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EXPERIENCES IN FLOOD EMERGENCY ACTION PLAN

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ABSTRACT:

Golestan Province located at the north of I.R. of Iran, suffered three devastating flash floods in August 2001, 2002 and 2005. Like the 2010 floods in Pakistan, these three major floods can be considered as unprecedented super floods, affecting a vast area with considerable damages. Local and national authorities have taken several measures to manage these floods. One of these measures has been the preparation of Emergency Action Plan (EAP) for three major dams located in the area. These are Boostan, Golestan and Voshmgir Dams built on the Gorganrood River. This paper reports on the background, motivation, methodology, results and challenges encountered for preparation of EAP for these three dams.

INTRODUCTION

It is a common practice to prepare Emergency Action Plan (EAP) for large as well as small dams [1]. Different countries have their own regulations and/or practices for development of EAP for dams [2, 3, 4]. Whenever people live in areas downstream of a dam, floods resulted by the failure or operation of the dam have the potential to endanger their life and properties. Preparation of EAP for dams is relatively a new practice in Iran. One of the first attempts to prepare EAP for dams followed the occurrence of three major floods in Golestan Province. This was just one component of an integrated approach for flood management in the area.

Study area

Golestan province is located in the Northern part of Iran on the south eastern shore of the Caspian Sea (Fig. 1). It is bordered by the Republic of Turkmenistan in the North, Semnan Province in the South, the Caspian Sea in the West and North Khorasan Province in the East. The total area of the Province is around 20,300 Sq. Km. The administrative capital is Gorgan City and as with other provinces in Iran, Golestan is divided into townships, districts, rural districts and villages. It has 16 cities, 11 townships and 47 rural districts. Total population of the Province is about 1,700,000 of which 41.3% live in urban areas and 58.2% in rural areas [5].

The Gorgan River system originates from the mountainous arid area in Golestan, Semnan and North Khorasan Provinces. The catchment is approximately 12,600 km^2 and the main Gorganrood River is approximately 350 km in length (Fig. 2). It discharges some 448 million m^3 of water annually. The river also transports some 1.336 million ton of sediment per annum. The Doogh River is a tributary of the Gorganrood River and spans approximately 101 km in a catchment of approximately 1,800 km^2. Of this 300 km^2 is covered by forests and 1,500 km^2 is covered by farmland and grazing land. The average slope of the riverbed is estimated at 1.5 %.

Figure 1: Location of Golestan Province, Islamic Republic of Iran

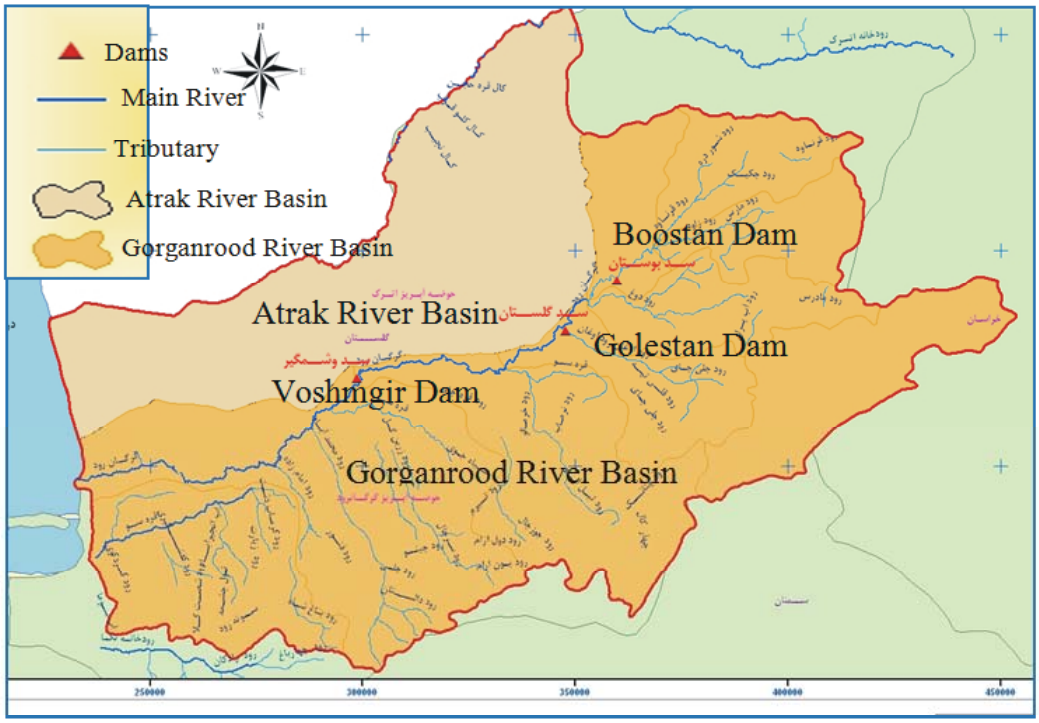

Figure 2: Dams location, Gorganrood and Atrak river basins

August Flash Floods

On Friday, 10th August 2001, torrential rains triggered flash floods in the Gorgan and Doogh Rivers in Golestan, Iran. Areas of North Khorasan and Semnan provinces were also

affected. It reached 450 mm in the first 12 hours with a return period of app. 35000 years. The flash floods in Golestan were the worst in 200 or more years, killing some 247 people and leaving over 10,000 people homeless. In addition the floods destroyed some 15,000 ha of farmland and 10,000 ha of forest and rangeland. Financial losses for the province were estimated at 491 billion Rials, or US$61.6 million.

Another catastrophic flood was occurred on August 11, 2002 in the same region but in different watershed. The total damage of the second flood was comparatively much lesser. Another flood in August 9, 2005 destroyed many structures that were rehabilitated after the 2001 floods.

The total death toll of these three floods is estimated about 400 people. Other flood damages are approximated as follows: 271'000 people were affected, 10'000 people homeless, 4000 infrastructure destroyed, thousands of livestock casualties and loss of 10'000 ha of forest and rangelands. The overall financial loss is estimated about 170 million US$.

After Flood Actions

Many actions were taken by local and national authorities for different stages of flood emergency management including: prevention, preparedness, relief and reconstruction. One of the main activities was the preparation of integrated flood management plan, including watershed management, dam and river training projects, flood preparedness, floodplain management and flood emergency management. Some emergency flood control projects were also defined including: river training, infrastructure rehabilitation, land use modifications, foresting and biological and structural flood and erosion control projects. Of the non-structural measures adopted after the flood preparation of inundation maps, flood zoning, dam break analysis, emergency action plan, integrated and local flood warning systems and public training programs can be mentioned. In what follows dam break analysis and emergency action plan for three dams in the region would be elaborated.

Dam Break Analysis

There are three large dams constructed on the main course of the Gorganrood River: Boostan, Golestan and Voshmgir Dams, mentioned in the order from upstream to downstream. All these three dams are earth-fill dams with heights ranging from 15 to 25 meters and reservoir volumes ranging from 60 to 90 million cubic meters.

To undertake the dam break analysis, first an investigation and review of dams were carried out [6]. Next a suitable breach development method was adopted. A coupled one dimensional- two dimensional (1D-2D) modeling approach was used to simulate the flow both through the main channel and within the floodplain. The DHI Mike-Flood commercial software was used for hydraulic calculations of dam break floods. For each dam two scenarios were applied: the sunny day and the spillway design flood (here PMF) dam break scenarios. In the first scenario it is assumed that the reservoir is at normal water level and the dam is failed for some reasons. For the second scenario it is assumed that PMF has occurred and the dam has been overtopped for some reasons. Since there were three cascade dams, the PMF scenario for the downstream dams meant that the upstream dam has failed and a much larger flood than PMF would be expected at the downstream dam. An interesting feature of Voshmgir Dam is the closeness of the border between the Gorganrood and Atrak Rivers to the course of the Gorganrood River (Fig. 2). This feature would cause any large flood to enter the Atrak River basin and thus the magnitude of the flood at Voshmgir Dam would reduce drastically. Thus the magnitude of floods reaching the Voshmgir Dam would not be big enough to increase the water level to its maximum value and thus the dam would not be overtopped in any case.

There were totally six scenarios of dam break and for each scenario the 1D-2D model was run to produce the relevant inundation maps. Fig. 3 shows the inundated areas for PMF scenario of Boostan Dam. This map shows that the area between the Boostan and Golestan Dams are not much affected in this scenario, but the Gonbad Qaboos city and its neighborhood are badly affected.

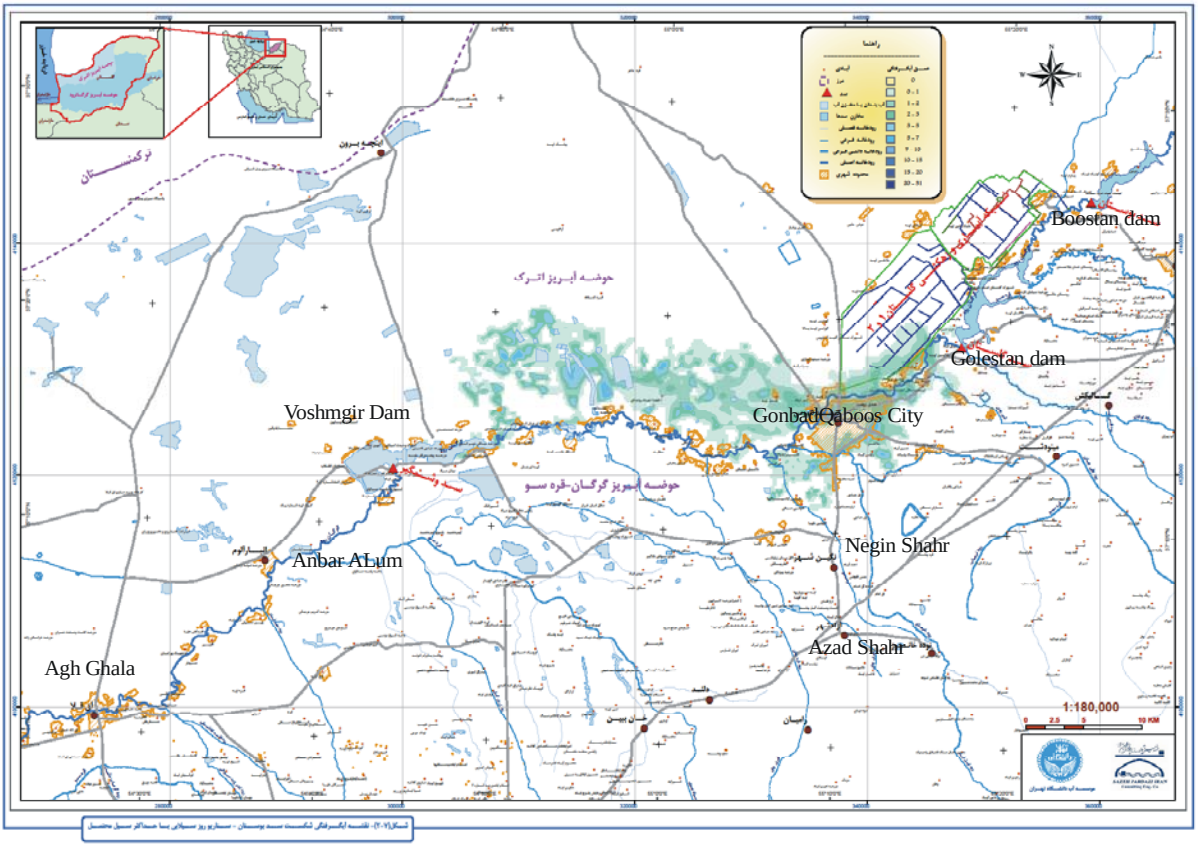

Figure 3: Inundation map for Boostan Dam, PMF scenario

Emergency Action Plan

Dam break analysis provides most of the necessary data for preparation of the Emergency Action Plan (EAP). Apart from the technical information obtained from the dam break analysis, one should be familiar with national laws and regulations concerning the disaster management in any country as well as the organization structure of dam owner and operator. In I.R. of Iran there is a high level national organization for disaster management which is called National Disaster Management Organization (NDMO). On the other hand most of the dams, including the dams under investigation in the present study are owned and operated by Regional Water Companies, in this case the Golestan Regional Water Company (GRWC).

Since the preparation of EAP and dam break analysis were new practices in Iran at the time of undertaking the present project, it was necessary to reach to a common understanding with the client as what an EAP actually means and what would be its proper format. It was agreed that an EAP is in fact a document for actions to be taken during an emergency situation and to identify potential emergency conditions at the dam. It specifies the preplanned actions to be followed to minimize loss of life and property damage. It consists of a main text and several

appendices. The main text is consisted of the purpose, dam description, notification flowchart, emergency detection, evaluation and classification, responsibilities, preparedness and inundation maps for different scenarios. Dam break analysis, site specific concerns, EAP approval, training, exercising, updating and posting the EAP are considered as appendices [7, 8, 9].

For example the following text is written as the statement purpose for Boostan Dam EAP.

"The main purpose of this document is to pursue and complete all previous activities to make Boostan Dam as safe as possible. It specifies the preplanned actions to be followed to minimize loss of life and property damage for downstream areas in case of dam failure. Thus this document is titled "Emergency Action Plan" for Boostan Dam. Since this dam is located upstream of Golestan and Voshmgir dams, the secondary purpose of this action plan is to make these two dams safer than before."

As to the dam description part of the main text information on items such as general location, adjacent dams, access roads, danger zones, dam reservoir, dam technical specifications, pump stations, project components, irrigation and drainage network and main functions of the dam are mentioned.

Three emergency levels of Red, Orange and Yellow have been considered. Red situation means that the failure is imminent or has occurred. By the Orange situation it is meant that a potential failure situation is developing but still there remains some time before failure. The Yellow situation refers to unusual conditions in which some flooding is expected downstream of the dam, mainly due to spillway operation.

Taking into account the Iranian disaster management laws and organization, for each scenario, a notification flowchart has been prepared. As an example, the notification flowchart for Boostan Dam at Red situation is shown in Fig. 4. This notification flowchart is based on the concept of an Internal Emergency Action plan in which the notification to the disaster management authorities (NDMO) is the responsibility of the dam owner (GRWC) and the rest of notification, including the public notification based on the Iranian laws are left to different Disaster Management Organization authorities and city and province level.

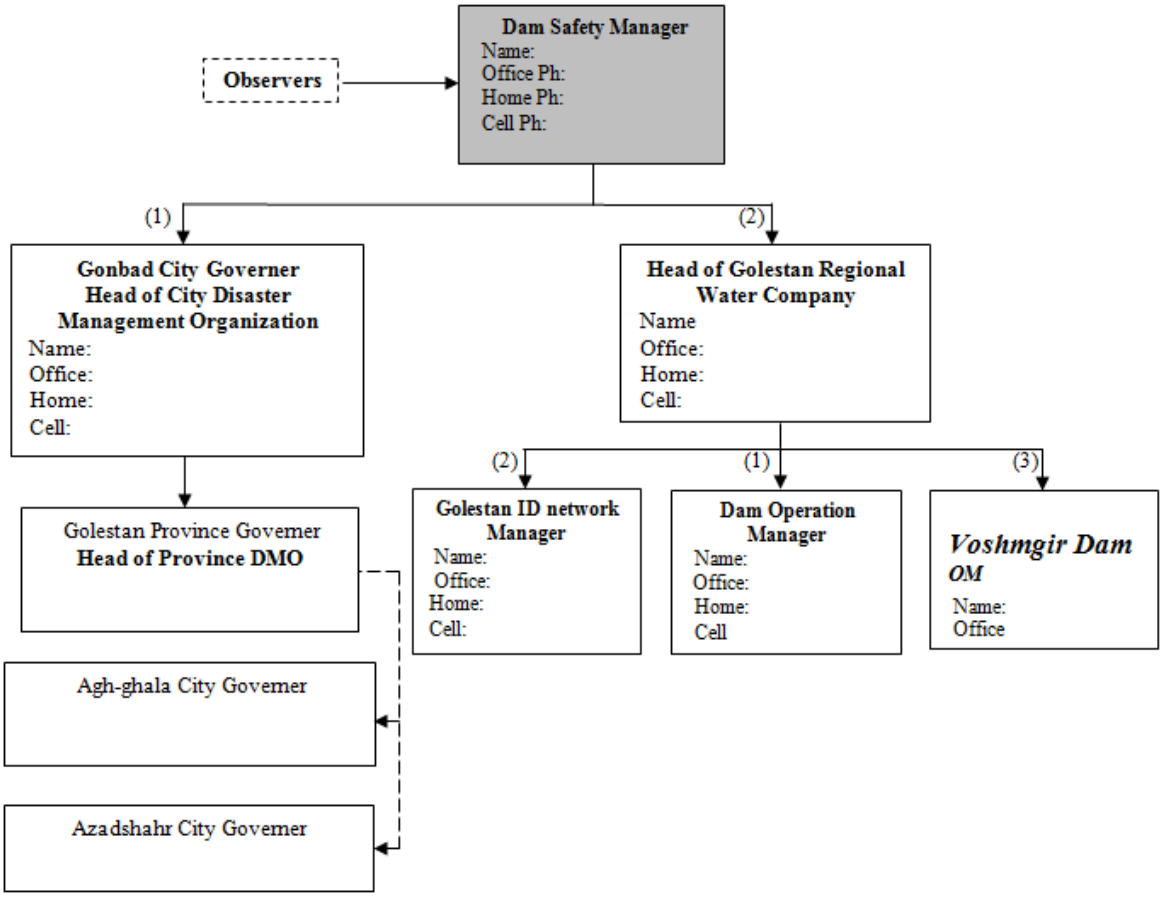

Figure 4: Notification flowchart for Boostan Dam, Red Situation

Different reasons might endanger dam safety and result in dam failure. These are: overtopping, unusual waves in the reservoir, large floods, structural failure, earthquake, piping, seepage, security or threat, sabotage and vandalism. There exists a table in the EAP document to guide the user on how to determine the level of emergency for each threatening event. Table 1 is extracted from Boostan Dam EAP and covers the overtopping event.

Table 1: Emergency Detection Guideline for Boostan Dam (Overtopping)

Level	Situation	Event
Red	Discharges more than 1720 (CMS) at Tamar Station	Overtopping
Oranges	Discharges more than 900 (CMS) at Tamar Station	
Red	Reservoir Water level increasing with a rate of 4 mm/min	
Orange	Reservoir Water level increasing with a rate of 4 mm/min	
Red	Reservoir water level reaching 104.7 m	
Orange	Reservoir water level reaching 104 m	

Determining the responsibilities of different parties is an important part of an EAP. Once again the concept of an Internal EAP shows its importance here. Management of different type of disasters necessitates determining the responsibilities of all relevant sectors and organizations within the framework of the National Disaster Management Organization. For

example, the responsibility of providing the emergency accommodation goes to the Red Crescent Organization, based on the Iranian Law of Disaster Management. In the process of preparation of EAP for Boostan, Golestan and Voshmgir Dams, it was assumed that general responsibilities such as public notification, evacuation, security and transport control and rescue operation are already determined by the Law, but the Disaster Management Organization need to know the detailed information of any specific disaster, here the huge flood resulted from the failure of dams. There still remain specific responsibilities of the dam owner, here Golestan Regional Water Company, to be determined and agreed upon. These responsibilities are determined as follows.

A) Responsibilities of GRWC during emergency

- Dam monitoring
- Emergency detection, evaluation and classification
- Notification to Disaster Management Organization (DMO)
- Helping DMO to make decision on emergency condition
- Updating DMO on the latest developments at site

B) Responsibilities of GRWC at normal operational condition

- Training EAP
- Coordination with DMO for approval of EAP
- Updating EAP
- EAP distribution
- Periodical dam monitoring (at least every 3 months)

With regards to the important task of notification, it was agreed that GRWC bears the responsibility of notifying DMO as well as the people living in the close vicinity of dams, for whom there would be a very limited evacuation time, and the rest of notification would be the responsibility of DMO.

The following responsibilities remain on the shoulder of Disaster Management Organization.

1. Determining of the Emergency Commander
2. Establishment of the Flood Emergency Management Committee
3. Coordinating the following activities:

- Public Notification
- Evacuation
- Security and Transport Control
- Emergency Accommodation
- Rescue operation
- Transfer and treatment of injuries
- Transfer and detection of dead people

- Recognition and cleanup of the damaged areas

Some important flood characteristics were extracted from the hydraulic simulation and mentioned in the EAP to assist DMO to fulfill its responsibilities as good as possible. For Boostan Dam EAP and the sunny day scenario, these characteristics are as shown in Tables 2 and 3.

Table 2: Important Flood times, Boostan Dam, Sunny day scenario

Start Time	Start of dam failure
2 hr 9 m	Complete dam failure
19 hr	First inundation at the upstream of Gonbad (Sarli makhtoom and Totly Khouchak)
19 hr	Beginning of inundation of Gonbad –Kalale road
21 hr	Beginning of the flooding of Gonbad City- Salman Farsi SQ & Alavi St.)
21 hr	Inundation of Gonbad-Dashlibroon Rd. (Dashlibroon Bridge)

Early warning time: 19 hr.

Table 3: Flood peak discharges (CMS), Boostan Dam, Sunny day scenario

Boostan Dam outlet	8300
Golestan Dam outlet	1550
Gonbad City entrance	922
Dashlibroon Bridge	647
Voshmgir Reservoir entrance	212
Voshmgir Dam outlet	107
Ag-ghala City entrance	96

CONCLUSIONS

The background, motivation, methodology, results and challenges encountered for preparation of EAP for three dams located at the Northern part of I.R. of Iran, Golestan Province, were presented. It is obvious that the preparation of EAP for high hazard dams should be done based on the regulations and common practices of each country and should not be interpreted only as a necessary action after occurrence of large unprecedented floods. However, the human being is forgetful and usually the preparedness for natural disasters reduces, if not diminished, as the memories of previous disasters are vanished by the time!

Flood emergency management is a more comprehensive task, compared with Emergency Action Plan (EAP) which is prepared for actions to be taken at the stage of “relief”. One should not expect the EAP to cover all stages of emergency management such as

prevention, preparedness and reconstruction. Furthermore, one should distinguish between normal floods and floods due to the failure or operation of a dam.

Preparation of EAP for dam in the first place needs a very good familiarity with the organization structure and laws and regulation related to disaster management of each country. There are tasks such as public notification, evacuation and relief which are common to all types of disasters. The national and local disaster managements should be ready for these types of tasks, regardless of the type of disaster. They should specifically determine the responsibilities of all parties. The dam owner should bear the responsibility of preparation of EAP and foresee important tasks such notification to disaster management organization, evacuation of people located at the near vicinity of the dam, reaching to an agreement with disaster management organization on the emergency levels and selection of proper name and tags for them, such red, orange and yellow states. The team which is responsible for preparation of an EAP should benefit from the presence of staffs that are specialized in hydraulic modeling as well as those who are familiar with the main concepts of emergency management.

In general, no EAP is useful and applicable, until it is approved by both the dam owner and the disaster management authorities.

Finally it should be stressed that the preparation of an EAP should be viewed as a process and not a project. It needs approval, training, exercise, updating and posting. The resolution of EAPs can be increased by preparation of different plans for different tasks as well as covering more sectors of potentially affected society. The major classification, however, could be differentiating between the EAP prepared mainly for the dam owner, the internal EAP, and the one which should be used by the disaster management organization, the external EAP.

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