood hazards distribution ( 1940-2005 )

The spatial occurrence of floods is not spread uniformly over Turkey (Fig.5). The valleys all along the Black Sea and Aegean coasts are particularly threatened, i.e. the Black Sea, the Marmara and the Aegean geographical regions. Floods in western Turkey and in the coastal zones are mainly produced by heavy rainfall in combination with geomorphologic features. In the central and eastern parts of Anatolia snow accumulation plays an important role.

Floods are due to heavy rainfall on the coastal areas of the western and southern parts of Turkey or to a sudden snowmelt in the eastern, mountainous part of south-eastern Turkey. In the northern and central parts of the country, including the Eastern Black Sea Basin, both factors may occur depending on the time of the year. Precipitation types are frontal, orographic or convective. During occluded fronts, long lasting intense rainfall may produce flooding, depending on the season of the year. Most of the coastal precipitation in the Black Sea region, where the mountain ranges run parallel the shore sea, is of the orographic type. Convective precipitation mostly occurs during the transition seasons of spring and autumn and affects central Anatolia. The most dangerous type of flood occurs in coastal regions when orographic and frontal lifting of the saturated air masses causes surface convergence, leading to very intense rainfall. The snow accumulated in the upper reaches of the drainage basins of Anatolian rivers melts as of the beginning of May or June, and can cause flooding in downstream areas of the rivers. (Ceylan, 2004).

The types of precipitation that occur in Turkey are frontal, orographic and convective rainfall and snowfall ( Munich Re,2002 ). In contrast to cold fronts and occluded fronts, which may cause floods, warm fronts do not because the total amount of water they produce is too small. However, they may help to reach a high soil saturation level before the wet season starts in the spring. During occluded fronts, long, intense rainfall may produce flooding depending on the season. Most of the coastal precipitation in the Black Sea region, where the range of mountains runs parallel to the seashore, is of the orographic type. Convective precipitation mostly occurs during the transition seasons of spring and autumn and mainly affects Central Anatolia.

**On the average 18 flood events occur in a year and they take about 23 lives (Fig.6). 1,344 people died due to 1,768 floods in last 50 years in Turkey.**

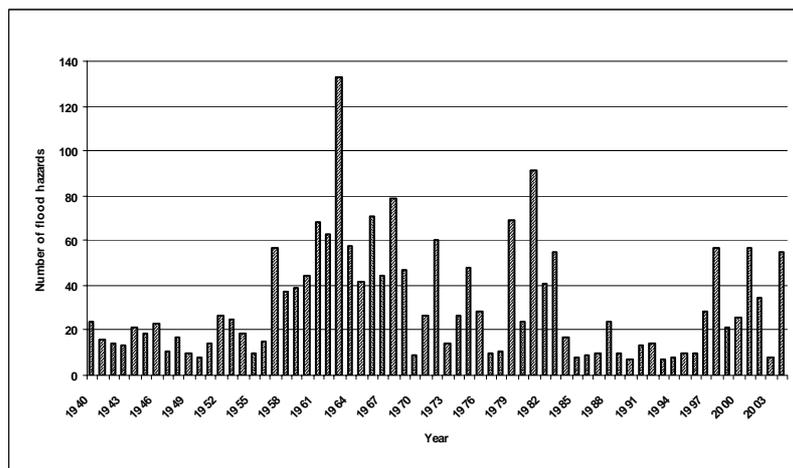


Fig.6 : Long-term distribution of Significant Flood Hazards in Turkey

| MAJOR FLOODS AND LOSSES |   |   |  |        |
|-------------------------|---|---|--|--------|
| DATE                    | AREA AFFECTED                                 | LOSS EVENT                                    | ECONOMIC LOSS  | DEATHS |
| 9-15 May 93             | Eastern and South-eastern Parts               | Heavy rain                                    | Hundreds of houses damaged. Major losses to agriculture      | 5      |
| 1-2 Dec. 1994           | SE, Adana                                     | Heavy rain                                    | Hundreds of houses damaged. Major losses to agriculture      |        |
| 1-5 May 1995            | E, Bitlis                                     | Heavy rain                                    | \$23,000,000.00  |        |
| 8-14 July 1995          | Istanbul, Senirkent, Ankara, Trabzon          | Heavy rain, landslides                        | \$ 30,000,000.00   | 70     |
| 3-5 Nov. 1995           | Izmir, Isparta, Antalya                       | Floods  | \$ 50,000,000.00   | 61     |
| 6 Feb. 1996             | Izmir, Antalya, Canakkale                     | Heavy rain                                    | 1,000 houses damaged   | 5      |
| 9 Aug. 1996             | Istanbul                                      | Heavy rain                                    | \$ 4,000,000.00  |        |
| 11-13 Aug. 1997         | Istanbul, Zonguldak, Bursa, Bolu              | Heavy rain, landslides                        | \$ 1,000,000.00  | 13     |
| 6-22 May 1998           | North, Southeast, South and Anatolia          | Heavy rain, large hail, landslides, mudslides | \$ 2,000,000,000.00  | 27     |
| 12 June 1998            | Sanliurfa, Diyarbakir                         | Heavy rain                                    | Roads flooded, bridge destroyed                              | 8      |
| 9-13 Aug. 1998          | Trabzon                                       | Torrential rain, landslides                   | 300 building, 1 mosque destroyed                             | 10     |
| 27 May 2000             | Samsun, Tokat, Carsamba, Salipazari,          | Heavy rain                                    | Hundreds of houses flooded, roads, bridges damaged.          | 2      |
| 7-18 May 2001           | Hatay, Osmaniye, Konya, Nevşehir              | Rainstorm, torrential rain                    | \$ 3,500,000.00  | 3      |
| 10-12 May 2001          | Antalya                                       | Heavy rain                                    | 500 homes flooded, 37 buildings damaged, 4 bridges collapsed |        |
| 10-14 Nov. 2001         | Rize, Artvin                                  | Heavy rain, mudslides                         | Buildings, roads, highways, bridges damaged                  | 8      |
| Dec. 2001               | Mersin, Izmir, Istanbul, Ankara, Icel, Yalova | Heavy rain, blizzards, high wind speeds       | \$ 30,000,000.00   | 5      |
| 23-25 July 2002         | Rize, Corum, Yozgat, Kars, Tokat, Van         | Torrential rain, high wind speeds, mudslides  | \$ 20,000,000.00   | 40     |

### RESULT AND RECOMMENDATION

To minimize the adverse effects of floods on communities and people, a comprehensive flood management programme is required for each newly proposed development zone. It is also very important to have good coordination among all the partners: the state, the local population and insurance companies. Overgrazing in the upper areas has to be stopped and reforestation has to be stepped up. These measures together with river training structures will lead to a decrease in erosion and sediment transport and certainly alleviate the flood problems as well.

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