

EXAMPLE OF THE BIGGEST FLOOD DISASTER IN IRANIAN HISTORY: GOLESTAN PROVINCE (NE IRAN)

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ABSTRACT

The Golestan province is one of the regions with high natural disaster risk in Iran due to many natural disasters. In the last 30 years, many flood disasters have occurred because of heavy rains, and thus many people lost their lives, animals perished, residential and agricultural areas submerged, and significant structural damages occurred. These flood disasters caused the most loss of life and damage that occurred between 2001 and 2019.

On August 10, 2001, a flood event had resulted in more than 243 people and the missing of 190 people. Kalaleh, Galikesh, and Minodasht settlement areas in the Golestan Province were the most affected areas by the flood. Flood disaster caused submersion of forests and farmland in 500.000 hectares of Gorgan river basin, devastated two dams, and destroyed the main road connecting the Golestan and Khorasan provinces. Additionally, the accumulation of human and animal corpses behind the dam caused some epidemic diseases. The United Nations has announced this flood event as the deadliest flood event in the world in 2001.

Another significant flood disaster in the Golestan Province occurred on March 20, 2019. At least eight people were dead in this event, and 116 people were reported to be injured. The overflow of dams in the region has caused the submerging of residential areas and 240.000 hectares of farmlands. Also, 287 kilometers of roads, 84 bridges, and 200 meters of railways were destroyed, and landslides have occurred in 31 villages.

Considering major flood disasters of the last decade in the region reveals that the negative impact of human activities on nature such as deforesting for industrial use and developing farmlands in forest areas, which result in widespread soil erosions, and heavy rains that increase due to climate change causes the occurrence of disasters. Therefore, disaster risk determination, reduction, and preparedness studies must be made in the region immediately. Preparing the precaution plans for settlement areas and infrastructures and superstructures in the region against flood disasters that likely to be repeated is preferential. Improvements in the river or streambeds are among the necessary preferential precautions. The protection of forest areas in the region is also crucial in minimizing flood risks.

Keywords: Natural disasters, Flood, Golestan, NE Iran

INTRODUCTION

Natural disasters cause extensive damage every year, especially in developing countries, where records indicate a steady increase in natural disaster events (Aldrich, 2012). Several factors, such as geographical conditions, climate, or natural and human-made impacts, can control disaster's severity and recurrence events in every region. Floods can cause widespread devastation that results in loss of life and damages to personal assets and critical public infrastructure. Although flood is among the deadliest disaster, interestingly, it has some benefits such as recharging groundwater, maintaining flood plain ecosystem, or boost in food production for birds.

Flood disasters are among the most frequent natural disasters in Iran, which annually causes significant damages (Figure 1A). The Golestan province, located in NE Iran with about 22,000 km² total area and Mediterranean precipitation regime (Figure 1B), is one of the regions with high risk due to its topography, climatic conditions, and flood potential causes the occurrence of iterative floods and drought events. Flood-prone catchment areas consist of two significant parts; a) Mountains with high altitude terrains, and b) flood plain areas and adjacent areas located within the valleys and mountains. The existence of numerous rivers within the plain area in the central and north parts of the Golestan province, development of settlement areas, and occupying the natural flood beds are reasons that the floods cause many casualties.

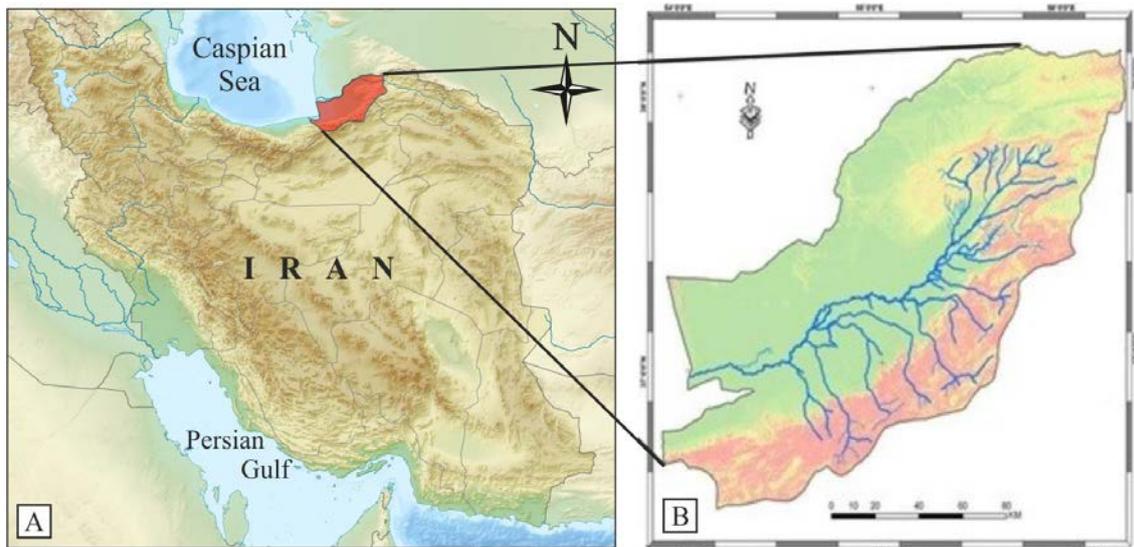


Figure 1. A) Map showing location of Iran and the study area, B) Shaded relief map of Golestan Province and its major drainage systems (Eftekhari et al., 2010)

45 rivers with an approximate length of 2,700 km are spread along 5 major river basins called Gorganrud, Karasu, Atrak, Gorgan Gulf, and Nekarud basins, where most of the documented flood events have occurred in Gorganrud and Karasu river basins. Gorganrud river basin is one of the most important river basins around the Caspian Sea, with a length of 350 km and an area of 12,600 km². This river originates from the western side of the Khorasan Mountains then enters the Kelale region and, after passing through the Turkmen Sahra and north of the Gorgan, reaches to Gorgan Gulf. The flood events of 2001 and 2019 that are the subjects of this study have occurred over the Gorganrud river basin.

FLOOD DISASTER OF AUGUST 10, 2001

The flood of August 10, 2001, occurred in the Eastern part of the Golestan Province, approximately 8 km to Minodesht and 107 km to the center of Gorgan city (Ardalan et al., 2009) (Figure 2). Before the flood event, the region has suffered a prolonged drought period for about four years, which negatively affects afforestation and vegetation processes in the region. Additionally, the drought period caused drying the soil surface, penetrating water between the pores, and filling the soil with small-grained clay that makes the soil very suitable for destruction (Mosaedi, 2001). The heavy rain started at 7.00 pm on August 10 and continued until the next day, which amount of precipitation was equal to the amount as the annual average precipitation for the region.



Figure 2. Images showing 10 August 2001 flood disaster. A) Bridge collapsed by the debris flow, B) Deforestation by the debris flow, C) Mixture of fine, coarse logs and sediment deposited in the upstream of Golestan dam (Sharifi et al., 2012), and D) Destruction of the building in Dasht village

The significant factors in the occurrence of the August 10, 2001, for the Golestan flood were precipitation intensity, deforestation, the high slope of the area, and the morphology of the river basin. A few hours after the heavy rain, flooding start in all over the area, and the muddy water flows (characterized by high flow rate and high density), from the upper parts of the area, caused overflowing in the river bed, which resulted in massive destructions, including covering the roads with debris and damaging severely two small dams: Giz Galeh and Mashhadi dams. The mud and sediments accumulated over the years behind dams were driven by the turbulent water, therefore enhancing the flood's intensity even more (Figure 2). The flood event had resulted in the death of more than 243 people and the missing of 190 people. Kalaleh, Galikesh, and Minodasht settlement areas in the Golestan Province were the most

affected areas. Approximately 387 villages and 4,000 buildings were damaged (Ministry of Agriculture - Jihad, 2006), and 500,000 hectares of forests and farmland in of Gorgan river basin were submerged (Figure 2B, D). The flood devastated Giz Galeh and Mashhadi dams and destroyed the main road connecting the Golestan and Khorasan provinces, which most of the people who lost their lives were tourists crossing the road (Figure 2A, C). Additionally, the accumulation of human and animal corpses behind the Golestan dam caused some epidemic diseases. The United Nations has announced this flood event as the deadliest flood event in 2001 (Irans Book News Agency, 2019).

FLOOD DISASTER ON MARCH 20, 2019

The precipitation starts at 6:30 am on March 17 and has continued non-stop until March 22, where the amount of precipitation has reached 354 mm at the Minudasht, Tuskachal precipitation station (Figure 3). This amount was superior to the annual average rainfall and led to floods and overflows. One of the most criticized aspects of handling the disaster has been the planned redirection of floodwaters towards populated areas and the release of emergency discharge waters toward farms and crops to avoid a significant overflow of reservoirs and dams (Figure 3A, B).



Figure 3. Images showing March 20, 2019 flood disaster in Golestan Province

At the time of the event, the Golestan and Bustan dams were already at maximum/ or close to the maximum capacity, so the flood caused by heavy rainfall resulted to overflowed from the Bustan dam and then Golestan dam, and later has moved towards the Voshumgir dam (Iran Water Resources Management Company, 2019).

March 20, 2019 flood has affected ten cities, including Gorgan, Bandar Turkman, Azad Shahr, Agh Ghala, Gonbad-e Kavus, Bandar Gaz, Ali Abad, Kalaleh, Kordkuy, and Minudasht. Due to the overflow of the Golestan dam, 25% of buildings (~3000

buildings) in the Gonbad-e Kavus were submerged (Figure 3C, D). 10 villages were submerged as the flood has flowed from the Golestan dam towards the Voshumgir dam (Hydrology and Water Resources Working Group, 2019). Overflow of the Voshumgir dam has caused the flood towards the Agh Ghala, where most of the settlement areas were submerged. In order to evacuate the water accumulated on roads and railways, the authority detonated several points of the railway and the roads. Precipitation has affected an area of 8.500 km² with a population of 695.000 throughout the Golestan Province.

According to the data of Golestan meteorological department, the amount of rainfall in one station reached 354 mm (in about 3 days at Tuskachal Minudasht station) that comparing to the long-term average of the region and even the statistics of recent years, the amount of rainfall and its intensity were very high. The amount and density of precipitation were the most critical factors affecting the severity of flood damage in the March 20, 2019 flood event, but the morphology and slope of the basin have controlled the movement and direction of the flood to the critical areas also. The fine-grained structure of soil and deposits in the region was an effective factor in preventing the percolation of water into the soil, which led to water saturation in the way of floods. On the other hand, rivers and stream beds mostly not subjected to periodic cleaning and expanding, deforestation, and the water reservoirs being already at maximum capacity before the flood event were other influential factors in multiplying the destructive power of the flood. The infrastructure and superstructures in the area are not adequately designed; for example, roads and railways must be built at higher levels. On March 20, 2019 flood disaster, 287 km of roads, 84 bridges, and 200 meters of railways were destroyed. 116 people get injured, 8 people have died, and many people get homeless, also. Residential areas and 240.000 hectares of the agricultural area were submerged by the overflow of dams and rivers.

CONCLUSIONS

The Golestan province is among the regions with high natural disaster risk in Iran due to the occurrence of many natural disasters. The occurrence of several destructive floods in the last decades, such as 2001, 2002, 2003, 2005, 2017, 2018, and 2019, indicates a high flooding risk for the region. After the August 10, 2001 flood event, several dams were constructed that were effective in controlling floods and reducing the damage. Additionally, relocating the villages which built along rivers with high risk and improvement of flood warning system using new advanced technologies in forecasting were among other precaution efforts. Floods have caused high destructive effects in the Golestan province, so taking advantage of experiences obtained from prior disasters to apply adequate, appropriate preventive measures against future hazards are critical. Therefore, management policies are essential to the protection of people and their properties, reduction of flood risk, and monitoring, researches, forecasting, and establishing early warning systems. Increases in unfavorable human activities in the last decade, such as widespread deforesting and development of farmlands in forest areas, together with climate changes, resulting in the recurrence of flood disaster and related risks.

One of the most critical factors which are triggering the flood events is changes in land use. Therefore, adopting new policies such as reforestation plans is essential to

minimize flood risks in the future. The preparation of precaution plans against flood disasters that likely to be repeated in settlement areas, including infrastructures and superstructures, are among preferential activities. Redesigning or relocating roads and railways and villages located in risky areas must be the next precaution plans. Improvements in the river or streambeds are among the necessary preferential precautions also. Finally, the protection of forest areas in the region is also crucial in minimizing flood risks.

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