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Full Length Research Paper

Flood management to prevent flooding damages in western Black Sea region in Turkey

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River flooding is the most frequently experienced natural hazard all over the World. The effects of flooding are mainly related to the function of the intensity and distribution of precipitation, and the rate of filtration of water into the soil and rock, vegetation and topography. Flood management is considered as one of the basic strategies that can reduce flood damages and in this context, flood protection planning should consider the full range of hazard mitigation activities. The realistic solution to reduce flood damages involves a combination of floodplain regulation and engineering approaches. In 1998, there was a major flooding in Zonguldak - Bartin region located on north of Turkey. Due to this catastrophic flooding, people lost their live and a number of engineering structures built on the river and surrounding area were totally destroyed or heavily damaged. In this study, some solution methods for the region have been suggested and presented.

Key words: Natural hazard, flood management, flood plain, land-use, mitigation.

INTRODUCTION

In recent years, flooding has been one of major concerns for regions located in different part of the world and especially western Black Sea region in Turkey due to heavy rainfall on the coastal area or rapid snow melting on the mountain area (Arman et al., 2010).

The flood potential of Northwest Black Sea region was evaluated with the aid of geographical information system (GIS) by Temiz et al. (2004). In this study, a number of input parameters such as precipitation climatology, Digital Elevation Model (DEM), land-use and drainage network characteristics were considered. For a period of 50 years, potential flood areas were determined. It was found that the northwest part of their study area was relatively susceptible to flooding based on the analyses carried out. Due to flash floods generated by heavy rainfalls typical of the Mediterranean climate, the southern part of France near the Mediterranean Sea is subject to flash floods in November 1999 and September 2002 (Vinet, 2008). The damages cost hundreds of millions of Euros and there were numerous casualties. The cost of the damage for both flash flood events were detailed using available survey data. Unfortunately, heavy losses were in rural areas since flood prevention issues as flood warning systems and land use planning were focused only on the cities.

Bell and Tobin (2007) present a synopsis of several terms used to describe US policy’s benchmark flood and a preliminary study of how such terms are interpreted. In a flood prone community with residents living in and out of official flood plains, questionnaire surveys were conducted. Statistical analysis and qualitative observation indicated a disjuncture between understanding and persuasion, potential problems with the 26% chance method, and a preference for concrete references in describing risk.

An overview of flood characteristics with respect to their

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applicability for estimating and analyzing direct flood damage to buildings was presented (Kelman and Spence, 2004). Also, floods actions were classified in different categories with respect to relative importance for flood damage assessment. In order to fully understand the physical processes by which flood damage arises and, hence, how flood damage may be prevented, new researches are needed in this area.

In order to calculate flood disaster losses quickly, accurately and wholly for effectively reducing or avoiding flood losses and promoting correctness and validity of flood control and regulation decision of Hunhe River, it was necessary to establish an evaluation system (Zhang et al., 2005). From the view of flood control and disaster reduction of Hunhe River, this study designs flood damage evaluation system of Hunhe River basin and also describes its functions and characteristics.

Impact of disasters on society mostly depends on the affected country's economic strength prior to the disaster. Also, many governments lack an adequate institutional system for applying cost effective and reliable technologies for disaster prevention, early warnings, and mitigation.

An integrated flood catastrophe model as well as some results of a case study made in the Upper Tisza region in northeastern Hungary: The Palad-Csecsei basin (the pilot basin) were described by Ekenberg et al. (2003). Based on provided data, and simulation and decision, analytical model provided insights into the effects of imposing different policy options for a flood risk management program in the region. It was clear that this was a multi-criteria and multi-stakeholder problem and could not be solved using standard approaches. However, the main purpose of this report was not to provide any definite recommendations, but rather to explore a set of policy packages that could gain a consensus among the stakeholders (Ekenberg et al., 2003).

Tunay and Atesoglu (2004) studied changes in flood plains in Bartin Province with 1992 and 2000 dated Landsat 5 TM data. The analysis of the changes was done in the flood areas of Kozcagız and Ulus streams which constitute Bartin River. They reported that the total amount of changes in both flood areas was 78.91 ha between 1992 and 2000 (Tunay and Atesoglu, 2004).

Flood and flash analysis was carried on Bartin River's basin (Turoglu, 2007). In the study, GIS, Remote Sensing Technologies (RST) and satellite images and topographical maps in different scales were used. A geographical feature of Bartin River's basin was very adequate conditions for natural disasters such as floods and flash floods. Finally, flash flood risk maps were prepared.

The existing flood measures, flood and water management deals with the effectiveness of river flooding and its destructive damages on human and their structures built on the river and its surrounding area were summarized by Arman et al. (2010). Flooding in the Zonguldak-Bartin region in Turkey during the spring of 1998 caused lost of lives and extensive damage in the region.

The importance of the geological structure, hydro-geological properties, slopes, destruction of vegetation cover and uncontrolled construction on the creation of flooding in Kozlu, Zonguldak, northwest of Turkey was investigated by Citiroglu and Baysal (2011). In the study, they proposed that, in order to prevent or mitigate flooding, integrated multiple measures should be adapted within a programme which regulates human activities ranging from reforestation to public education. Also, no construction should be allowed along the shoreline since it increases the risk of flooding and soil is prone to liquefy.

The main objective of this paper is to strongly express and expose the importance of flood management in order to prevent and mitigate flooding damages and suggest some solution method in a flood prone area such as western Black Sea region in Turkey. A good and successful flood management system in developing countries should have early warning system, prepare intensive hazard mitigation plans, strategies and scientific and technical background information about the flood.

FLOOD MEASURES IN TURKEY

In Turkey, the flood related measures carried out in the framework of flood management can be summarized as:

1. Structural projects
2. Hydrometric and meteorological observation works
3. Survey reports on past floods
4. Surveys relating to land use plans
5. Regional flood plans
6. Stream bed modification by setting up new diversion structures, dykes and groins
7. Reforestation, land improvement
8. Education and information;

However, these methods listed which are available and applied at many places does not mean that they are effective everywhere (http://www.meteor.gov.tr).

Flood management

In urban areas, flood plains along the rivers crossing cities and towns are used for car parking, recreational purpose and for sporting activities, but at rural areas, the flood plains are used for agricultural or others purpose.

The farmers cultivate at their own plots as before the land acquisition (http://www.meteor.gov.tr).

Experiences gained from the floods of last decade show that structural measures implemented in the basin-wide are effective but too costly in reducing the risk of flood damages. In this respect, it has been considered that more importance should be given to non-structural measures, particularly modification of traditional land use and updating building code guidelines and design standards, early flood warning system, creation of public awareness, insurance and timely and effective emergency management, in order to be more effective for integrated flood management in the project area and in the whole country. However, the existing non-structural measures are not always successful because of two main reasons:

1. In the present situation, the non-structural measures are mostly dealt with by the local administrations including municipalities and mayors. However, due to the present economic conditions, the implementations of the needed activities by these bodies are limited.
2. The local units do not have enough educated and trained personnel to implement the nonstructural measures.

Within the framework of flood management, with the increase of structural measures, it is true that the occurrences of floods and their damages become less in Turkey. However, in recent years, the more importance is given to the non-structural measures, in a given comprehensive plan, including the arrangement of the human activities, the education of the people and the informing of the stakeholders. From the previous experiences, it is understood that most of the damages is directly related to the irregular and uncontrolled urbanization at the high-risk areas in the flood plains (Arman et al., 2010).

The enforcement is realized by the close cooperation of the central government at capital city; and the government's top level representative at the provinces; where the flood disaster is encountered. The basic steps are the first aid, evacuation, safety, and shelter, normalization of the daily routines, rebuilding and recovery of local economy. When a natural disaster like flood is encountered in a city, the governor is the top decision maker. The experts from various state organizations and mayor and army representatives help the governor to shape up the final decision (http://www.meteor.gov.tr).

Cooperation for flood management

There should be a good and effective cooperation among the responsible institutes and local interest groups for flood management. A number of governmental and non-governmental organizations have direct and indirect responsibility in integrated disaster management of floods in Turkey. Institutional framework has three levels; namely, decision making, executive and users level.

In the long run, all the rehabilitation works are planned and realized by the state, but during the planning stage, all the local interest groups express their views freely. At this stage, local parliamentarians and administrations play the most effective role on deciding the priorities.

When a flood disaster is encountered at a province, according to the existing laws, written rules and regulations defining the responsibilities of each organization in emergency case, legislation, administrative principles, hierarchy and the local traditions, emergency aid organizations and programs related to disaster management initiated the following points:

1. Pre-disaster planning
2. Set up some units of the different services in cities for disaster management
3. Set up other special service units and related details.

Generally, there are written rules and regulations defining the responsibilities of each organization in emergency case, but due to human factor, just after the disaster, there may be always chaos, but soon it is over and the system starts to work properly.

The floods of the last decade, with their costly results have brought Turkey to a new view-point to reduce and control the susceptibility to the flood damages, namely the "Integrated Flood Management". In this context, a sound underwriting for land use control, flood insurance and early warning system are being considered.

It can be said that from the years of experiences gained, structural measures such as dams, levees and dykes, diversions, channel improvements, implemented in the basin-wide were effective with rather high cost, to reduce the risk in flood damage. Therefore non-structural measures are becoming more important in flood hazard management in the country (Arman et al., 2010).

FLOODING DAMAGES IN WESTERN BLACK SEA REGION

It is a generally accepted fact that especially the dams constructed at a point very close to the shoreline destroy the natural balance of shoreline by totally changing the flow regimes and therefore the sediment load in the rivers. However, the existing problem could easily be solved in case there is sustainable growth. In order to achieve joint management, it is obvious that a good monitoring study has to be done and reliable data must be obtained (Seker et al., 2003).

Flash floods are common, but it is not easy to estimate its environmental features. A major concern with flash flooding is the development within a very short period of time. Human life and infrastructures are under a major threat of flash flooding. The lack of understanding sometimes compounds problems of flooding, with settlement, road and other structures inappropriately located and designed relative to the flood risk (Foody et al., 2004).

Floods are due to heavy rainfall on the coastal areas of the western and southern parts of Turkey or to a sudden increase in air temperature, resulting in snow melt in the eastern, mountainous part of southeastern Turkey especially Eastern Black Sea Region (Yuksel, 2003; Yuksel et al., 2005). In the northern and central parts

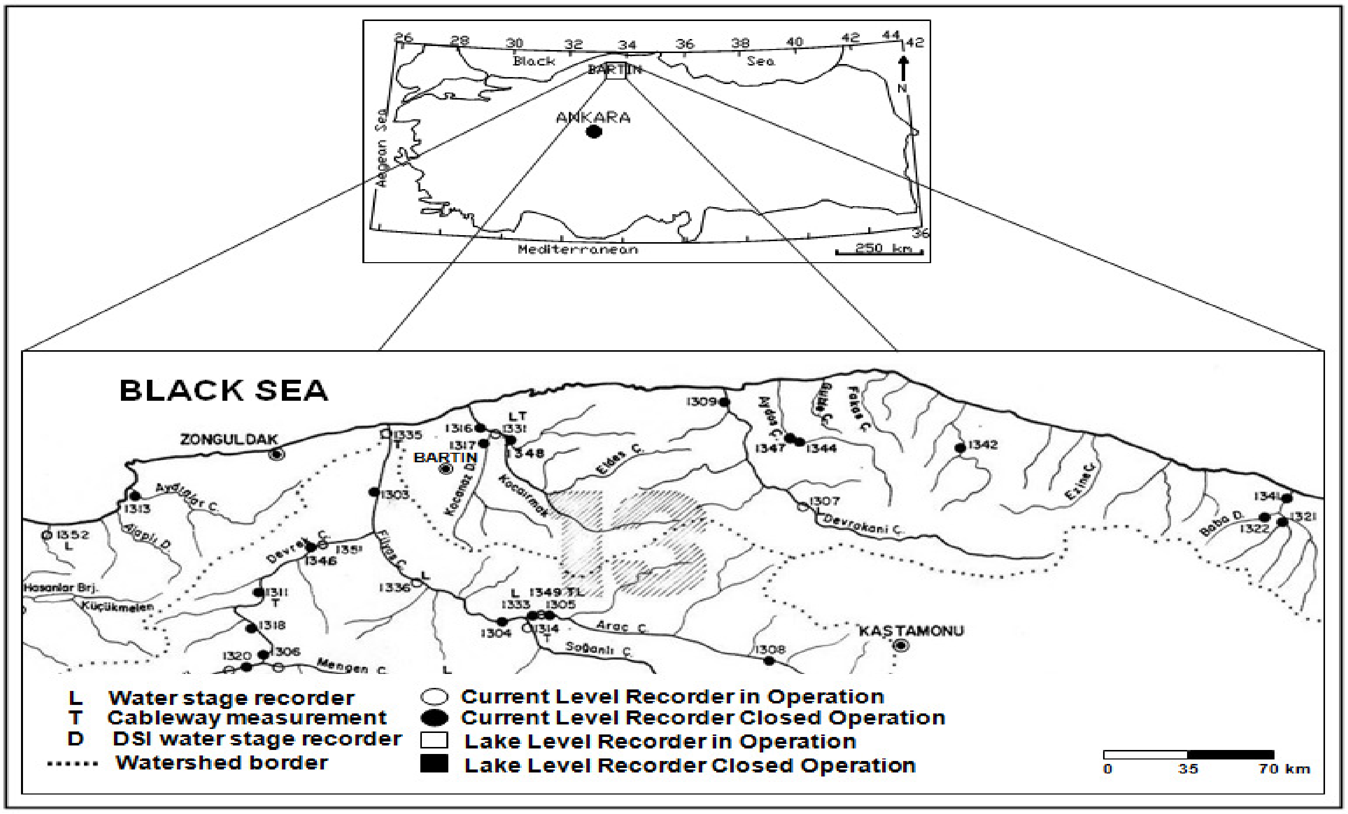

Figure 1. Location map of the study area (Arman et al., 2010).

of the country, both factors may occur depending on the time of the year.

The precipitation types in Turkey are frontal, orographic or convective. During occluded fronts, long lasting, intense rainfall may produce flooding depending on the season of the year. Besides, most of the coastal precipitation in the Black Sea region where the range of mountains runs parallel to the shore sea, considering some others properties of the region such as hydraulics, hydrological and meteorological characteristics at least a few floods have occurred in a year in this region (Yuksel and Yuksek, 2004a, b).

In Turkey, it is known that erosion flooding and land sliding events are widespread due to unconsciously destruction of nature, and weathering. In many regions, flooding and land sliding cause death and wealth loses every year.

ANALYZING OBSERVATION DATA IN THE STUDY AREA

Zonguldak-Bartin region is located on north of Turkey. In 1998, there was a major flooding in the region caused by Bartin Stream (Figure 1). Level observation station of Bartin Stream was opened on March 01, 1963, but closed on February 04, 1967. Therefore, data for 1998 Bartin flooding was not available. However, data for Bartin Stream during flooding was obtained according to basin simulation method used in hydrology. Soganli (Level Recorder No:1314), Kocairmak (Level Recorder No:1331), Arac (Level Recorder No: 1333) and Filyos Stream (Level Recorder No: 1335), which are the most representative streams of Bartin Stream, data were used to evaluate 1998 Bartin flooding event (Figure 1). As in Figure 2, Soganli, Kocairmak, Arac and Filyos streams reached peak discharge value in May 1998 which is known as 1998 Bartin flooding phenomena.

Based on available data, the relationship between flow and months for two years (1996 and 1997) before and (1999 and 2000) after major flooding of Bartin were also presented as in Figures 3 to 6. In 1996 and 1997, there was a major flooding caused by Filyos Stream on April (Figures 3 and 4) in the area. Similarly, when May 1998 flow values were evaluated for May 1999 and 2000, it can be clearly seen that May 1999 and 2000 flow values were much less than May 1998 peak flow values (Figures 2, 5 and 6). The level observation of Arac Stream was closed after May 1998. Therefore, Arac Stream Station was not given in Figures 5 and 6.

When Figures 2 to 6 are analyzed, the obtained results have been presented as in Table 1. In May 1998, the

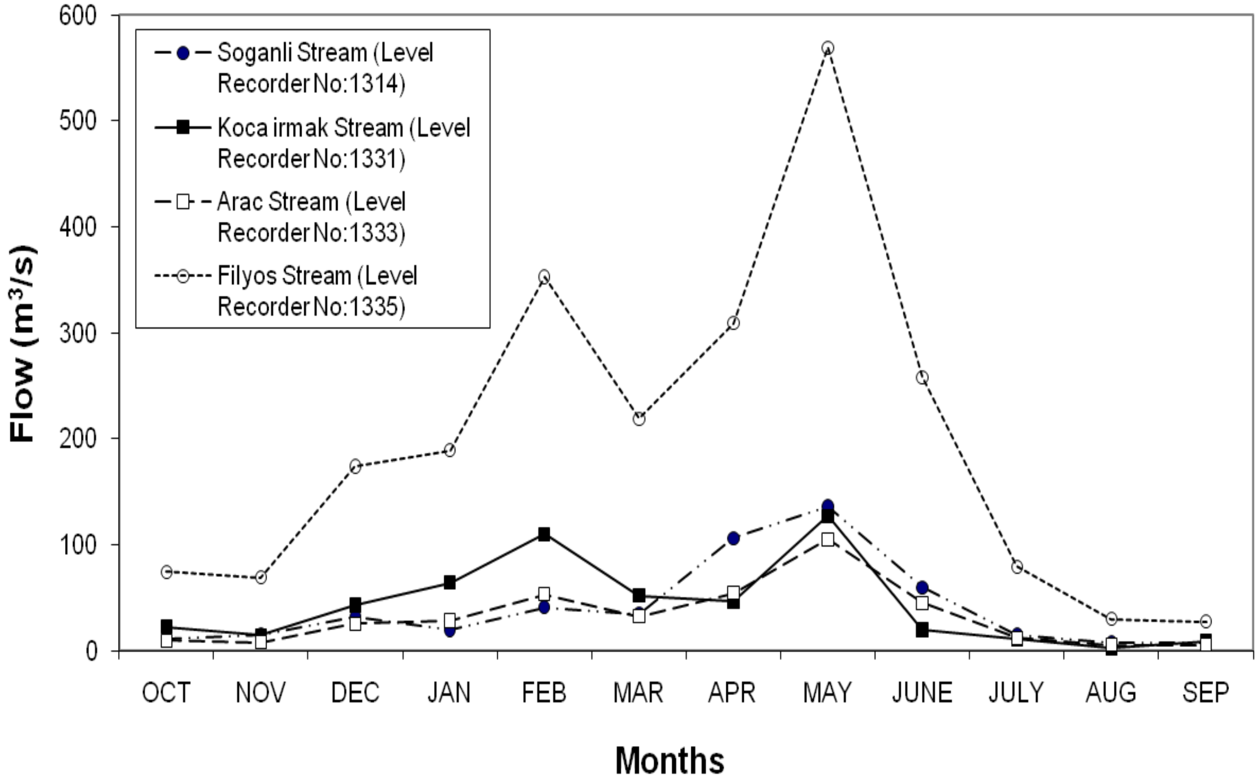

Figure 2. Relationships between flow and months for representative streams in 1998.

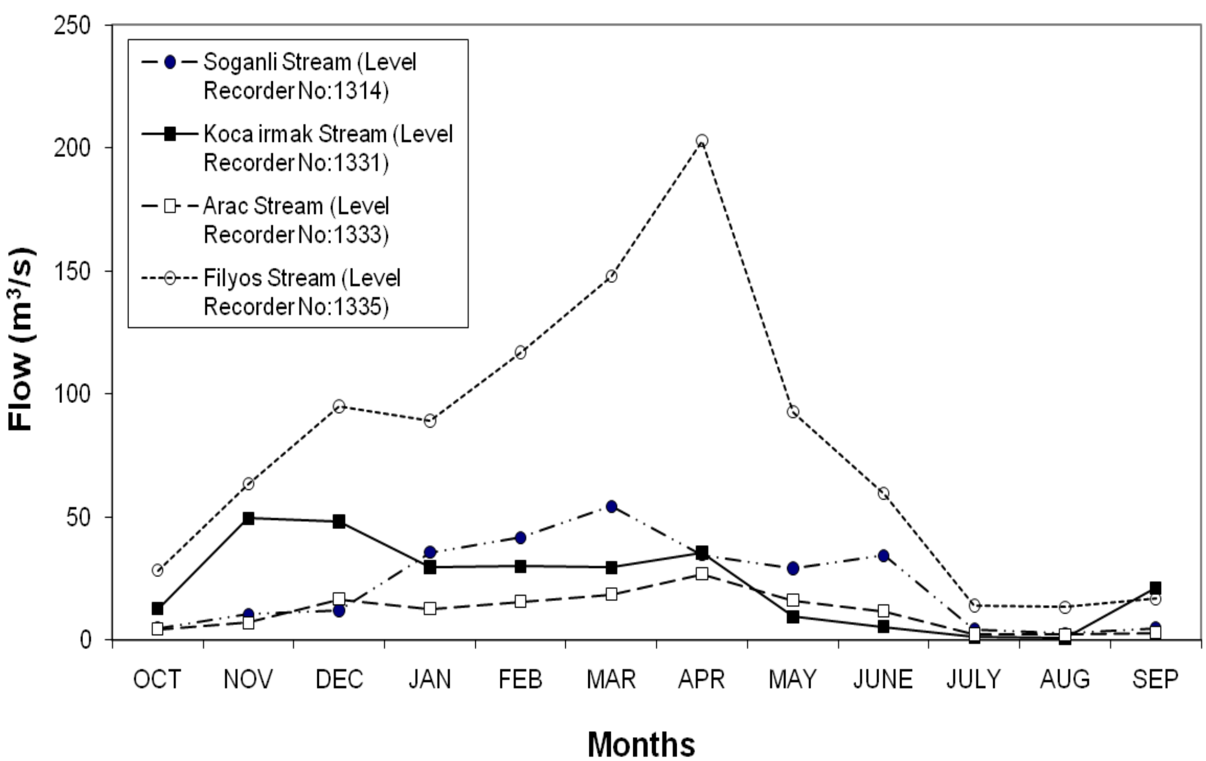

Figure 3. Relationships between flow and months for representative streams in 1996.

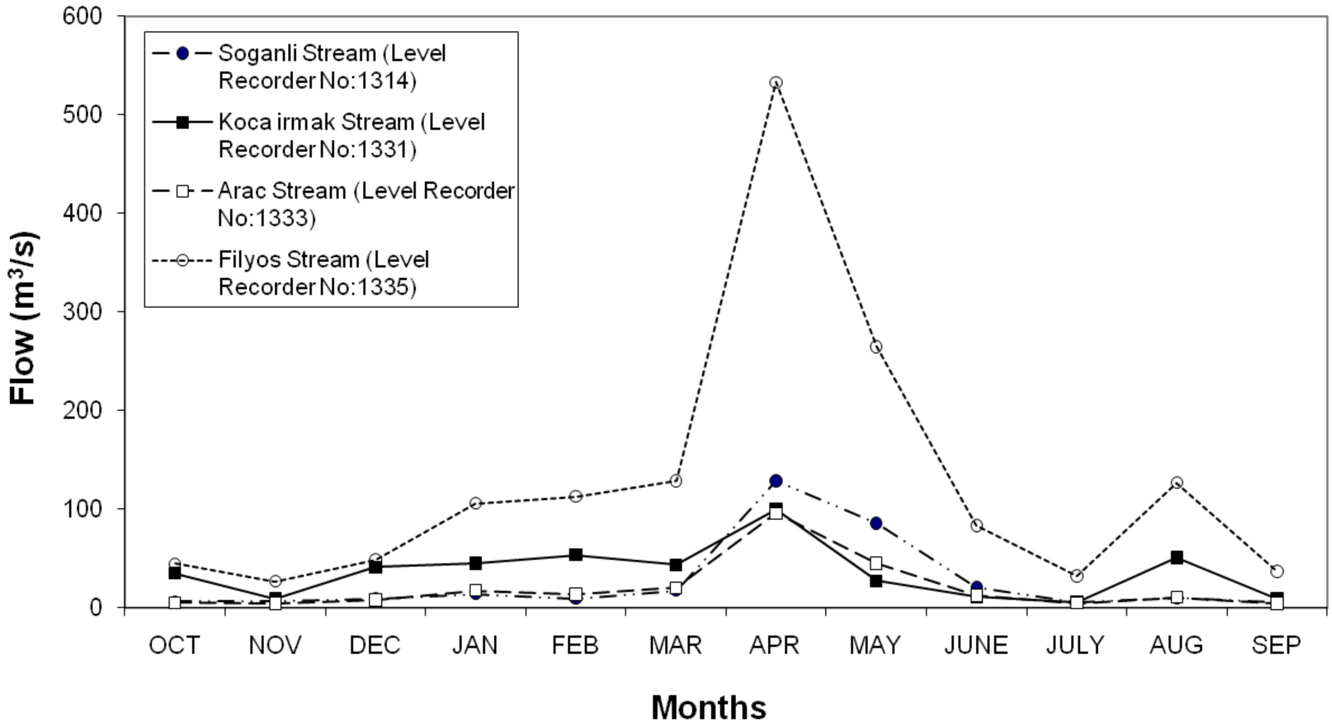

Figure 4. Relationships between flow and months for representative streams in 1997.

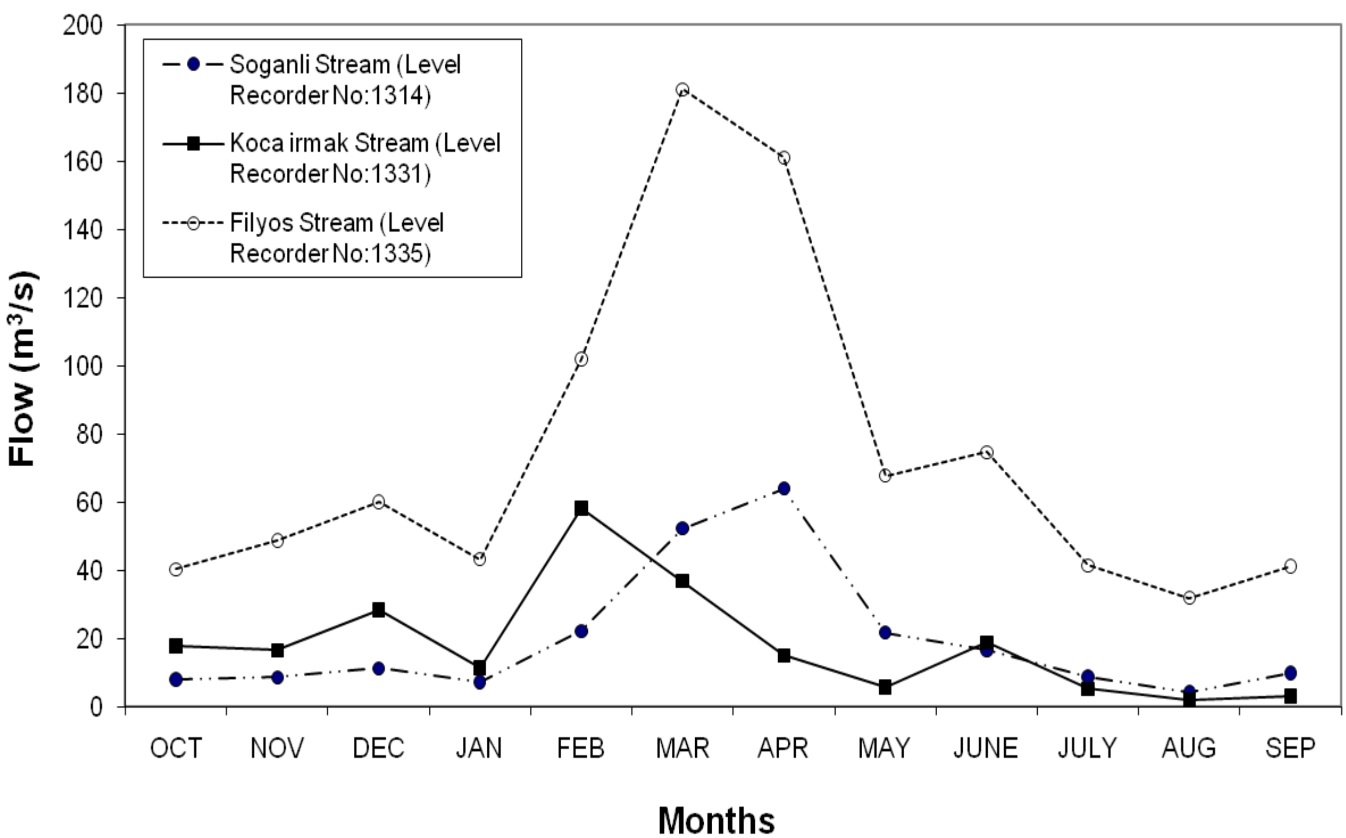

Figure 5. Relationships between flow and months for representative streams in 1999.

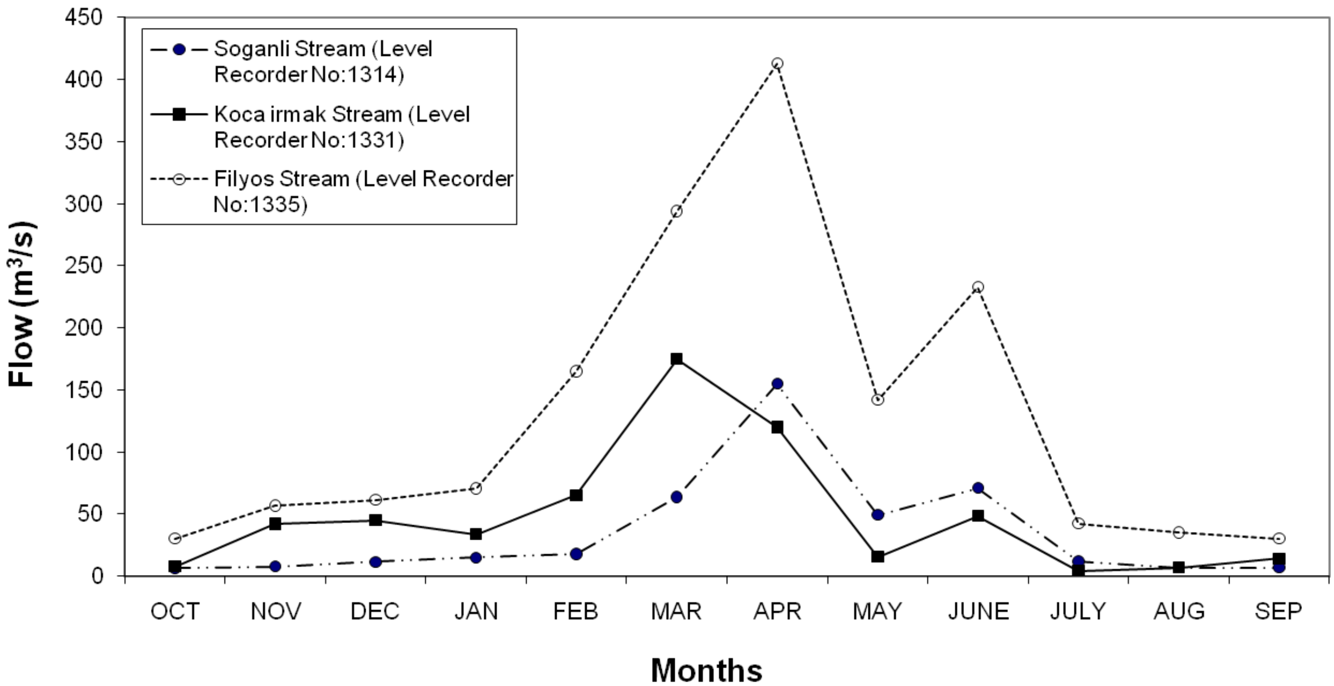

Figure 6. Relationships between flow and months for representative streams in 2000.

Table 1. Average flow for all streams from 1996 to 2000 (m^3/s), (in May).

Year / Stream name	1996	1997	1998	1999	2000
Soganli Stream	34.4	85.7	136	21.7	49.4
Kocairmak Stream	9.54	27.3	127	5.64	15.7
Arac Stream	16.3	45.4	105	*	*
Filyos Stream	92.8	265	569	67.7	142

* Level observation of Arac Stream was closed after May 1998. Therefore, there were no data for 1999 and 2000.

peak flow was reached in all streams and eventually the major flooding event occurred.

Due to this devastating flooding, people lost their life and a number of engineering structures built on the river and surrounding area were totally destroyed or heavily damaged. Both sides of the canal were covered with muddy soil having 0.10 to 0.15 m thickness. This thickness reaches more than 0.50 m in some locations specifically near the riverbed. River water rose to approximately 3.00 m during flooding. Cleaning up process took time in the region (Arman et al., 2010).

Conclusion

It is almost impossible to prevent floods and landslides in a condition such as devastation of forests, paying insufficient attention to forests and forestry. Also, setting up adequate monitoring and warning system can prevent or at least minimize damages.

The dams and other flood control structures played very important role in protecting the human life. However, flood control and management based on structural solutions could be insufficient. Therefore, effective solutions based on land use control, zoning, building ordinance, modifications in building codes, flood information programs by local communities are needed. This required major restructuring of both present legal systems and institutions responsible for management. The flood plain use along the narrow valleys, encouraged by local civil administrations, had to be put under control. Otherwise, future human loss will be greater.

From the view point of flood, considering the old experiences, to decrease flood damages or to take under control flood, the following suggestions was proposed for countries especially developing countries:

1. They should improve early warning system
2. They should prepare hazard mitigation plans and strategies, and
3. They should be supplied with scientific and technical information about the flood.

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