



# The Economic Impacts of Historical Water Reservoirs and Ghanat in Ancient Iran

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## Abstract

Iran has situated in hot and dry zone, so Iranian have been understood the value of water from long time ago. This factor was the important reason for familiarity and optimum use of water resources by the technical people. If we carefully see the construction of reservoirs, ganats, locks etc we can understand that each of them has been constructed based on technical and engineering principals with respect to climate conditions in each area. Ganats and reservoirs of Shahrood area show the importance of water resources use in past years. Present research work has been conducted based on importance and old of ganats and reservoirs in Shahrood suburb. Results of study showed that there were 100 ganats in shahrood and Bastam up to 55 years ago which are working only 10 ganats in present time. In Bastam the biggest and full water ganat is Sadeg Khan ganat and it is working more than 200 years. This ganat belong to different people and discharge of that is 50 lit/s. In an arid area like Shahrood such ganat improves the Bastam agriculture and it is so important to environment of this area. It is irrigating more than 200 ha gardens in Bastam and increases the economic in this area. The optimum use of water of this ganat and Black ganat in Galeh Now Kharagan village and springs in Meyghan are the main objectives of their designers.

**Keywords:** Ganat; Reservoir; Spring; Discharge; Tube Well; Volume of Water

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## 1. Introduction

All living beings of earth require four elements water, soil, air and light for continuity of existing. For this reason, may be old Iranian people believed these are respect. Water is the shear of creature body from one side and from another side it is working as a human enemy.

Saem (2005) reported that for drinking and agriculture propose, ganats are the only water resources in Shahrood before 45 years ago, but after sometimes discharge of ganats limited and decreased [1]. Azhdary (1999) reported that controlling of ganats and springs water is effective method for solving the economic problem [2].

The big area of Iran has arid climate with less rainfall in half of year, so some controlling systems have designed for providing the drinking water. The reservoirs were saving the water in rainy season for optimum use in other season (Divandary, 2000) [3].

## 2. Material and Methods

### 2.1. Geographical Situation

Shahrood situated in southern part of Alborz Mountain in east of Semnan and west of Khorasan state. It has limited to desert from south. Shahrood area is 51420 km<sup>2</sup> with longitude of 54° 25' 57" to 57° 9' 34" and latitude of 34° 22' 37" to 37° 19' 04" and has 1321 miter height from sea level. This area has 160 mm rainfall in year and it is one of the

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Semnan state city. This city has 7 part and 296 village. Shahrood has 10 in depended watershed. Figure 1 shows the Shahrood area.

## 2.2. Existing Lands

Study of different references shows that each part of Shahrood has a big plain. Water resources are situated in plains in each part of area. Famous plains are: Shahrood plain, Bastam plain, Mojen plain, Byarjomand plain, Mayamey plain, Torood and Khartouran plain. Bastam is one of the Shahrood part and it is very important in case of agriculture. Bastam has so many garden with different fruits like grape, pear, nut, cherry and apple. Tomato and potato are the important vegetable of this area. Bastam is in east part of Shahrood and it has a watershed. There were some ganats and springs in this watershed long time ago but nowadays unfortunately few number of ganats are active. There are so many tube wells also in this area. Figure 2 shows the Bastam watershed.

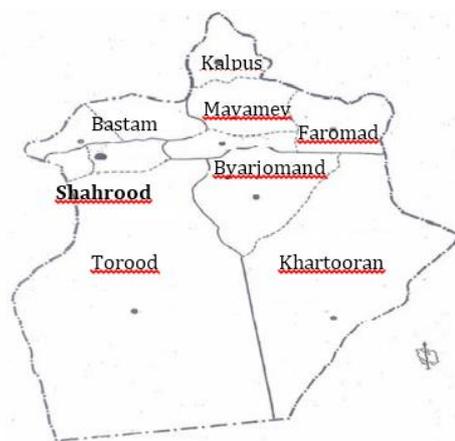


Figure 1. Shahrood map with related suburb

In this research work history of the water resources in Shahrood and Bastam plains are evaluated [4]. The study was carried out for evaluating the water resources like ganats, reservoirs, springs and tube wells in this area. In this study at first plains are visited so many time, after that references are reviewed which are available in Shahrood Water Organization. Results of this part of study are presented in table 1, 2 and 3. Table 1 shows the number of ganats, springs and tube wells in Shahrood and Bastam area. Table 2 and 3 shows discharge of these water resources.

Nowadays there are only two important ganats in Shahrood and Bastam. One of them is Shahrood City Ganat with 125 lit/s discharge. It is using only for drinking water in Shahrood. Another one is the Sadeg Khan Ganat with 52 lit/s discharge which is

working for agriculture purpose and irrigating more than hundred gardens in Bastam.

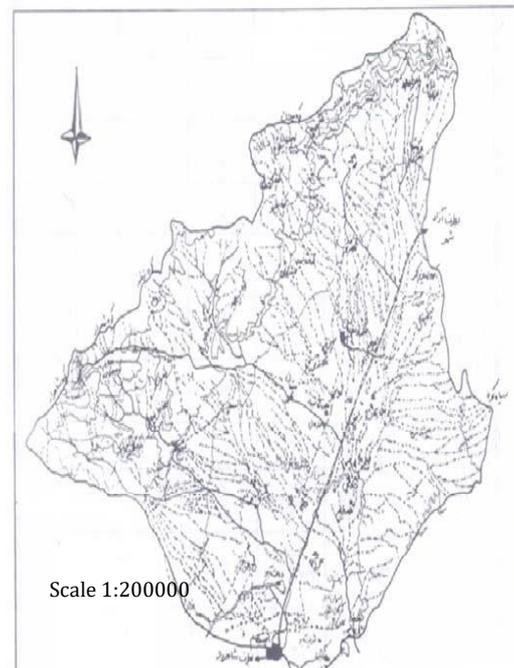


Figure2. Bastam watershed

## 3. Results and Discussion

Water resources changes in two main plains of Shahrood and Bastam are presented in tables 1, 2 and 3. This tables show that water resources changes are only in case of ganats and tube wells in last 50 years and springs do not show any changing. Table 1 reveal that there were 44 ganats in Shahrood plain 50 years ago and nowadays only one ganat is working. This table shows that number of ganats are decreased more than 40 time or 98 per cent in this period and number of tube wells have been increased from 0 up to 400 in same period [5]. Table 1 also revealed that in Bastam plain number of ganats has decreased from 95 to 15 in last 50 years, it means 85 per cent of ganats are out of work in present time.

Tube wells of this area also increased from 0 up to 375. This table shows that discharge of springs has not changed in same period.

Discharge changes of water resources in Shahrood plain are presented in table 2. This table reveal that ganats discharge has decreased from 14.2 MCM to 1 MCM per year in last 50 years. It means 93 per cent of ganats water has been decreased. The tube wells discharge has increased from 0 to 137 MCM. This table also does not shows any changing in springs discharge in same period.

**Table 1.** Number of ganats, springs and tube well in Shahrood and Bastam in 50 years

plain	ganat	spring	Tube well	year
Shahrood Bastam	44	6	0	1955
	95	54	0	
Shahrood Bastam	37	6	34	1965
	89	54	13	
Shahrood Bastam	24	5	93	1975
	89	54	90	
Shahrood Bastam	5	5	250	1985
	49	54	200	
Shahrood Bastam	2	5	355	1995
	23	54	296	
Shahrood Bastam	1	5	424	2005
	15	54	375	

**Table 2.** Discharge of ganats, springs and tube wells in Bastam

year	Discharge (MCM/year)		
	ganat	ganat	ganat
1955	-	88	0
1965	100	87	4.5
1975	90	86	8.5
1985	26	86	28.3
1995	9.5	86	54.5
2005	7.5	86	72.7
-1995	<b>188</b>		
-2005	<b>166.2</b>		

**Table 2.** Discharge of ganats, springs and tube wells in Shahrood

year	Discharge (MCM/year)		
	ganat	spring	Tube well
1955	14.2	2.4	0
1965	11.6	2.4	35
1975	7.56	2.3	75
1985	4	2.2	104
1995	1.5	2.2	120
2005	1	2.2	135.1
-1995	<b>16.6</b>		
-2005	<b>138.3</b>		
MCM= million cubic meter			

Table 2 shows that total amount of discharge in Shahrood plain has been increased from 16.6 MCM up to 138.30 MCM per year. It is showing 88 per cent increasing, however table 4 shows total amount of rainfall runoff in Shahrood area is 178 MCM, so it means only 22 per cent of rainfall is runoff and other losses. This study shows that 50 years ago potential of water saving was more than present time. Figure 3 shows the Shahrood City ganat [5].

For Bastam plain also we can have same interpretation but ganats and springs discharge was 188 MCM 50 years ago and present time it is 166 MCM per year and most portion of water flowing from tube wells. Mean rainfall of this plain is 160 mm and its runoff is 300 MCM, it means surface recharge is more than discharge. Study of water resources in this plain reveal that groundwater table came down few meters in recent years. It concludes that main part of runoff has not used for groundwater recharge.

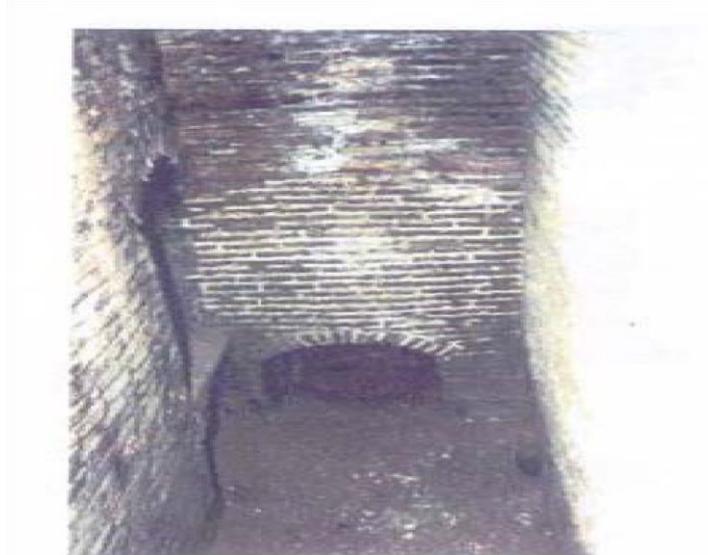
Discharge changes of Bastam plain water resources are presented in table 3. This table shows that ganats discharge decreased from 100 MCM to 7.5 MCM per year in a 50 year cycle. This decreasing is 92.5 per cent. The springs of this plain also do not show any decreasing in discharge. This table also shows that discharge of tube wells has been increased from 0 to 72.7 MCM per year.

**Table 4.** Mean annual rainfall in Shahrood and Bastam

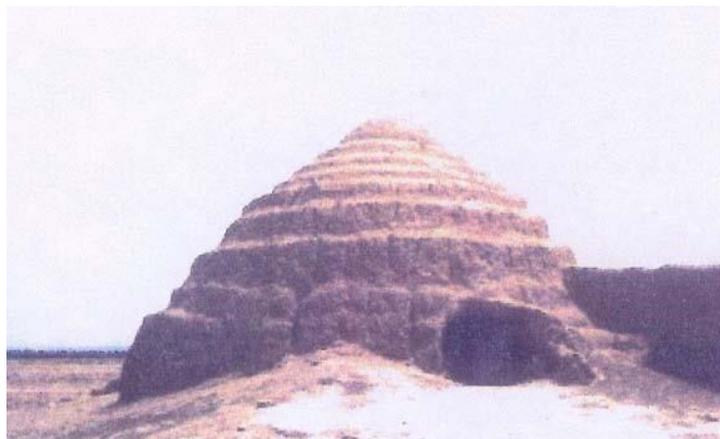
Plain name	Rainfall (mm)	Area (km <sup>2</sup> )
Shahrood	170	1048
Bastam	160	1876



**Figure 3.** Shahrood City ganat



**Figure 4.** Water way of Yagmaey reservoir in Shahrood



**Figure 5.** One kind of old refrigerator in Mazaj village, Shahrood

Study of water resources in Shahrood reveal that any house in this city had personal reservoir in past (Divandary, 2000) [3]. Yagmaey house reservoir is one of these reservoirs. Figure 4 shows some part of this reservoir. Another reservoir is Ali Akbar mosque reservoir which is big and famous to forty stair. Galeh School Reservoir and Mirza Ahmad Reservoir which is situated in Bastam are other reservoirs in this area [6-12].

Study of water resources in Shahrood also shows that there were some old refrigerator for collecting the ice in Shahrood suburb in past. Figure 5 shows one of such refrigerator in Mazaj village of Shahrood [13-14].

#### **4. Conclusion**

Final results of this research work reveal that the number of ganats and reservoirs in Shahrood and Bastam area has been decreased to minimum level in last 50 years. Nowadays in Shahrood, City ganat and in Bastam Sadeg Khan ganat are working well.

This study reveal that number of tube wells has increased with high rate within 50 years. If the increasing of tube wells continues, in 10 to 20 future years amount of discharge will be more than rainfall and any kind of agricultural and industry work be will have so much problems.

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