

Study of Hydrological Inflow Regime to the Maroon Reservoir Dam and Flood Events

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ABSTRACT

Maroon Dam with maximum volume of 1274 MCM was built on this river by Khuzestan Water & Power Authority (Dams Identity). The dam Controls the Destroyer Floods and adjusts water And Energy and prevents from seasonal high flood damages and saves large amounts of water for agricultural consumptions. The river has flash floods with high peaks, so it seems that flood control and management are cases of high importance in this catchment and it is necessary to have information about flood volume for flood management, downstream programming and consumption estimation. In this study, Flood Hydrographs Analysis was used to check inlet Hydrological regime to the reservoir and Flood Events and To Assess Flood Control Volume of reservoir With Entrance Flood events relatively. Also this study is tried to Analysis the Act of Medial Basin. The Results Indicated that Only in The Rare Cases Flood's volume was More Than Reservoir Control volume. So One Can simply Decrease Flood Control Volume and use it To Supply Water and Energy Requirement goals. in the Terms of Quantitative, Simply can Dedicated Within Amount 140 Million cubic meters of Flood control Reservoir For other needs that Confidence in this Volume is At least 90% Observed events .

KEYWORD

Hydrological regime, Maroon Reservoir dam, Control Volume, Floods Hydrographs, Act of medial basin

INTRODUCTION

Iran has the arid and semi-arid climate such that the mean Annual precipitation is about 250 mm and its rainfall is a quarter of average raining of world. Therefore, the water has extremely important role in this country and will have a more important role in future with the population increase and programs development. Any plan of development and restoration is incomplete without water studies. In addition to the great rivers, there is sufficient water for municipal,

industrial and irrigation purposes. Therefore, a large part of advances of urban developed centers, industrial and agricultural is located along the rivers. But gigantic flood in the river was considered a threat to the facility constructed adjacent. However, an important part of rivers flood has controlled, but it still damaged to the human communities and resources [1]. Maroon River is Located in Iran and emanates from zagros mountain in Kohgilooie & Boierahmad province and flows to downstream to khoozestan plain. Inflow to Maroon River in dry season is very low. It is up to 9 cubic meters per second in normal years and falls to 3 cubic meters per second in dry years as a result of low snow interception capacity of the basin, compared to Karoon and Dez watersheds. However there are dangerous and disastrous floods in this river during wet seasons like autumn, winter and early in spring. The peak flood is sometimes over 5000 cubic meters per second. High water flow volume of this river has an usual and monotonous regime. But because of the torrential rains, the flood loses its usual regime and flows to khoozestan flat severely. Jare river, so joins to Maroon at downstream of the dam and then both of them constitute the "Jarahi river". These rivers are active when flood occurs. And so control task should be done So that excess water ejected and to control the reservoir for supporting downstream that is so vulnerable from damage [2]. Flood event discharge equal to 5704 cubic meters per second in 1993/02/03 in this river is the biggest flood that have been entered to this Watershed. This watershed, cause of its special estate is rain shelter and usually be active when flood occurs. These floods are very terrific and leaves much damages. For this reason Introduction of constructing Maroon dam Project is executive. Maroon dam location is 19 km from Behbahan city. Khuzestan Water and Power Authority assume the responsibility for the dam. Its reservoir volume is 1274 million cubic meters with an area of 24.6 km² (normal level) and its deep drainage has two intakes located 420 and 435m above sea level. (Fig.1) shows an over view of Maroon watershed. Also (Fig.2) shows satellite map of the lake of the Maroon dam.

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Fig.1. view of Maroon watershed

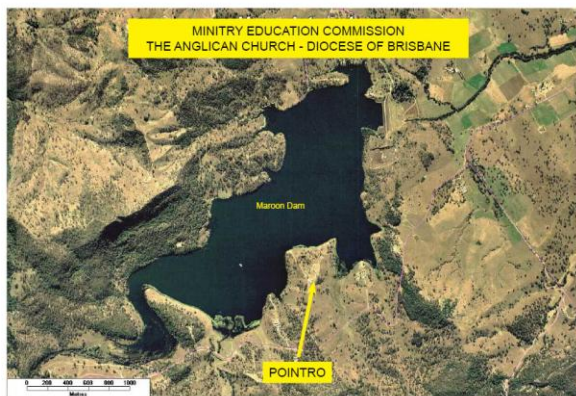


Fig.2. satellite map of the lake of the Maroon dam

Shehni Darabi et All (2011) calibrated runoff data based on the real precipitation data, using HEC-HMS Rainfall-Runoff Model and Schneider Method. They considered several sample observed floods in the past years, observed and calculated runoff values were compared and the best parameters were calculated for initial & final soil infiltration and time of concentration. They also made it possible to plot inflow prediction hydrograph to the reservoir of Maroon Dam, with 90% accuracy [4]. Raaiat pishe (2003) therefore to estimate flood discharge of Maroon river compared absorbed and calculated hydrographs and indicated synthetic unit hydrograph methods can make a good coincidence in estimate of flood discharge, quantity and quality point of view. They can so be recommended as capable model to estimate maximum discharges [5]. Mir Mehdi and Jahangir, studied the flood predict and rainfall-run off simulation using HEC-HMS model in Maroon watershed. Flood estimating of this basin is very important so that flood Caused very problem to the Maroon dam and it's downstream. So it is important to recognize and predict floods and Proportionate to the runoff apply suitable controls and prevent serious damages [6]. Shamkoeian et al (2010). Accomplished flood regional frequency analysis in Khorasan watersheds. They showed one can calculate flood index for each point of homogenous regions and to scale regional dimensionless flood values [7]. Rostami et All (2010) used statistics of hydrometric stations of Dez watershed, and analyzed station and regional flood frequency with linear moments. Results of error analysis between observed and calculated data showed in the regional analysis there are more errors in low return period

than high return period [8]. Naghshine et All (2013) studied flood routing in the Maroon River bases on hydrometric stations between Behbahan and Chamnezam. They used HEC-RAS software and Muskingum and Muskingum -corners methods. After calibration and testing, the results of methods were compared. So, the HEC-RAS model results considerably better match with the observational data [1]. During heavy rain, the inflow to the reservoir increases suddenly and this process continues at every moment until it reaches to peak level [3]. If the water level in the reservoir rises rapidly in flood time, it will be necessary to use spillways to discharge the excess water from the reservoir to the downstream. This study is carried out on this problem, whether flood events have caused more than dam's flood control volume or not. For this purpose an analysis was done on the all floods occurred during a 26 year statistics period from 1982 until 2009 and inflow volume per each flood was analyzed. Then the percentages of floods that had more volume than dam capacity was calculated. Thus flood control volume of dam with inflow occurred flood was relatively compared. In the next step, flood process before the establish of the dam in hydrometric stations on the Maroon river was tented to clarify when inflow volume is less than dam capacity and flood is controlled by dam (no water over flow), what is the possibility of the Medial basin to be active and cause downstream discharge to increase. So general study on the hydrological inflow regime to the dam and also flood events are basic purpose of this research.

MATERIALS AND METHODS

In this research hourly flood data that had been recorded in Idanak and Behbahan hydrometric stations by Khuzestan Water and Power Authority Control Center in statistics period of this study were gathered, corrected and completed. Idanak station is the most important station of the Maroon river and is located on the upstream of Maroon dam beside the Idanak Village and is used to check the input discharge to the reservoir. Behbahan hydrometric station is located 45 kilometer downstream, after Maroon Reservoir dam. Now this station is closed Because of Maroon dam Construction and also despite of Ario Barzan regulatory dam. Stats remaining from this station from 1966 to 2000 are available. (Fig.3) shows the location of hydrometric stations on Maroon river. (Behbahan and Idanak hydrometric stations are used in this study).



Fig.3. the location of hydrometric stations on Maroon river

Some Physiographic properties of watersheds of the both hydrometric stations is showed in (Table.1).

Tab.1. Some physiographic properties of Maroon river watershed [9].

Row	Watershed Characteristic	Idanak	Behbahan
1	watershed Area (Km)	2761	3802
2	watershed Perimeter (Km)	291.4	377
3	Lag time (Hr)	41.6	61.4
4	Time of concentration (Hr)	9.8	14.2

At first, for Evaluate of The inflow floods volume to the Maroon dam, Total flood events had been occurred in Idanak station was extracted from flood data had been recorded in hydrometric station. 176 hydrographs obtained with different duration before and after dam Exploitation and necessary analysis accomplished on them. For this purpose peak discharge, peak time, Volume and Runoff Resultant of flood for all inflow hydrographs to the reservoir were investigated And controlled. After that, Amount of inflow volume to the Dam reservoir was investigated and the issue that So far few percent of inflow flood volume to the Maroon dam was more than Tyranny control volume of the dam Were dealt. In order to Evaluation of Activity of Medial basin effect and flood Process in Idanak and Behbahan hydrometric stations Whole position 232 hydrographs Has been extracted In the statistical period before the exploitation of Maroon dam. 127 hydrographs were Related to Idanak hydrometric station and 105 hydrographs was Related to Behbahan station. All the hydrographs were analyzed and peak discharge of Flood in two hydrometric stations compared

DISCUSSION AND CONCLUSIONS

A) Study of Hydrological Inflow Regime to the Maroon Reservoir Dam

All flood events were studied in this statistic Period. It was found that 176 hydrographs entered to the reservoir. Peak discharges of this hydrographs were between 100 and 5700 cubic meters per second and their volume were 8 to 370 million cubic meters. Pure runoff of this hydrographs which is obtained by dividing the volume to the basin's area computed about 3 to 140 millimeters. (Table.2) shows flood occurrence frequency with 24 hours until more than 72 hours Durations (96 and 120 hours) in Idanak hydrometric station

Tab.2. flood occurrence frequency with different Duration

Row	Duration (hr)	Absolute frequency	Relative frequency	Percent of frequency
1	24	25	0.14	14.20
2	48	85	0.48	48.30

3	72	46	0.26	26.14
4	>72	20	0.11	11.36

One of the features of the Maroon Reservoir dam is having the Capacity Up to 250 million cubic meters for Flood Control. In order to Survey of inflow volume to the Dam reservoir, Volume from all Flood events During the statistical period of this study were arranged in descending order and Frequency of occurrence Related to flood's volume Was classified in different classes. (Table.3) shows the entrance volume Frequency to the Maroon Reservoir dam from Flood events occurred in Idanak hydrometric station.

Tab.3 .entrance volume Frequency from occurred Flood events in Idanak hydrometric station

Row	Volume classes	Center of the class	Absolute frequency	Relative frequency	cumulative frequency percentage
1	0-50	25	110	0.63	63
2	50-100	75	34	0.19	82
3	100-150	125	18	0.10	92
4	150-200	175	7	0.04	96
5	200-250	225	3	0.02	98
6	250-300	275	3	0.02	99
7	300-350	325	0	0.00	99
8	350-400	375	1	0.01	100

About 250 million cubic meters Equal to 25% of the active volume of the reservoir is dedicated for Flood Control. As (Tab.3) shows only 2 percent of the flood events during the years 1982 to 2009 was more than 250 million cubic meters and have caused more than dam's flood control volume. Only in The Rare Cases flood's volume is More Than Reservoir Control volume. Therefore, with the use of Short term atmospheric forecasts which has improved in recent years Can simply Decrease Flood Control Volume and use it to supply Water and hydroelectric power generation purposes. In the Terms of Quantitative, Simply can Dedicated within Amount 140 Million cubic meters of flood control Reservoir for other needs that Confidence in this Volume is At least 90% Observed events.

B) Study of medial basin's activity:

In this part, the process of flood hydrographs in Idanak and Behbahan hydrometric stations located on the Maroon River's route before dam Exploitation Was investigated. Up to Discover When the volume of inflow Flood events to the reservoir dam is less than flood control volume and Flood is inhibited by dam reservoir what extent is Possible that medial basin of the dam's activity increase the discharge at the downstream of the dam. 105 flood hydrographs in Behbahan station was analyzed in order to assess the process of flood In statistical period before the construction of dams. Peak discharge of this hydrograph was between 150 and

5200 cubic meters per second and their volume were 8 to 270 million cubic meters. Also pure runoff of this hydrographs were obtained about 3 to 100 millimeter. (Tables.4 & .5) respectively show summary of flood hydrograph analysis With more than 2,000 cubic meters per second peak discharge, in Idanak hydrometric station (before and after dam exploitation) and in Behbahan station(only before the Maroon dam exploitation).

Tab.4. Summary of flood hydrograph analysis in Idanak hydrometric station

Row	Date	Duration (hr)	Qpeak (m ³ /s)	Peak time (hr)	Volume (Mcm)	Runoff (mm)
1	1993/02/01	96	5704	51	366.84	132.86
2	1989/12/02	96	2990	64	294.21	106.56
3	1992/02/24	72	2630	34	142.12	51.47
4	1998/03/30	48	2550	10	150.42	54.48
5	1993/02/21	72	2363	16	276.72	100.22
6	1993/01/07	72	2349	34	200.69	72.69
7	1994/11/16	72	2226	36	120.14	43.51
8	1998/01/05	48	2080	22	117.38	42.51
9	1991/12/12	96	2042	52	290.77	105.31
10	1998/03/18	48	2030	18	178.26	64.57
11	2004/01/07	48	2373	22	121.74	44.09
12	2007/03/28	48	2309	22	115.32	41.77
13	2002/11/29	72	2205	46	129.91	47.05
14	2004/01/13	48	2052	18	160.05	57.97

Tab.5. Summary of flood hydrograph analysis in Behbahan hydrometric station

Row	Date	Duration (hr)	Qpeak (m ³ /s)	Peak time (hr)	Volume (Mcm)	Runoff (mm)
1	1993/02/01	96	5164	60	269.66	70.93
2	1989/12/02	96	3961	64	315.60	83.01
3	1985/02/01	48	3475	34	163.99	43.13
4	1985/01/02	96	3325	46	269.66	70.93
5	1984/11/10	72	3125	60	103.23	27.15
6	1994/11/16	72	2882	40	180.32	47.43
7	1991/12/12	96	2639	54	292.06	76.82
8	1992/02/24	72	2395	38	198.06	52.09
9	1994/11/23	120	2302	70	210.70	55.42
10	1993/02/21	72	2176	18	16.59	4.36
11	1998/01/05	48	2146	28	146.61	38.56
12	1998/03/30	48	2146	16	170.98	44.97

Although the exploitation of Maroon Dam Has faced with drought period but high flood peak discharge occurred in this period. (Tab.4) shows that during 3 years, 4 Flood event

occurred that their peak discharge was between 2000 to 2400 cubic meters per second with volume equivalent 120 to 160 million cubic meters. All of these floods are depreciated by dam reservoir. To determine the activity of Medial basin, Flood hydrographs have been frequency analyzed in Idanak and Behbahan hydrometric stations and Were determined that in 69 cases of the this Floods Faced with increasing peak discharge in Behbahan station. Even in some cases peak discharge in this station was more than twice in the same event of that flood in Idanak station. In other words medial basin was activated and increased the peak discharge on the downstream of the basin in about 70% of flood events. For example Two different flood events from the above tables were investigated. Comparison of the flood hydrographs in hydrometric stations in this study In 1 Feb 1993, indicates the amortization of flood by the river between Behbahan and Idanak stations in the about 45 kilometers interval. Flood peak discharge of hydrograph was approximately equal to 5700 cubic meters per second at Idanak station and 5160 cubic meters per second in Behbahan station. Duration of this flood event was 4 day and it volume was 370 million cubic meters. Also pure runoff has been generated In the productive Sub basin (Idanak) is approximately equal to 140 millimeter. This number is equivalent to 25% of the average of all of annual runoff in this Sub basin. In other words, in a specified flood event, 25 percent of the annual runoff volume has been occurred. But the flood event on the 16/11/1994 did not act like the previous example and medial basin between the Behbahan and Idanak was activated. Contrary to the depreciation of flood by the river, This Medial basin activity makes Behbahan's hydrographs to reach a higher peak discharge. Examining these examples represents the variability of Maroon River. Thus nevertheless depreciating upstream floods by dam reservoir, It must be considered to prevent flood damages in downstream of Maroon Reservoir dam, so it is necessary to estimate the probability of floods and using appropriate methods and specific facilities to control the flood impacts. For example, it can be named from the embankment, flood and prudential measures and reform of the rivers.

RESULTS

In summary, the following results were obtained:

1. Maximum volume of Maroon Reservoir Dam is equal to 1274 million cubic meters. 260 million cubic meters of this amount is for hydroelectric power generation and also Includes Dead volume of dam reservoir. About 250 million cubic meters Equivalent to 25 percent From Whole Active volume of reservoir is flood control volume. Only 2 percent of the flood events before and after dam exploitation was more than 250 million cubic meters and have caused more than dam's flood control volume. So Only in The Rare Cases flood's volume is More Than Reservoir Control volume. Therefore, with the use of Short term atmospheric forecasts which in recent years has improved Can simply Decrease Flood Control Volume and use it to supply Water

and hydroelectric power generation purposes. In the Terms of Quantitative, Simply can Dedicated within Amount 140 Million cubic meters of Flood control Reservoir for other needs that Confidence in this Volume is At least 90% Observed events.

2. Medial basin was activated and increased the peak discharge on the downstream of the basin in about 70% of flood events. Thus, Most of the time the Upstream flood events are depreciated by dam and It is better to consider a solution for Increasing flood discharge in downstream of Maroon dam caused by the central basin activities in the flood time such as embankment, flood and prudential measures and reform of the rivers.

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