USE OF QANAT WATER FOR IRRIGATION OF INSIDE HOME LANDSCAPE IN KOUHPAYEH REGION IN CENTRAL IRAN

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ABSTRACT

Qanat is an ancient water provision technology that can be described as the greatest contribution made by Iranians to hydraulics and has been globally distributed over 34 countries. Qanat is an environmentally friendly and proper system of water conveyance with gravitational force and without consuming energy. Irrigation water allocation and irrigation method of landscape inside homes are the most interesting tasks in central desert of Iran such as Kohpayeh region, near Isfahan city. The home yards in the region consist of two parts. The first part situated at the same level of natural surface land and the second part situated at the same level of qanat bed for irrigation of landscape. In this study the land use of region which was fully adapted with qanat system, traditional irrigation water allocation and the optimum water use for irrigation of landscape inside homes are described.

1. INTRODUCTION

Qanats have been found throughout the regions that came within the cultural sphere of ancient Persia: in Pakistan, in Chinese, oasis settlements of Turkistan, in southern areas of the U.S.S.R., in Iraq, Syria, Arabia and Yemen. During the periods of Roman and then Arabian domination the system spread westward to North Africa, Spain and Sicily. In the Sahara region a number of oasis settlements are irrigated by the qanat method, and some of the peoples still call the underground conduits "Persian works". Iran (known as Persia until 1935), is part of the arid and semi-arid zone of the earth, and so water is an important factor for the Iranian people, especially for agriculture. Iran has a continental type of climate, with cold winters and hot summers prevalent across the plateau. On the plateau, the annual rainfall does not exceed 300 mm, with the deserts and the Persian Gulf littoral receiving less than 130 mm. In most semi-arid and arid regions of Iran which is called Karizi Civilization (Papoli Yazdi and Labbaf Khaniki, 2000), the annual rainfall does not exceed 250 mm, with the deserts receiving less than 60 mm. Therefore, since antiquity supplying and restoring water for drinking, irrigation,

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washing, etc have been the essential issue for survival. That is why all those qanat (kariz) systems, water reservoirs, icehouses, water mills, water dams, bridges and diversion dams have been built.

This system must have been started at least 5000 years ago in Iran. Qanat system is usually found in central Iran toward the east and southeast of Iran. An existing ancient example of water provision in Iran is old Zavareh qanat dating back to 5000 years ago. Iran's qanat system stands out today as an impressive example of a determined and hardworking people's achievement. The qanat system consists of underground channels that convey water from aquifers in highlands to the surface at lower levels by gravity. This is done by means of a gently sloping tunnel. There are about 22,000 qanat units in Iran, comprising more than 272,000 km of underground channels. The system supplies more than 70 percent of all the water used in the Karizi Civilization (Papoli Yazdi and Labbaf Khaniki, 2000), providing water not only for irrigation but also for house-hold consumption. Commonly the length of qanat is between 10 and 16 km. The water discharge obtainable from individual qanats also varies widely. For example, of some 200 qanats in the Varamin plain southeast of Tehran the largest yields 0.280 (m^3/s) or 280 (lit/s) and the smallest only a few liter per second.

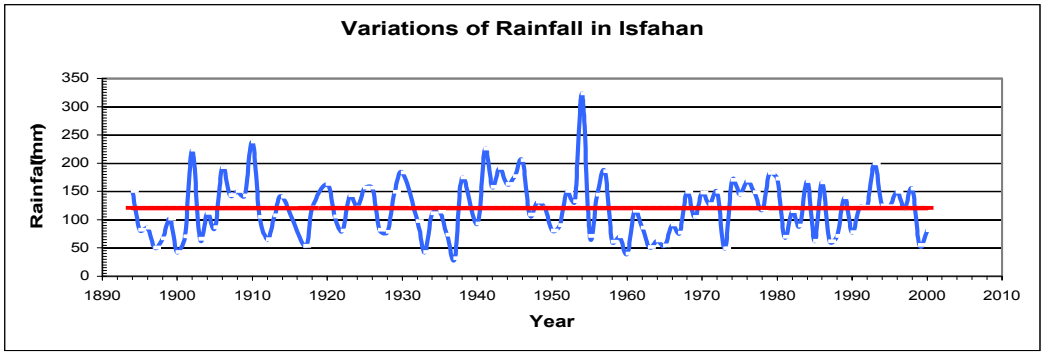

Figure 1. Annual precipitation average at the Isfahan city is about 120 mm.

Isfahan city located in the arid and semi-arid zone, in central Iran, so water is an important factor for the people. Annual precipitation average at the Isfahan city is about 120 mm (Figure 1).

1.1. KOUHPAYEH

Kouhpayeh is located 70 km away from the east of Isfahan city in central Iran, with Longitude 51º, 26´, 45" E and Latitude 32º, 42´, 35" N (Figure 2). Kohpayeh qanat system has been dug in the slope of Mareshnan Mountain where material washed down the slope has been deposited in alluvial fans. At the present, there are two active qanats with the length of about 3 km in Kouhpayeh. The stream of qanat water first flows through the town and then is diverted into farm irrigation channels.

The excavated soil, piled around the mouth of the shafts are seen the Figure 3. Row of craters, each one marking the mouth of a qanat shaft. The shafts provide ventilation and give access for cleaning and repair of the conduit tunnel below. The walls of the craters

protect the shafts and the tunnel below from erosion damage from the inflow of water during a heavy desert rainstorm.

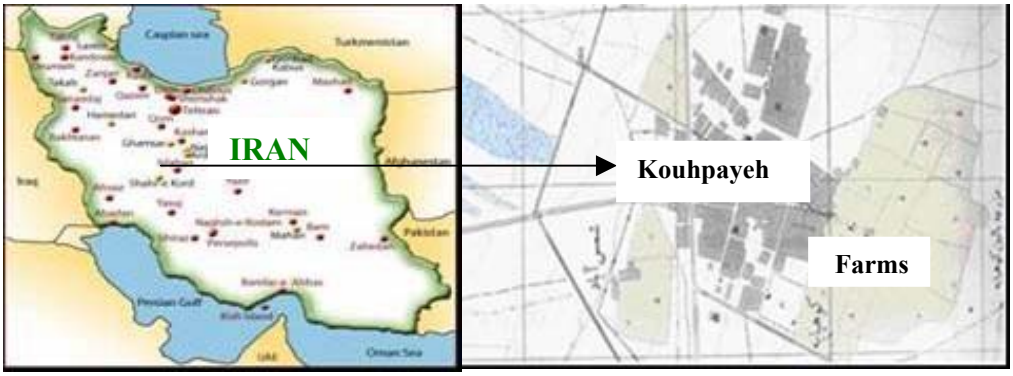

Figure 2. Kouhpayeh is located 70 km away from the east of Isfahan city in central Iran.

(a) (b)

Figure 3. (a) Row of craters (b) The excavated soil, piled around the mouth of the Kohpayeh qanat shafts.

Tunnel cross sections indicate some of the variations possible in qanat conduits. The tunnel walls may be strengthened with tile hoops (Figure 4) or where the tunnel passes through clay or well-compacted soil the walls may be left unlined. If the head well should go dry and therefore need to he dug deeper, the conduit would also need to be deepened.

Figure 4. Kouhpayeh tunnel walls have been strengthened with tile hoops in downhill end.

1.2. INSIDE- HOME GARDEN OR LANDSCAPE

An underground conduit through which the water can flow from the head well or group of wells to the ground surface at some point farther down the slope. The downward pitch of the conduit has a slight gradient so that the water flows slowly.

Garden or landscape inside home has been made in home yard. As the qanat advances towards down the slope, the depth of excavation is reduced (Figure 5).

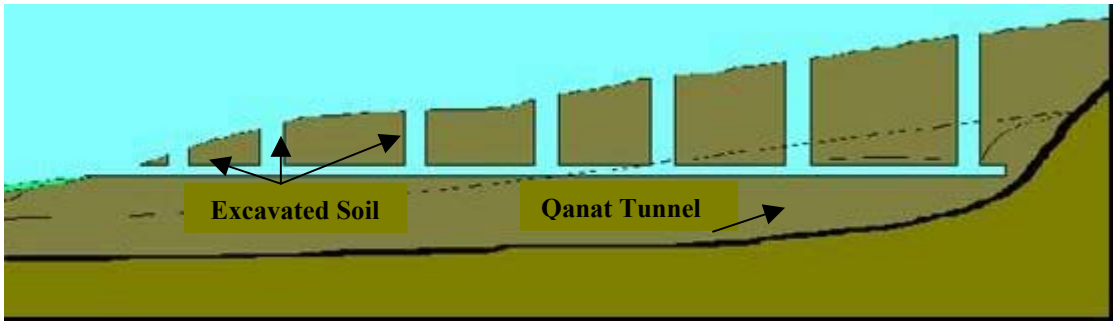

Figure 5. To form inside home garden, excavation of surface land to reach qanat tunnel begins at the downhill end (left). Where the gradually sloping surface land to go far from downhill end, the depth of excavation is increased.

As shown in Figure 6, depending on the depth of the qanat and the slope of the ground, the depth of garden or landscape varies greatly from the upper part (about 4m) to the lower part (about 1m).

Figure 6. An inside home garden having the depth of 3m from the land surface.

Where a qanat passes through inside house garden, it was equipped with a slump that allows for house-hold consumption (Figure 7).

Figure 7. (a) The stream of qanat flows through inside home landscape and then is diverted into farm irrigation channels. (b) Masonry mouth of a qanat in Kohpayeh.

1.3 WATER ALLOCATION SYSTEM

There were traditional systems for the fair allocation of water from a qanat to the users. People appointed a water bailiff, called Mirab, who supervises the allotment of water to each tenant in accordance with the size of the tenant's farm and the nature of the crop he is growing. Water bailiff who saw that each farmer receives his just share of the water at the proper time. The bailiff is guided by an allocation system that has been fixed for hundred of years. Allocation system consisted of a bowl (termed Roneh) having seven small holes (orifices) in the bottom and perimeter. It was placed inside a bigger bowl (termed Qadah) and put on the water in the basin made at the outlet of qanat (Abedi-Koupai, 1999). The time passed to fill bowl with water took about 3-4 minutes and was set to 1 Serejeh which is equal to irrigate a basin (a strip of farmland) with the area of approximately 12 m^2 and 50 mm irrigation water depth (Figure 8).

Figure 8: Water allocation system using a bowl with orifice to distribute water between farmers.

1.4 TAIL WATER

Tail water is downward steps to reach underground qanat tunnel for water consumption (Figure 9). This structure is called "Sarbetagh" in Dezful (Zighami, 1989), "Virab" in Arak and Farahan (Zighami, 1989), "Sipak" in Kashan (Kalantar-Zarrabi, 1962),"Pakaneh" in Yazd (Honari, 1974), "Piu" in khour and Biabanak (Honari, 1974)," Mirabak" in Rey and Varamin (Garrosi, 2000), "Viro" in Ardestan (Zighami, 1989) and "Nilab" in Kouhpayeh.

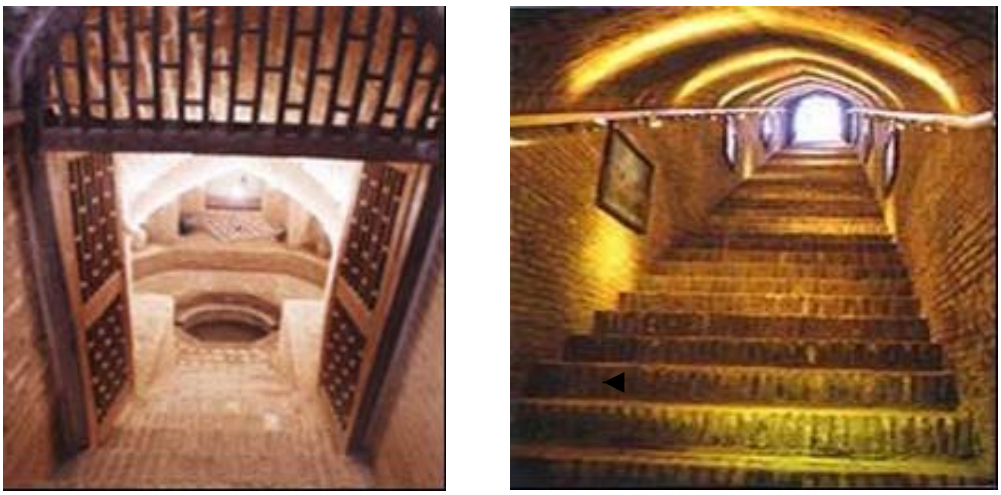

Figure 9. Public tail water is used for water consumption and as a chatting room.

Figure10. (a) A public Nilab in Kouhpayeh to reach underground qanat tunnel for water consumption. A mosque has been located in the middle of steps. (b). Mosque door inside Nilab.

There are two kinds of tail water (Nilab) in Kouhpayeh: private and public. The first one has been located inside home and is used by members of a family and some neighbors around the home and the second one has been located in pubic areas and used by all people. Tail water has different applications consisting water consumption, house-hold consumption, washing, chatting room, resting room etc. There are 2 Nilabs in Kouhpayeh which included small mosque for doing prayer and small public meeting. The small mosque has been located in the middle of steps in Nilab (Figure10).

3. CONCLUSION

As an essential and integral part of ancient Iranian, qanat has played a key role in forming many aspects of culture within community. Kouhpayeh qanat water still used as the main water provision sources for farming. Some features of Kouhpayeh qanat are common in the qanat features of central Iran; however there are some ancient structures which seem to be a unique structures in the region (e.g. mosque inside Nilabs and lowland landscape inside home yards). They need further considerations by Cultural Heritage Organization's authorities.

4. REFERENCES

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