The role of humans in the initiation of floods. Case study: flood, August 1998 – Masouleh, Guilan-Iran

B. R. Gourabi
Department of Physical Geography, Islamic Azad University, Rasht Branch, Iran

Abstract

As an ancient and a small tourist town, Masouleh is located in a mountainous and forested area in the western part of the Guilan province in northern Iran. The altitude of the town is 1050 meters above sea level and it has been recorded as a national heritage. Because of its uniqueness, Masouleh has also been recorded by Unesco. During the tourist season, this town receives a considerable number of domestic as well as international tourists. Natural hazards such as the 1998 flood adversely affected the number of tourists to this area.

The aim of this paper is to analyze the main factors which attributed to the 1998 flood in Masouleh, through which more than 50 lives were lost and extensive damages were left. Through fieldwork, the possible climatic, geomorphologic and human factors associated with the 1998 flood were analyzed. The study found that the role of the human factor has been crucial amongst the others. From a morphological point of view, the area is mainly covered with glacial sediments, therefore, if proper steps are not taken, we could face severe floods in the near future.
Keywords: flood, glacial deposits, Guilan, Masouleh, natural hazard.

1 Introduction

The town of Masouleh is registered under No.1090 in the inventory of history works by Unesco and Iranian Cultural Heritage. What has much significance from any point of view whether economical, or related to the income and subsistence of the people, has originated from the tourism both local and international.

Having these in mind precautions should be taken to secure the safety in the roads and transportation facilities of the town from the eventual environmental hazards and to protect the lives of the increase of the income earned from the tourism in the region. The viewpoint or policy leads to a more vigorous development in the tourism and there by originates the objectives and initiatives of the present survey.

Natural hazards such as landslide, flood and man made technological risks including road construction building bridges, water reservoirs, etc, may be named among the perilous factors that contribute to the development of higher risks for any town, of which a landslide that took place in Masouleh during the earthquake in 1990 and an outbreak of the flood in 1998 are momentous incidences to be mentioned as both caused great losses and damages of peoples life and property [1]. Though some researchers have surveyed the flood which occurred in the year 1998 [2,3,4] they have described the outbreak but not dealt with certain factors. Thus what is presently being dealt with here is the trial to identify the constituting agents of the flood incidence that happened to be among the highly significant factors in the environmental hazards, either climatic, geomorphological, or man made and technological [5,6], and those having a major role in the outbreak of floods in various geographical regions. The geographical features of the town of Masouleh are identified and a few strategies are offered in order to confront and stand out the hazards, expecting that their implementation would prevent the eventual losses that incurred in the summer of the year 1998, in fact the effects of the reluctance of tourists to come are still evident here long after the incidence.

2 The survey methods

This basin has on area of 40 square km and is located in the south of the city of Fouman in Guilan province; the latitude is across 37,7,10 to 37,11,46 northern, and the longitude is along 48,53,56 to 49 eastern; the mean elevation being 1883 m above sea level; the most elevated point is 3600 meters and the lowest is 850 meters; the slope is 48% and the flood channel is 8.7 km in length; and we have estimated the figure of 17.5% in the flood slope, having a time of concentration 42 minutes with the Kirpich method, fig.1.

For survey purposes, two available topographic maps of the region drawn with a scale of 1:50000 by the Geographic organization of Iran and another map charted by the Natural Resources organization with a scale of 1:25000 were used. Following our observations and field surveys the map delineated by the Natural Resources Organization in the scale 1:25000 was chosen as the reference base map. Also, in order to analyze the meteorological, climatic features of the region we employed the statistical data gathered by the meteorological authorities at Masuleh, Ghala Roudkhan and khalkaei through their Evapometric Stations which have been recorded by Guilan Regional Water Organization.

A geological map with a scale 1:250000 traced by the Geological Organization was used together with the field observations of the Masouleh basin as well as Winsurfer software (G.I.S) and Minitab statistical software for

analysis. The basin including the town of Masouleh is a minor basin of a larger wider one consisting of Masouleh River, so we initially specified the basin comprising the town in the topographic maps and the relevant omissions were amended by means of aerial photographs and field observations.

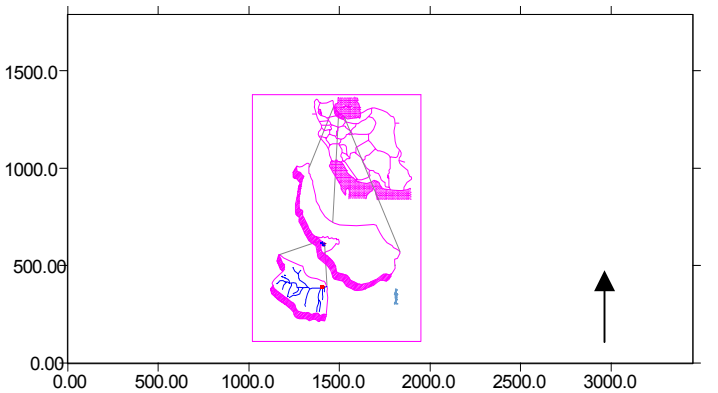

Figure 1: Situation of Masouleh basin in Guilan province, IRAN (per 1 cm=6km in basin map).

3 Results

The basin of Masouleh consists of four minor basins among which Khalil Dasht, located in the south, was the place where the flood way run during the outbreak of the flood in the year 1998. The geographical structure of this minor basin in its highest altitudes consists of limestone of the Permian period, of the first Era, and the lower altitudes of the basin up to the mainstream of Masouleh River formations having white and grey limestones are found which are partially weathered with Ammonites of Cretsceous period including Quartzite, lime and Shale of Triassic origin, from the second geological Era. Up to an altitude of 1100 m, the rocks of this minor basin are covered with fine-grained glacial deposits that are relatively profound in depth and also traces of steep glacial cirques can abundantly be found; there are also several glacial features such as moraines that are standing 5 km from the town up to an altitude of 850 meters above sea level. There exist glacial sediments along the valleys extending to Masouleh valley, namely Ghala Roudkhan and Karganroud of Talesh [7,8]. The rainfall recorded at the Masouleh meteorological station on the date the flood happened was figured to be 10 mm, and the precipitation at the surrounding basins laying across it was less than 2 mm. Also, according to the discharging stream rate or water flow logs, it was 1.1 cubic m/sec on the date in the Masouleh River and less than 1 cubic m/sec at the surroundings, as shown table 2.

The field observations together with an analysis of the meteorological and hydrometric measurement indicate that the sweeping surface of the flood on the

31st of July, 1998,could reach up to 142.2 square m [9], though the recorded rainfall could not justify the body of water raising in the said flood; in other words, the flood so produced could not have risen directly from any mild rainfall as that so, what else could be found as the main cause?

Table 1: Rainfall statistics, Masouleh basin and the surrounding basins (area), in mm.

Date	Maso-uleh	Maso-uleh	Ghlae	Ghale	Masal	Masal	Kasma	Kasma
	a.m	p.m	a.m	p.m	a.m	p.m	a.m	p.m
Jul30 /98	2	0	0	0	0	0	0	0
Jul31 /98	10	0	0	0	0	0	0	0
Aug1 /98	0	0	2	0	1	0	0	0

Source: Guilan Regional Water Organization.

Table 2: Statistics of the water discharge in Masouleh River and nearly rivers(lateral), in cubic meter/sec.

Date	Masouleh	Ghale,H	Ghale,N	Khlkhayee
Jul30/98	0.34	0.07	0.12	0.94
Jul31/98	1.1	0.07	0.12	0.94
Aug1/98	0.7	0.08	0.32	1.09

Source: Guilan Regional Water Organization.

4 Discussion and conclusion

The researchers who surveyed the flood concerned have addressed the rainfall as the contributing factor. This assumption is asserted for the date that the flood took place, but on the contrary there happened to be only 10 mm of precipitation in the basin and the body of the water discharged from the basin was about 20 cubic meter/second; however one should reasonably expect an outburst of this dimension once in every five years with respect to the statistical restitution cycle of the river in as shown in table 3.

Table 3: Estimate of the return period annual maximum moment discharge of Masouleh River with the Gumble method, in cubic meter/sec.

Year	2	5	10	20	50	100
Output discharged	17.3	22.6	26.1	29.4	33.8	37.9

But such an event has not occurred since that date, furthermore, though a coefficient run-off water of 46% was prevailing, only 5.4 mm was spent for the

channel flow and according to the daily report of records the hourly output of the river was 0.31 cubic meter/sec from 02:00Am up to 18:00Pm and from the said hour up to 20:00Pm it was 0.4 and at 22:00 reached 7.8 and 7.4 at 24:00 Pm. The precipitation fell short at that hour and the fact indicates that the rainfall could not be involved with the flood at all. The field observations assert other causes could be as follows. The sweeping surface of the flood was about 142.3 square meters and the body of water was amounting to as in figure 2. What happened was that a large reservoir of water together with mud were released from the higher positions at Khalil Dasht basin (locally called Malarzan, that literally means a quaking area) and produced the overwhelming flood. The mechanism through which the flood developed was a total fix occasioned as described below. The upper heights of the Khalil Dasht area, located in the southwestern area of the town of Masouleh, are covered with embanked sediments that are fine-grained and have glacial features of the Quaternary period. These sediments are laid on the area of Malarzan Dasht which is a vast and levelled play ground now used for outdoor games. From the geological time, since the Quarternary period the precipitations have infiltrated into the deposits due to their porous nature and huge underground reservoirs have developed through the ages from where excess water has been draining and flowing out as natural springs at several lower places. While we were walking along this field the unsteady state of this mountain foot and the water-containing features of the ground could easily be felt, fig.2.

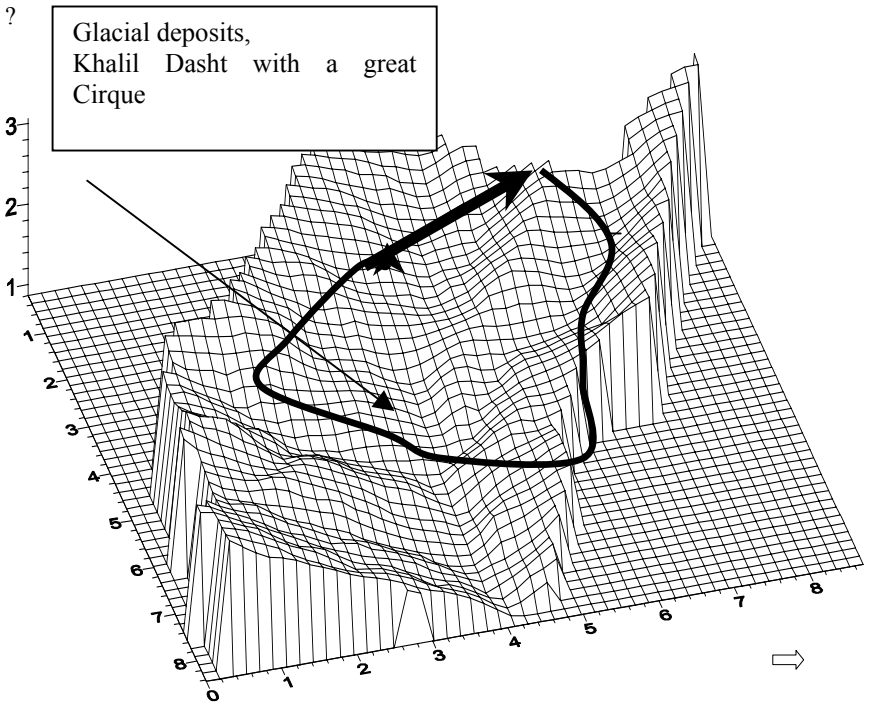

Figure 2: Situation of glacier deposits in Masouleh basin.

The unprincipled human-induced modification of road making on the lower lands, and soil compaction on the glacial sediments have caused the under ground channels and streams to be retained and trapped. Formerly these springs were the drainage that worked as the passages of excess water gushing through Quaternary deposits, but as a consequence of constrictions a huge body of water had been confined and stored therein. At the higher grounds of these sediments there had been flourishing Artesian wells prior to the occurrence of the flood and the column of water that gushed into the air reached 1.5 meter, [10]. The confined water was thrown forth through wells due to both its gravitational forces and potential energy and as a result this lead to a total eruption and gave rise to the creation of the flood which washed away and pushed down the road built by men over the drainage channel and route. This evidence proves that the flood would have evolved accompanied by a total eruption even if no rainfall existed, fig. 3.

The double action of the flood was such that the body of the flood water together with mud forced its way down toward the town and the bridge. Before long the transportation of an immense body of water was blocked as great masses of rock and gravel at the high altitude poured down and in their path had to pass through the span of the bridge. It could only allow 35 cubic meter of water to pass through and was destined to stand against a flood tide increasing overwhelmingly up to 108 cubic meter/sec. In a short while the surging water rose to the higher altitudes of the banks of the river and the road and this involved the death of 54 people, (31 victims were discovered and 23 were missing), and also destroyed 48 vehicles, (20 discovered and 28 missing) causing a total ruin and damage amounting to 5000 million rials, [11].

5 Some suggestions

The following points are offered for the purpose of maintaining and taking safety measures and preventive actions against the reoccurrence of the flood in the town of Masouleh in the Malarzan basin:

-Any type of construction works, road making on the Quaternery glacial sediments should be performed by observing the scientific and technical requirements of such features.

-The span of the bridge in the town should be enlarged enough to allow for an input increasing up to 100 cubic m/sec.

-The unsettled masses of huge rocks from transportation of the glacier in the Malarzan Dasht and the sides of the branching rivers should be crushed and stabilized within the river bed.

-The location of the boarding school and the building site down the road should be changed or the required technical and engineering precautions should be taken because they are located along the bed of the flood and the route of the over flowing water.

-Installation of flood monitoring [12, 13], and alarm systems are crucial for the whole area concerned which may well serve the safety purposes with the existing topographic features:

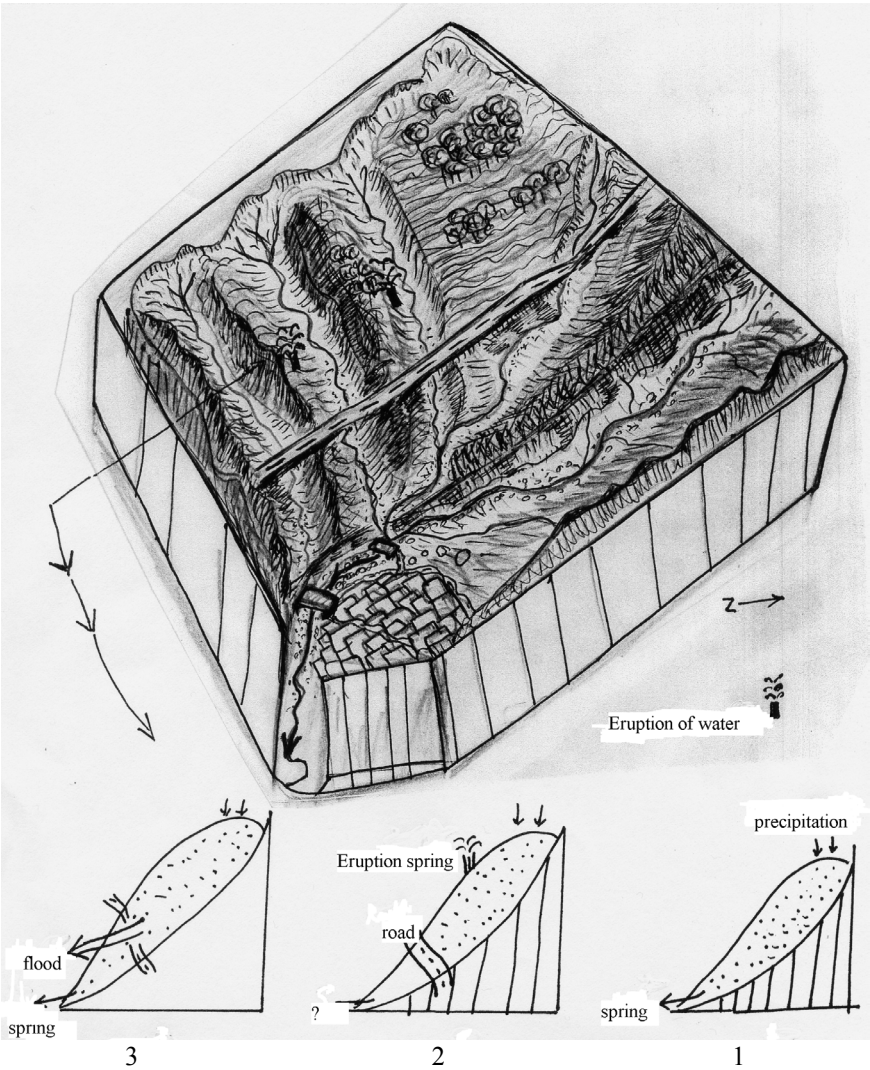

Figure 3: Building of road on glacial deposits and initiation eruption well (Artesian spring) in the upper slope.

On the day that the flood took place, the experienced and well-informed native people were alert enough to go for the higher places and also could communicate in their local dialect but most visitors and non natives who were not in a position to understand the calling uttered by the native people had tried helplessly to rush down to the lower places where their cars were parked and some of them fell victim to the outbreak while still in their cars with their families. They had tried to push through traffic jammed along the road (the scenes are video taped by those visitors who were saved) [14].

-Confinement and amending the path of the Khalil Dasht River, at the beginning of the children's park would cause double damages of any flood that may outbreak in future with regard to the unnatural existing deviation.

Acknowledgements

This research has been part of a research project titled "the study and recognition of natural hazards in Masouleh on inframework physical geography "and so, the author thanks, from the research department of Islamic Azad University, Rasht Branch, for financial support.

References

[1] Ramezani B, knowing the Masouleh catastrophe in the framework of natural geography project plan, Islamic Azad University, Rasht, Iran, 2001.
[2] Sharifi A, flood in Masouleh, Tous, 1998.
[3] Sharifi Kia, M, paying for the natures avenge, Tous, 2000.
[4] Mirzakhany A, Flood Risk Analysis and its damaging effects upon Iran, Insurance Quarternary pp7, No.13, 1999.
[5] Smith, K, Environmental Hazards, Routeldge, New York, 1992.
[6] Chivis P. C., Environmental Hazards, Routledge, New York, 1994.
[7] Mahmoudi Farajollah, Geology and Geomorphology of Guilan, ketab Guilan, vol 1, 1995.
[8] Mahmoudi F, A passage to the Talesh Altitudes, Talesh Qarternary No.1, 2001.
[9] Rafie, B, two visions on the construction of bridges, and a glimpse to the flood in Masouleh hosing and Enghalab magazine, No.88, 2001.
[10] Ramezani, B, The study and recognition of natural hazards in masouleh, Fazay geographical Qaurternary, no.4, 2001.
[11] Foroughi, N, Masouleh a town on rocks and its historical buildings, Guilan publications, 1998.
[12] Zhang, J.C. Zhou, K. Xu and Watanabe, flood disaster monitoring and Evaluation in China Environmental Hazards vol.4, number 2-3 pp33-34, 2002.
[13] Weichselgartner J, Oberstiene M, kowing sufficient and applying, Environmental Hazards Vol.4, numbers 2-3 more challenges is hazards management, pp72-77, 2002.
[14] Foroughi N, Video typed scenes of the flood in action, 30 minutes, 1998.