HISTORICAL, STRUCTURAL AND ENVIRONMENTAL FEATURES OF THE QANAT IN IRAN

Ghasem Zarei[1], Abolfazl Nasseri[2]

ABSTRACT

Average rainfall in Iran (With 250 mm) is less than one-third of the global average annual rainfall and similar to that of arid and semi-arid countries of the world. For overcome water shortage in Iran, an old and interesting technique called as qanats was devised which convey water from an aquifer to lower-elevation fields. The qanats consist of a horizontal tunnel that taps ground water in an alluvial fan, brings it to the surface due to gravitational force. It provides required water for production of agricultural crops. Construction and exploitation of qanats have some environmental benefits. For instance, qanats waters don't have any contaminations. Also, improving vegetation cover without a biological changes in vegetative population are local achievements of the qanats. Other environmental advantages, historical and structural features in Iran were presented in the paper as detail.

Keywords: Qanat, Irrigation history, Structural and environmental features of the qanat.

INTRODUCTION AND HISTORICAL FEATURE

Water and its resources is development key for Iran. Therefore, the qanats as a main water resource is very valuable natural resources in arid zone in Iran. There are some 22000 qanat units in Iran, comprising more than 170000 miles of underground channels (Saffari, 2005). Some qanat advantages are as follow (Davarpanah, 2005):

a) Utilization of gravity force for bringing out water.

b) Lack of need to fuel, electric power, and motor pump station.

c) Existence of local specialists for building and repairing and dredging qanats and is consistent with culture and environment.

d) Ground water utilization in mountainous regions.

e) The qanats don’t impair the quality and quantity of ground water.

1- Assistant Professor of Agricultural Engineering Research, Institute (AERI), Karaj, Iran, Ghzarei45@yahoo.com
2- Assistant Professor of East Azarbaijan Research Center for Agriculture and Natural Resources, Khosroushahr, Tabriz, Iran, ab-nasseri@azaran.org.ir

The qanat innovation is belonged to Iranian and has developed in the other countries over the world (Glober, 1992). Also, the Greek historian Polybius in the second century B.C. described a qanat that had been built in an Iranian desert “during the Persian ascendancy” (Saffari, 2005).

The qanats are extended in the arid and semi-arid zones of Iran. The provinces benefiting from important and longest qanats are as follow:

A) EAST-AZARBAIJAN

The longest qanat is Dagh Cheshmeh located in Bostan Abbad - Estyar. It is 8000 m. long and its mother well is 20 m deep. Vakil & Cheshmeh Armanistan qanats are the longest ones in Azar shahr. They both enjoy a length of 6000 m. and the mother wells are 15 and 30 m deep, respectively. The deepest recorded mother well of the region (115 m) belongs to Hassan Abbad and Bareh-khuni of Mamaghan. Kalantar qanat in Tabriz and is more than 10000 m long.

B) KERMAN

There is no agreement regarding the longest qanat in kerman. For instance, Hashu-eieh located in Baghein (31 km long with 22 liters discharge) is the longest qanat according to the Regional Water Organization. Safi-Nejad believes that the Kerman qanat which is 40 km long with the depth of 120 m. of the mother well and 20 l/s discharge is considerable. Petroshevski has recorded the Mahan qanat 50 km and Bastani- Parizi believes that there is a qanat in Kerman which is about 42 km long with a mother- well enjoying 145 m of depth. The most splendid qanat of the province is called pa-ye-kam on the outskirts of Bam with a length of 4600 m 4000 of which is the wet zone. The mother well is 47 m deep. In Bam and Narmashir, Rashidi qanat in Barvat and Fazl-Abbad dates back to Rashid-Al-Din Fazlolah's Children and Gardun qanat precedes Mongols.

C) KHORASAN

Bidokht and Saleh Abbad are the active qanats in Gonabad. Bidokht enjoys a mother well depth of 350 m. with a discharge of 150 l/s irrigating 150 ha of the agricultural lands. The Keikhosro is another qanat in Gonabad with 400 m. depth of the mother well according to Saed-lu. Kurus believes that the biggest qanat gallery in Gonabad is 70 km long. This is probably the one with a mother well depth of 140 m according to Saed-lu. It is believed that the Sanabad qanat in Mashhad is 1200 years old and dates back to pre-Islamic-era.

D) SEMNAN

Shah-rud qanat is considerable due to its discharge in this province which exceeds 250 l/s with a mother well enjoying 60 m of depth. It is to be notified that this qanat is the only source of water in the town.

E) YAZD

The claims concerning the lengths of qanats in Yazd seem rather doubtful. Saed-lu believes that the longest canal is 120 km. long with a 116 m deep of mother well while Afshar claims that the longest one is and 84 km. long and its mother well enjoys a depth of 100 m. The Programming and Budget Organization have announced that the qanat of Mahdi Abbad Rostagh whose mother well is 50 km. away from the appearance with a discharge of 40 l/s is the longest. Djalal Abbad qanat (48 km. long 80 m. deep of mother well) is considerable as well. Sadr Abbad qanat with a 70 km gallery is considered long. As well one of the ancient qanats of Yazd Yaghubi is 900 years old.

ENVIRONMENTAL FEATURE

This structure was made by an ancient civilization to a specific environmental condition. The qanat water does not transport any external materials and so is friendly environment. Water transportation to surface consumes energy, which raises water-harvesting cost. Although, electric pumps are using in wells but in most rural regions pumps works with fossil energy, so qanats that works with gravity energy can reduce production cost and has positive effect on environment. It had and has high effect on economic, social and cultural life of huge plains in Asia, Africa, and South America. The qanat improves ornamentals and agronomy, and new ecosystem helps neighbor lands to preserve land race species, typical genitors, old trees etc. The qanat improves wild animals. There is a shelter for migrate birds and drought escape animals. Researches for suitable fish species for pisciculture in qanats make some financial advantages. Solute water and suitable media for high quality red and poultry meat without any contamination are some qanats advantages. The qanats regulate ground water discharge with optimum watersheds hydro-geologic cycle. There is no negative effect on watershed.

If qanat discharge the underground reservoir, lagoon, or marsh, it will have negative effect on environment but if it regulates the period or extent of underground reservoir, it will have a big positive effect. Because lagoons are hatching place of birds, and discharging these by an undesired qanat may destroy the animal species and led to migrate them to other regions.

STRUCTURAL FEATURE

The methods used for qanat building in Iran today are not greatly different from the system devised thousands of years ago (Saffari,2005). The building project begins with a careful survey of the land. A qanat system is usually duf in the slope of a mountain or hillside.

The qanat include some wells and one gallery with slope less than earth surface which drainage water from saturation layer or river or wetland by gravity. Figure 1 shows all parts of qanat (Agazari, 2005). The qanat becomes a ditch near its destination. The qanats depths reaches 30 m (the record is about 60m) and can cover distances of many km (the longest Iranian qanat is 70 km long.). A qanat, once built, can exist for a long time, but agriculture with qanats is extremely labor-intensive. Not only is it difficult to

dig an underground canal, but it also needs a visit every spring to clean it out. Here, some of important elements of qanat were presented and was demonstrated by Figure 1.

- (1) *Mother well*: is the farthest water infiltrating well.
- (2) *Appearance:* is the place where water comes into view on the surface.
- (3) *Gallery:* is the canal whose section resembles a horseshoe inside the ground enjoying a gentle slope for water conveyance from the aquifer to the appearance.
- (4) Dry zone: is a portion of the gallery between the wet zone and the appearance.
- (5) Wet zone: is referred to the infiltrating walls inside the gallery of a qanat. The discharge rate is directly dependent upon the wet zone.
- (6) Pish-kar: is drilling along the wet zone for having excess to water.
- (7) Shaft: is the dry wells situated across the gallery in order to facilitate soil extraction as well as ventilation and dredging. The distance between two shafts was based on the depth of the qanat and the air passage. The nearer the shafts were to the mother well, the deeper they were.
- (8) Poshteh: is the distance between two shafts.
- (9) Mound: is the soil and sediment extracted from a qanat well, is heaped like a frustum.
- (10) Abandoned gallery: is that portion of wet or dry zone of the canal abandoned.
- (11) Well curbing: is inside the shaft curbing is devised 20-30 cm wide and 40-50 cm high to prevent any collapse. Curbing is done near to the mouth, in the middle and close to the gallery. In mouth curbing they use bricks, stone and mortar to prevent floods, floating sand or every other thing from entering the qanat passage; they block the mouth with brick, stone and mortar. This procedure was once called kamar-gir.
- (12) Kaf-shekani: is digging the qanat gallery deeper due to the decline of the aquifer.
- (13) Baghal-bor: is a portion of the qanat passage is blocked and there is no possibility to unblock it.
- (14) Dredging: is removeing soil and sediments from the qanat galleries.
- (15) Edge Cutting: is widening the qanat passage.

CONCLUSION

Qanat has been made in ancient ages and help to establishment of agriculture in arid and semi arid regions. some of important elements of qanat are Mother well, appearance, gallery, dry zone, wet zone, pish-kar,shaft, poshteh, mound, well curbing, abandoned gallery, baghal-bor, kaf-shekani, The 22000 qanats in Iran with their 170000 miles of underground conduits deliver a total 19500 cubic feet of water per that would be enough to irrigate 3 million acres of arid land for cultivation if it were completely used for agriculture. Utilization of gravity force; lack of need to fuel, electric power, and motor

pump station; Existence of local specialists for building; don't impair the quality and quantity of ground water are advantages of qanats. The qanat improves agronomy, ornamentals and new ecosystem helps neighbor lands to preserve land race species, typical genitors, old trees and wild animals. On the other hand the qanats regulate ground water discharge with optimum watersheds hydro-geologic cycle. The qanats are extended in the arid and semi-arid zones of Iran. The provinces benefiting from important and longest qanats are East-Azarbaijan, Kerman, Khorasan, Yazd, Semnan provinces.

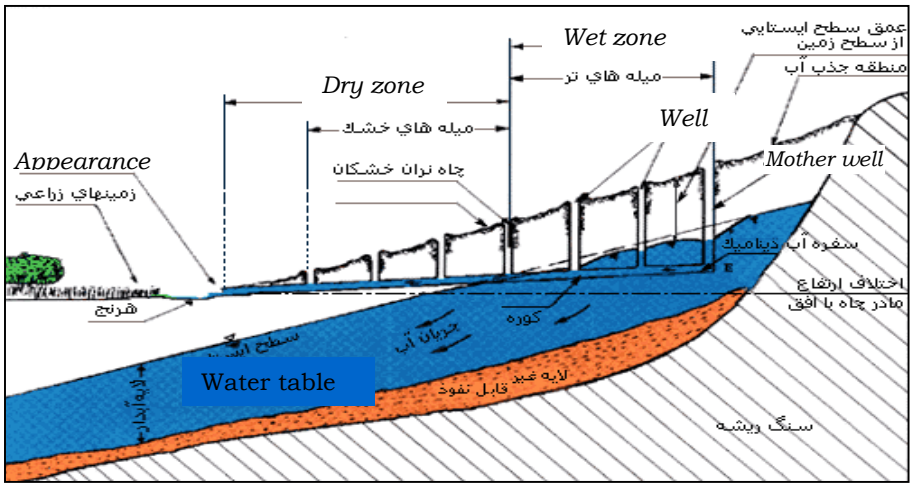

Figure 1- Characteristics and building terms of qanat (Nasseri, 2005).

REFERENCES

1. Agazari, (2005).Introducing qanats of arak city and use of them.Iran academic center for education. Culture and research-Kerman branch.Shahid Bahonar University of Kerman.Vol. I.
2. Davarpanah, G.(2005). Comparable survey of benefits and disadvantage from ground water to the method of wells and qanats. International conference on Qanat. Iran Academic Center for Education. Culture and Research- Kerman branch. P: 22-31. Shahid Bahonar University of Kerman.
3. Emami, K., Saarang, A. Adedi, F., and Hematian, S. (2005). A review of systematic approach of storage and transfer for water resource management in Tabas region, International conference on Qanat. Iran Academic Center for Education. Culture and Research- Kerman branch. Shahid Bahonar University of Kerman
4. Ghafari. F. (2005). Qanat and Environment. International conference on Qanat. Iran academic center for education. Culture and research- Kerman branch. Shahid Bahonar University of Kerman. Vol. I. 210-221.
5. Nasseri, A. and S.H.Tabatabaie. (2005). Application of geophysical methods in exploitation of qanat. Iran Academic Center for Education. Culture and Research-Kerman branch. P:183-196. Shahid Bahonar University of Kerman

6. Nasseri, A. and M.B.Khorshidi. (2006). Qanats: Environmental and Economical Aspects. International Conferernce on Human and Economic Resources, May 24-25, Izmir University of Economics, Turkey.
7. Nasseri, A. and Khorshidi, M.B. (2006). Iran's Qanats: Structural, Environmental and Economic aspects. International perspective on Evironmental and Water Resources. 18-20 Dec. New Delhi, India.
8. Rahbari, P., and M. Afshari. (2005). Evaluation- methodology of environment effects on Qanats. Iran Academic Center for Education. Culture and Research-Kerman branch. Shahid Bahonar University of Kerman
9. Saffari, M. (2005). Iran: land of Qanats. Iran Academic Center for Education. Culture and research- Kerman branch. Shahid Bahonar University of Kerman. 73-78.
10. Web site: (2006). http://www.qanat.info.