Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 19 (2011) 556–566

Procedia Social and Behavioral Sciences

The 2nd International Geography Symposium GEOMED 2010

A Case Study on Seasonal Floods in Iran, Watershed of Ghotour Chai Basin

Seyed Esmaeil Asgharpour[a]*, Behrouz Ajdari[b]

[a]Islamic Azad University of Shahre Rey Branch, Tehran, Iran
[b]Imam Ali University, Tehran, Iran

Abstract

This study focuses on the seasonal floods in Iran, namely in Azerbaijan province in northwest of Iran. Iran is located on 45 to 61 degrees E longitude and 25 to 38 degrees N latitude. It has an arid and semiarid climate with sporadic rainfall which creates seasonal floods and causes considerable economic, social and environmental damages. It is significant that priority of regional and national planning should be considered not only in preventing damages of floods, but also new strategies and innovative methods are necessary to be employed in controlling the floods due to geologic structures and geographic location of area.

Selection and/or peer-review under responsibility of The 2nd International Geography Symposium- Mediterranean Environment

Keywords: Flood; Disaser; ; Seasonal; Deforestation; Overflow; Livestock.

1. Introduction

One of the main problems which occur on human society at the present century is unpredictable events. The events that happen on the earth cause a lot of social and economic damages to the human society.

Human efforts must be used for reducing the effect of these natural hazards before social and economical structures have been weakened. Human settlements are always being threatened by natural events. Mankind has tried to prevail over these events such as, earthquake, floods, storms, drought, torrential rains, and fire but many people lose their life every year. There is no doubt that flood is considered one of tragic event for human beings which happens in the world. The natural events of the world since 1988-97 resulted 390, 000 people to be killed, 58 percent due to flooding, 26 percent by earthquake. 16 percent by the storm or other events [2].Therefore flash floods seem to be a threatening issue for human society. Injuries and damages of flood have been increased during recent years. Also the effect of hydrologic changes on the flooding area, associated with human activities on residential and

* Corresponding Author. Tel.: +98-21-44541681; fax: +98-21-88839382.
E-mail address: e_asgharpour12@yahoo.com.

1877–0428
doi:10.1016/j.sbspro.2011.05.169

agricultural area have caused natural events, it became so difficult to be prevented their hazards. Even if the technical knowledge (Know-how) has improved in different fields of science to predict the occurrence of some natural events but has not succeeded to tell accurately when they will happen. The decade of 1990 was named by General assembly of United Nations as a damage Reduction of natural events. For this purpose, on 12th of October ceremonies are held by member of United nations countries. Islamic Republic of Iran called it the national day for flood damage reduction. Hence, on 12th of October ceremonies are held for improving educational level of people and being informed about occurrence of these natural events. Table 1 shows flood damages in provinces of Iran.

So, new methods and strategies are needed against the natural hazards that cause many damages and casualties every year. Also ,new steps should be taken by cooperation of governmental organizations for improvement of houses which damaged by disastrous floods.

1.1. Flood Definition

Though, there is not any comprehensive definition for flood in the world but several definitions for its characteristics as a natural disaster are briefly explained [16]. Flood is a sudden natural disaster which is related to hydrological cycle and its discharge pertaining to drainage basin, duration of rain fall, climate conditions, and geographic location. Briefly, flood is called the flowing surface water which has risen from its natural bed continuing for a limited time.

Different kinds of floods which happen on the earth are as the following: (Natural flood, Man-induced flood, Initial flood, Sharp-crested flood, Wide-crested flood, Catastrophic flood, Extraordinary flood, Urban flood, Coastal flood, River flood, Flash flood).The natural disasters had more than 52000 victims in 1998.It was reported by U. N. O[8]. They happened on many regions of the world had 52850 persons death. From these numbers, 34300 persons belong to Asia Continent Asia continent was damaged more than other regions in the world.

1.2. Floods in Iran

The deadliest floods which have occurred in the past fifty years in Iran include the following (Khouzestan province1979, Sistan province 1998, Kerman 1987, Esfahan 1987, Fars province 1990, Golestan province 1999, Mazandaran,Neka, 1999, Neyshabour 1987, Qazvin 1999, Semnan 1987, Tabriz 1932, Tehran 1987, Zanjan 1999) (Fig.1).The amount of flood damages that occurred within forty years (1962-2002) was estimated to be $137. 7 million.

2.1. Precipitation and Temperature

With respect with climatology, Annual average rainfall in Ghotour chai basin was recorded about 245 mm during (1995-2005) which varies from west to the east. Distribution of rainfall from west to the east is decreased. The Maximum rainfall is in spring and minimum rainfall in summer. Precipitation, temperature, humidity and evaporation are atmospheric elements that affect the river basin of Ghotour-Chai [18]. Generally, Mediterranean climate affects the precipitation and temperature of this area. They are shown on table 1, 2 and 3. According to extracted data from Meteorological Organization the annual average precipitation and temperature in Khoy, Salmas, Maku and Urumiyeh cities are as the following: maximum temperature for Khoy city was 19. 29°C and minium 2.1°C for Salmas. The highest precipitation rate was for Maku 277. 75 mm and the lowest precipitation rate for Salmas 231. 75 mm

Figure 1. (a) Flood damage in Golestan province, Iran. (b) Flood in Sistan province, Iran

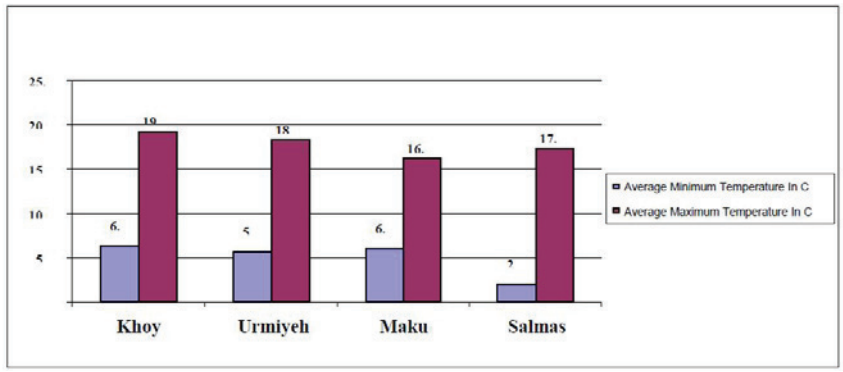

Figure 2. Temperature in west Azarbaijan (1995-2005)

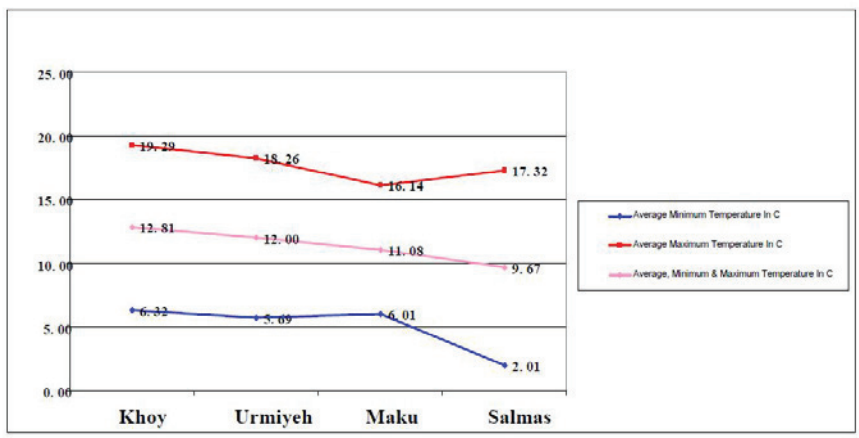

Figure 3. Maximum, Minimum and Average Temperature in West Azarbaijan (1995-2005)

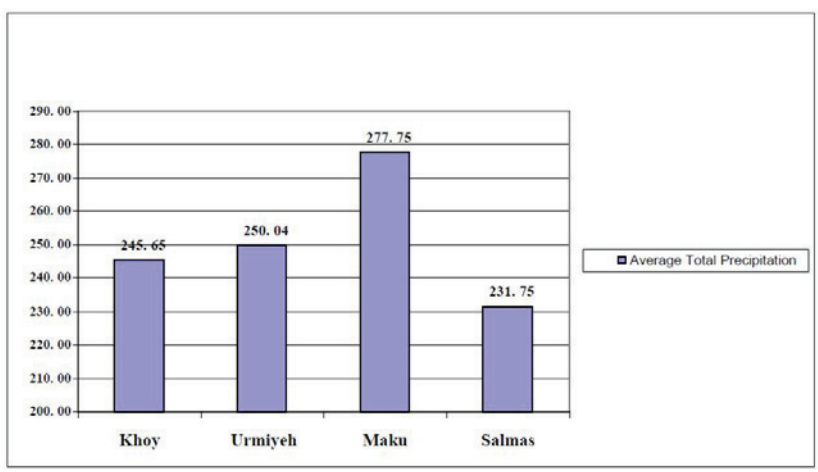

Figure 4. Average Precipitation in West Azarbaijan (1995-2005)

2.2. Geology of Ghotour Chai Basin

Based on geology map of Khoy, Ghotour Chai basin is divided into three parts; western, middle and northern part. Western part related to Paleocene and Eocene period. Red to green conglomerate and

light grey limestone with shale are seen. In the southwest of Khoy city near Avrin mountain green layers, Ultera Basalt rocks, intrusive rocks, limestone were appeared. Middle part belongs to Quaternary period. Travertine, old terraces and young terraces were observed. Northern part has been formed by Old Miocene, on this part; red conglomerate, cream to yellowish limestone and conglomerate with sandstone and shale are seen.

2.3. Drainage Basins

Stream flow is derived from two primary sources :

1. Surface runoff from rainfall and melting snow
2. Underground seepage of ground water into the stream channel.

Each channel in the network has more or less an upper limit on the size of the flow that it is able to accommodate, flows in excess of this limit over top the stream bank and flood lands adjacent to the channel, called the flood plain (Fig. 5) flood flows may happen by various means including heavy surface run off, natural or human–made obstacles in the channel hydrologic changes that resulted to storm water discharge [10].

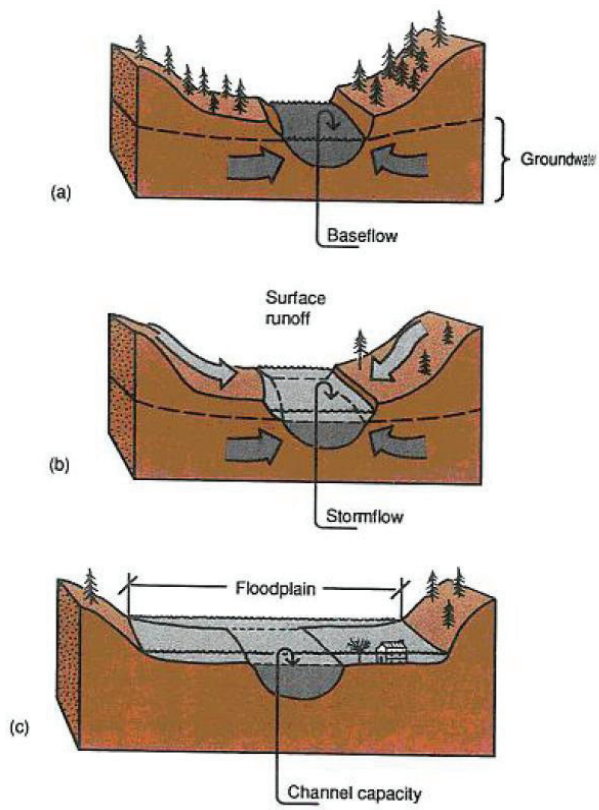

Figure 5. (a) Base flow generated by the seepage of groundwater into the stream channel; (b) storm flow generated by surface runoff in response to rainfall or melting snow; (c) channel capacity, flood flow, and floodplain.

3.1. Geographic Location and Drainage Basin of Ghotour Chai

Ghotour Chai is located at 44º 15′ and 45º 25′ E. longitude and 38º 30′ and 39º N latitude in the N. W. of Iran. It is counted as a water-shed of Aras river. Its length 204 Kilometers, the height of its source is 3550 meters. Basin area 8600 square kilometer, average slope %08 percent, average annual precipitation 370 millimeters, average annual discharge 47000 square cubic meter per second. It borders Maku city in the north, Salmas in the south, Marand in the east, Turkey in the west. Ghotour Chai basin was divided into eight sub-basins: Agh-Chai, Zonouz and Zilber Chai, Mahlazan, Ghazan, Aland, Hendvan, Upsteam and down stream.

The main tributary of Ghotour Chai originates from the northern slope of Ba Yazid Agha Mt. (its height 2914 m) placed in east of Turkey. It flows about 15 km from west to the east and enters Iran. After passing the Razi rail way station on the boundary line between Iran, and Turkey, it runs on a deep valley about 70 km to the east near Ghotour village where two tributaries Chelik and Sarik from the South are joined to it. Then it keeps on flowing to the east. In the Makhin village another tributary by named Gilando Sue from south is connected to it. From there, it flows to the northeast, and passes through a valley which is surrounded by two mountains, Torjan in the south and Avrin in the north. When Ghotour Chai reaches to the Khoy plain, the Aland river from north joins to it. In Nava Ye bridge which is located on intersection of Khoy to Marand road, another tributary by named Ghara Sue joins to it. From there, Ghotour Chai takes north- east direction and flows on a gentle slope to reach Ev Oghli village (Fig.6a).

In Some parts, river bed is widened. Its width reaches 300 meters. Near Bilvar village, another branch

by named Ghara Sue joins to it in a place called Ghodokh Boghan. In Mozaffar Abad, it receives Zonouz Chai which is one of the significant tributary of Ghotour Chai. It originates from Sultan Sanjar mountain (3100 m height) located in the east of Zonouz. It became flooded when there is a torrential rain. When Zonouz Chai reaches to Marand plain, Zilber Chai is joined to it. After irrigating the farmlands of Livar, and Yamchi, finally, it joins to Ghotour Chai in Mozaffar Abad. It passes through a salt- marsh area. In Marreh Kand village, another branch by named Agh Chai joins to it. In this area Ghotour Chai flows about 25 Kilometer to the north in a deep and narrow valley which is surrounded by mountains, then it goes out from this valley and reaches to the Sarkesh village.

Ghotour Ghai is a permanent river, its water source comes from rain fall and snow melt. The arch bridge of Ghotour Chai, is one of the most beautiful bridges which was constructed on rail way in 1962 under new technologies. The bridge construction is unique and incomparable in the Middle East. Its length being 448 m and height measured 128 m, the radius of its opening being 223 meters. Ghotour- Chai receives many tributaries; Aland, Ahg chai, Gharan Ghai, Zonouz Chai and Hendvan. Finally, it enters to Aras river in the north near Saint- Stephanus Church 18 km west of Jolfa city (Fig.6b).

Figure 6. (a) Ghotour Chai- photo taken by Author [a], (b) Aras river, photo taken by Author [b]

Table1. characteristics of hydrometric stations of Ghotour Chai river [4]

Year	Station	longitude	Latitude	Altitude	Annual average discharge
1959-85	Mileh Marzi	44˚ 19′	38˚ 30′	2030	1. 54
1959-86	Razi	44˚ 21′	38˚ 29́	1980	10. 93
1959-87	Gotour	44˚ 26′	38˚ 29	1920	2. 6
1959-88	Yazdkan	44˚ 47′	38˚ 29′	1320	5. 65
1959-89	Rahal	44˚ 52′	38˚ 29′	1240	2. 54
1959-90	Navaie bridge	45˚ 04′	38˚ 35′	1050	3. 48
1959-91	Ghotour Chai	45˚ 06′	38˚ 41′	1000	4. 59
1959-92	Malhazan	45˚ 06′	38˚ 41′	1000	1. 58
1959-93	Mozaffar Abad	45˚ 16′	38˚ 46′	970	1. 18
1957-95	Marakand	45˚ 17′	38˚ 51′	910	10. 98

Table2. Sub-basin of Ghotour Chai [4]

River	Length	Origin of river	Slope	Discharge (ml)
Aland	77	Girburan Mt. 3124m	3 %	2
Girin Gary	26	Berlook Mt. 2975m	6 %	4
Agh Chai	115	Shir Abad Mt. 2660 m	1 %	3.9
Zonuz Chai	114	Soltan Sangar Mt. 3180 m	2 %	0.21
Zilber Chai	102	Soltan Sangar Mt. 3180 m	2%	-
Gila Ligh (Hendvan)	16	Arvin Mt. 2755 m	11 %	0.53

4.1. Research Method

General plan for this study is based on three scopes: Library resources, operational process and observation. The collected data on flood issue were analyzed to obtain good results. The research method based on the following processes; Satellite images ETM land Sat 7, year 2002. Digital Elevation Modle (DEM) hydrologic maps, drainage channel systems, physiologic types, slope map, land use map were used for studying land erosional forms and flood hazard classes. Accuracy and validity of data were controlled by using software programs of GIS and RS. digital layers were conformed with geometric corrections then they were overlapped and incorporated. Matrix formula on spatial data were used for determining flood intensity, overuse changes on lands erosion intensity, sedimentation and flood hazard classes. The most critical flood that occurs on sub-basin of Ghotour Chai were classified into three groups; hard, moderate and low (Fig. 7a). On this paper, W 3, W 2, and W 1 indicate the low, moderate and hard flood hazard of sub-basin of Ghotour Chai respectively.

W 1=QU1 ∩ LS1 ∩ ED1 ∩ { FH1 Ụ FD1)
W 2=(OU1 Ụ OU2) ∩ (LS1 Ụ LS2) ∩ (ED1 Ụ ED2) ∩ (FH1 Ụ FH2) Ụ (FD1 Ụ FD2)
W 3=((OU1≤ OU3) ∩ (LS1≤ LS3) ∩ (ED1≤ ED3) ∩ (FH1≤ FH3)Ụ (FD1 ≤ FD3)
OU=over use LS=landside ED=erosion density FH= flood hazard FD=flood density

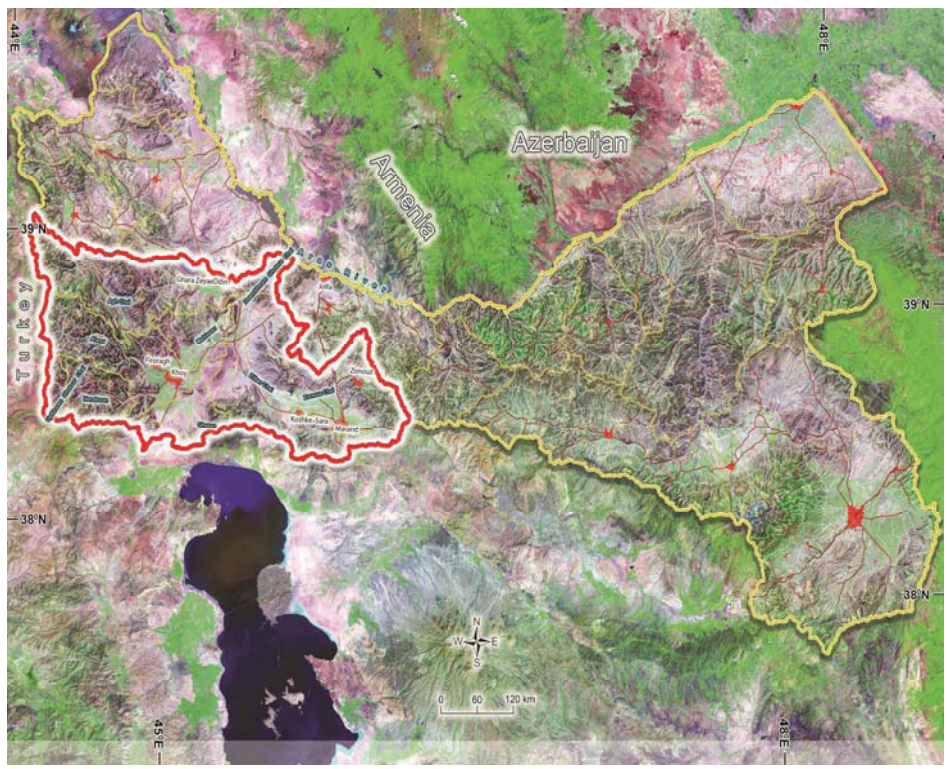

Fig.7. (a) Aras River Basin in Iran

The slope map apparently shows the Ghotour Chai watershed-basin. The slope map has been provided by classification of slope based on contour-line. Over 6o percent of lands with high slope have 135250 hectares. The lands with moderate slope 25 percent have 146507 hectares. The flood area, and landslide have made 15 percent of lands(Fig.8).

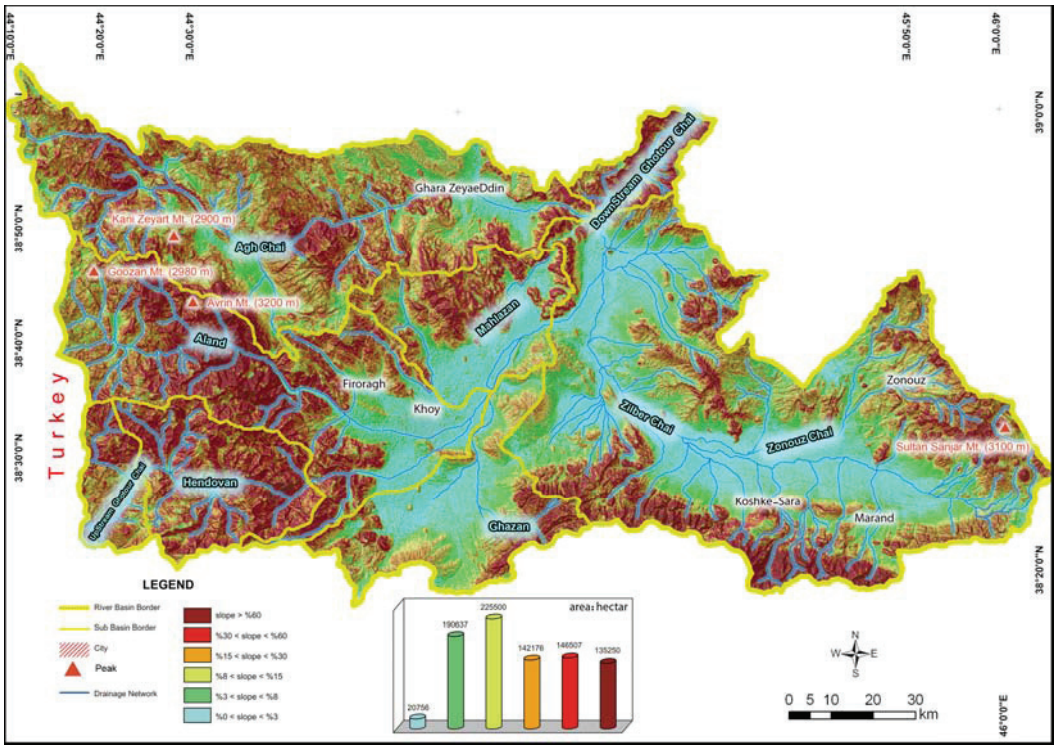

Figure 8. Slope map of Ghotour chai Watershed

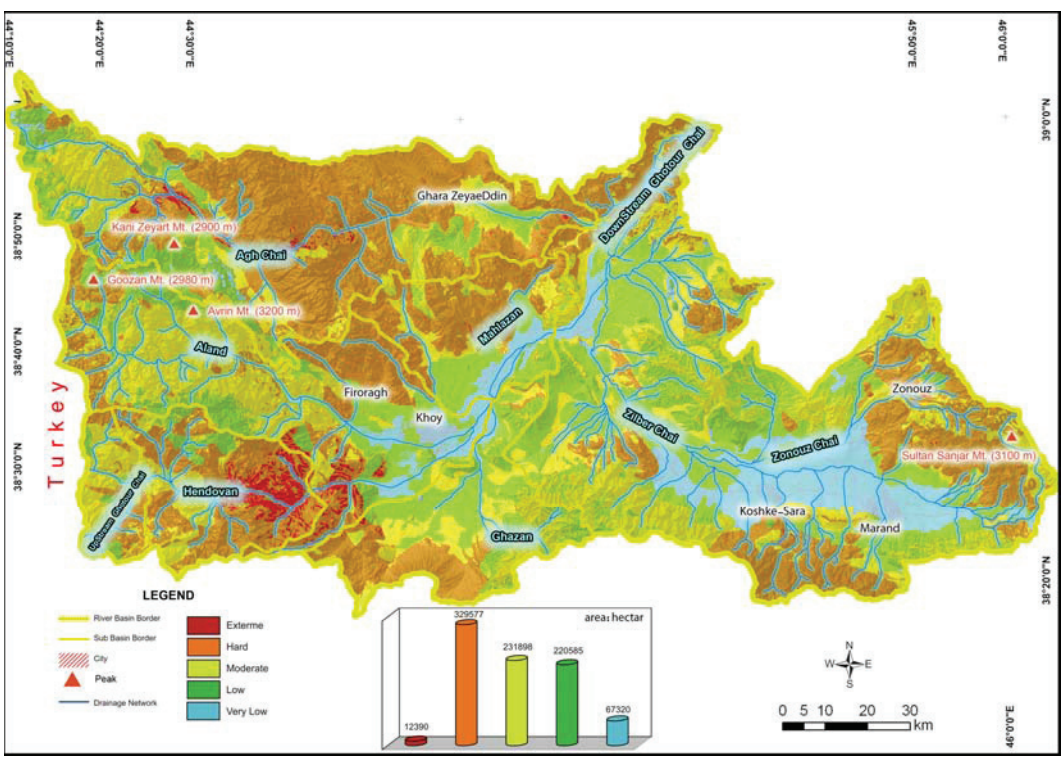

Figure 9. Erosion intensity map of Ghotour Chai Watershed

4.2. Erosion and Sedimentation

Erosion Potential Modle (EPM) has been applied based on the water-shed basin of Ghotour Chai. Four distinctive factors were distinguished for determining erosion intensity. These factors are land use, vegetation cover, slope and resistance of rocks. The main factors that affect on the erosion and flooding of Ghotour Chai are unstable texture of soil and sensibility of rocks in some part of region (Fig. 10).

Over half of farming lands are placed on vicinity of river bank in upstream which are extremely being eroded. 330,000 hectares of lands have intense erosion. In other words, they have occupied 15 percent and 38 percent of Ghotout Chai basin respectively.

4.3. Hazards and Intensity of Flood

The flood plain map was provided by combination of color bands 7. 4, two satellite images ETM 2002 and three dimensional similar Modle based on Radar system for determining the overflow area of Ghotour Chai basin (Fig. 11). It shows those villages and cities which are situated on inundated area. They consist 2 city and 14 village as follow: Khoy and Ziyaeddin city, villages are: Sinoor, Saed Abad, Ghooharan, Vishligh, Rajab garden, Malhazan, Bileh var, Ali Shakh, Yoozef Kandi, Aj Ay, Sheghofti, Khayrat, Bastam, Kissan.

Flood areas have covered 7504 hectares of lands. The study results indicates that Zonouz and Zilber river have covered the vast area of river basin which has 3164 hectare area.

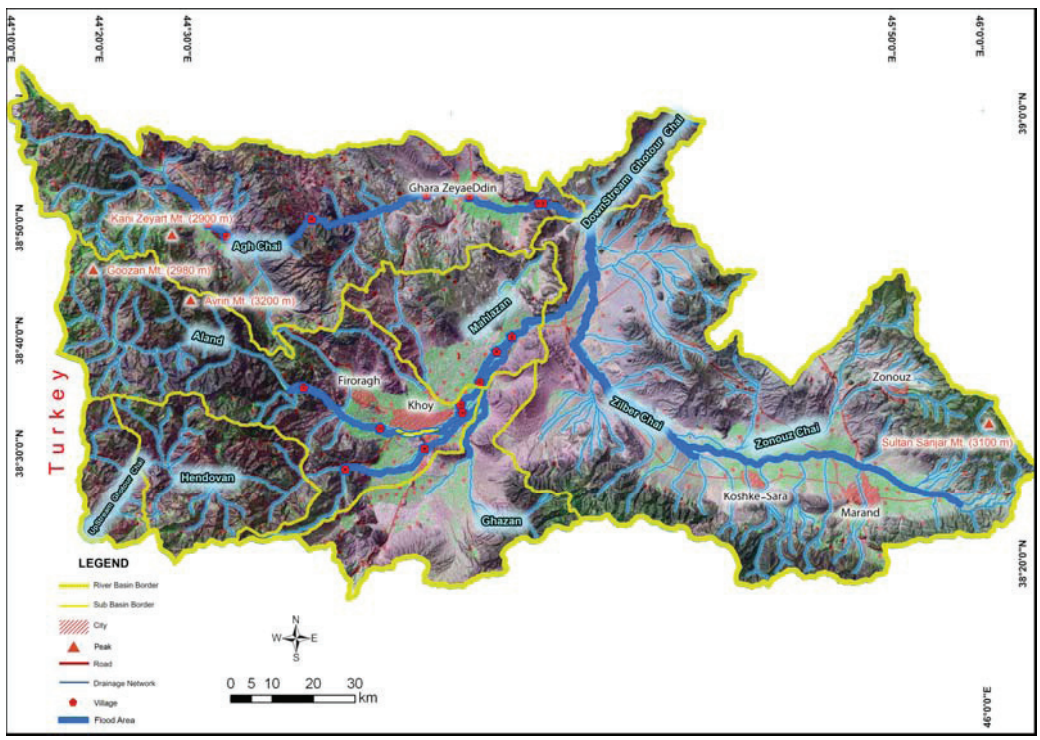

Figure 10. Flood Area map of Ghotour Chai Watershed

4.4. Flood Intensity Map

Flood area plays the most significant role on soil erosion and water protection. It should pay attention on the projects that will be performed on this area. When the rate of rainfall exceeds the soil infiltration rate, water flows along the surface as run off. . As a result, the discharge of river reaches to the highest point by torrential rain, causes flood flowing. We can say discharge of river can be considered as an indicator of flood area, the return of flood within 50 years can be estimated by analyzing hydrometric statistics of 1980-2000. Flood intensity can be measured by considering the area and discharge of river. Figure 13 shows a map of flood intensity in Ghotour Chai watershed.

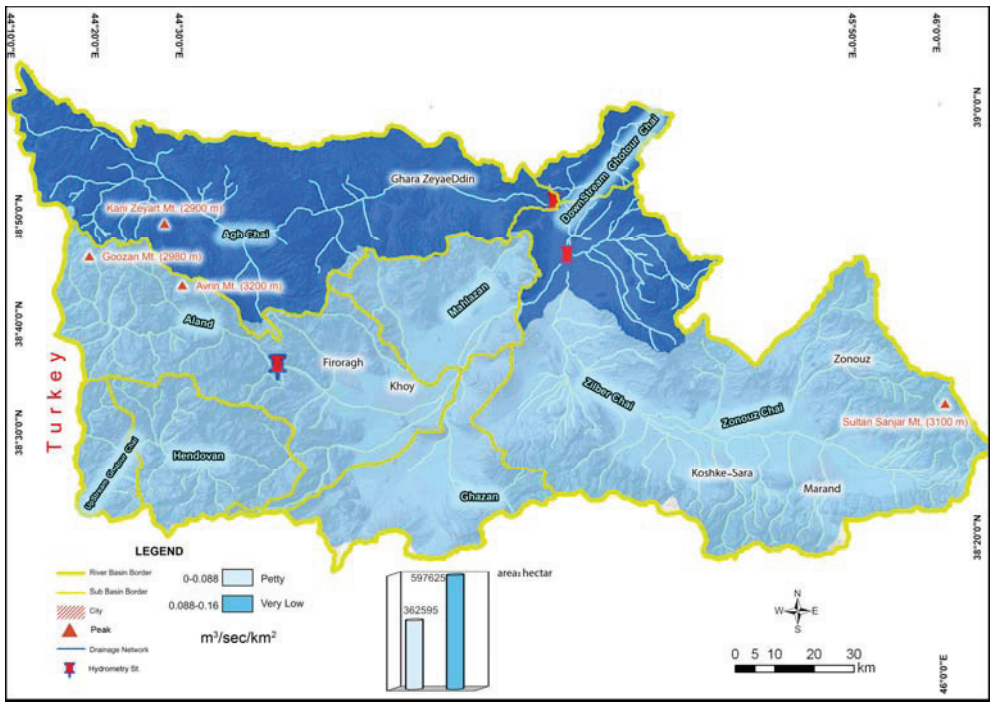

Figure 11. Flood Intensity map of Ghotour Chai Watershed

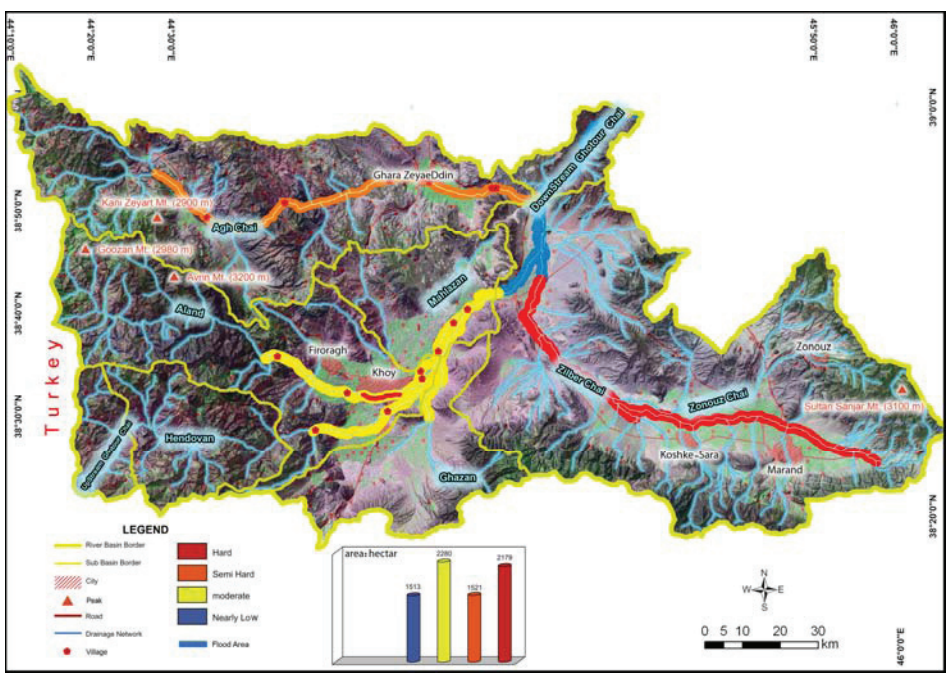

Figure 12. Flood Hazard Classes map of Ghotour Chai Watershed

4.4. Flood Hazard Classes

The collected data and statistics about flood occurrence in the past five decades (1950-2000) were analyzed

(Fig.14). Consequently, flood areas, flood damages and the core population centre which are exposed to flood hazard were distinguished. Five factors were recognized as main indicators on flood occurrence in water-shed basin of Ghotour Chai. It is clear that 2180 hectares of Zonouz and Zilber river are exposed to flood hazards and had more financial damages than other sub-basin.

5.1. Suggestions on Flood Damage Reduction

On a global scale, flood is considered one of the natural disasters that take place on human life. Flood damages are not less than the earthquake. Every year, million people are killed by flood in the world; consequently, Effective actions should be taken against the flood invasion such as Concrete walls, levee, and dike must be built along the river bank. Hydrologists and meteorologists can provide map of flood areas which are submerged and give more information about it [2].

On flood control, governmental organizations and participation of people are needed. Annual damages of flood in the developed and the developing countries have continuously been increased. It seems that amount of flood damages will reach 5 billion dollars in 2009. If prevention actions are not performed, the amount of flood damage will exceed over 6 billion dollars. In comparison, developing countries, mostly Asian regions have faced with flood problems more that other continents.

Land- use controlling: The areas that are being exposed to flood hazards and frequently being invaded by flood every 20 years. So, these areas are neither used for cultivation nor for settlements.

Flood control. It is necessary to protect lower lands that are exposed to flood hazards by constructing dam, reservoir, and deviation of channel.

Protection against flood on a local scale; It is significant to realize some patterns for development of area in a short time, therefore, constructing levee, and flood wall are needed for protection of agricultural lands.

Resistant constructions against the flood. In order to reduce flood damages, flood wall, levee, and gabion are needed to be built. These kind of measures and actions certainly will help the agricultural lands to be protected from flood damages.

Emergent plans: On the emergency case, when flood causes financial and physical damages to the inhabitants of area, public and private organizations are responsible to take serious actions against decreasing of flood damages.

Flood prediction. Flood warning systems are effective ways in preventing flood damages. Scientific strategies are suggested by commissioners of U. N. O On flood controlling. World Meteorological Organization and some other assisting organizations should take effective actions on flood damage reduction. All world organizations trying to take effective tragedies on preventing, controlling and predicting against the natural disasters in order to reduce them.

6.1. Results and Discussion

Water-shed basins of Ghotour Chai consists 165 hectares thinly scattered forest, 16000 hectares densely pastures, 14200 hectares irrigated lands, 6200 hectares dry farming and fallow lands, as a result erosion has been aggravated by changing land-use which resulted to flood intensity. Flood hazards mostly occur on Aland, Zonuz, and Zilber river basins. Considering flood hazards of the area, Ghotour-Chai basin is classified into three groups, critical, moderate, and poor lands.

Critical lands consists 130 hectares of agricultural lands having over 60 percent gradient. 340000 hectares have been eroded intensely. 2180 hectares are moderate flooding area. Moderate lands: about 6100 hectares of lands have30-60 percent gradient which are severely eroded. 230000 hectares has moderate erosion, 3800 hectares consist flooding area where flood hazards are relatively poor. . Poor lands: 1700 hectares of poor lands have 15-30 percent gradient where land is eroded severely. 220000 hectares of lands are eroded poorly. 2300 hectares of land are exposed to flood hazards; therefore, three mentioned areas, land-use reformation, soil conservation and controlling of soil erosion are needed. Structural and non-structural measures are needed for flood damage reduction on sub-basin of Ghotour Chai.

- Structural measures on flood prevention should be done.
- Making drainage belts on river bank is needed.
- Flood dams must be constructed on sub-basin of Ghotour-Chai
- Longitudinal embankment (dike, levee, gabion) should be built.
- Cleaning and maintenance of river channel on flood area are needed.
- Regional planning scheme should be performed on flood damage reduction.
- Flood mitigation reservoirs are required to be built.
- Horizontal grooves should be made on the slope of mountains.
- Biological methods should be used on bare slopes.
- Flood warning systems should be established.
- Analyzing data on seasonal rainfall and its changes during 20 years are important factors in flood prediction.
- Data concern to torrential rainfall and its returning periods should be analyzed.
- New strategies and innovative methods of developed countries to be used on controlling flood damages due to topographic features of area.

Acknowledgements

The authors wish to acknowledge Islamic Azad University of Shahre Rey Branch for their support.

References

[1] Ale Shaykh, Ali Asghar. applying GIS for localizing flooding area Seasonal magazine on geographic researches No.64 p. 22, 2003.

[2]Arthor, Skue. Article on "living by river side "translated by Majid Danesh seasonal magazine Nature & Resources published by UNESCO No 2 p. 8, 9, 1993.

[3] Comprehensive studies for agricultural development volume1, Aras river basin p. 42, 43, publication of Jahad agricultural organization 1994.

[4] Gazetteer of rivers in Iran, Caspian Sea watershed second volume published by National geographical organization of Iran p. 45,-46, 2003.

[5] Geologic map of Khoy city "Ghotour Chai basin published by geologic organization of Iran, 2006

[6] Jafari, Abbas. Gitashenasi of Iran, volume 2 p. 325, 326, 110, 97, 2001

[7] Jedari Evazi, Jamshid. Geography of waters published by Tehran University p. 131, 2008.

[8] Kayhan daily Newspaper, Iran p. 15 June 27, 1999.

[9] Khorasan magazine Aug 14, 2001. the deadliest flood of Iran in the past 50 years.

[10] Mahdavi, Mohammad. Flood management published by Ministry of Interior, development plan of U. N. volume 1, p. 22, 1999.

[11] Marsh, William M. Grossa, John M. Environmental geography, land use, science and earth systems published by John Wiley & Sons, Inc. p. 228, 1996.

[12] Muller, Peter O. physical geography of the environment published by John Wiley &Sons, Inc. p. 391, 419, 1996.

[13] National geographic magazine vol. 167, No 5 p. 577 May 1985.

[14] Natural resources& forest organization. Studies on water shed basin 2010.

[15] Sana ye Far, Military geography of Iran published by Emam Ali university p. 19, 2009.

[16] Satellite images ETM, Landsat 7, 2002.

[17] Seminar on flood vulnerability analysis and principles of flood plain management for flood loss prevention No 58 published by U. N. ESCAP 1984.

[18] Statistic data for rainfall & temperature of Ghotour Chai basin Published by Iran Meteorological Organization, 2006.

[19] Taheri Behbahani, Mohammad. &Bozorgzadeh, Mostafa. " Urban floods"published by scientific and cultural company. P.997.

[20] Taheri Behbahani, Mohammad.& Bozorgzadeh, Mostafa. "Flood control" published by A centre for architectural&urbanization studies and researches of Iran. p6. 1994.

[21] Taj Far, Reza. Military geography for neighborhood countries published by Emam Ali university p. 37, 2008.

[22] Topographic map scale 1: 50000 for Ghotour Chai basin published by geographical organization for Army forces, 2006.