

QANAT AND ITS CHALLENGES IN FERDOWS COUNTY-IRAN

Khodarahm Bazzi¹

¹Geography University of Zabol- Zabol- Iran

ABSTRACT

The purpose of digging qanat or subterranean canal, this domestic and national art of Iranian is an operation of underground water that today we use it less than the past. Reviving of this traditional method of irrigating is just possible by increasing its yield from an economical perspective. In the recent decade because of the cost of labor, force and changes in ownership basis and negligence of public sector put the most of qanat toward aridness and reduced its importance. In this paper, we will study the effects of bemire Baladeh's qanat. Baladeh's qanat that supplied water for agriculture in Ferdows city, nowadays this qanat almost is dried. In the past people made the water of this qanat bemire for prevention of osmosis to the ground, nowadays the yield of water has been decreased and because of inattention in its maintenance and reparation, it became dry. Among the product that was irrigated in the past by water of qanat was saffron and decreased the importance of qanat's water.

Key Words: Qanat, Iran, Ferdows city, Agricultural products.

INTRODUCTION

Iran is a country in the Middle East, and the country covers a total area of 1.65 million km² and a population of about 70 millions in 2007 estimate. The average annual rainfall is 250 mm and approximately 90% of the country is arid or semiarid. Overall, about two-thirds of the country receives less than 250 mm of rainfall per year.

Water is an essential component of Iran's history and the success of its economy moving forward. Catastrophic floods and prolonged periods of drought are the main 'water' challenges facing many countries. Therefore, the inhabitants have had to resort to ingenious ways of utilizing the available-water resources (Al-Ismaily and Probert, 1998). To make use of the limited amounts of water, the Iranians developed man-made underground water channels called qanat (Boustani, 2008). The qanat is not unique to Iran: they have also been constructed throughout the world, as well as in Oman, India (Balooni *et al.*, 2010), China (Trombert, 2008), Japan, Egypt, Morocco (Joffe, 1992), Spain (De Bustamante and Sanz, 2003), Mexico, even Peru and in other parts of the world (see <http://www.qanat.infor> for the website of Centre of qanat Information (CQI)). According to the CQI, the construction of qanats expanded from Persia eastward along the silk route to China and subsequently spread to India, Saudi Arabia, North Africa, Cyprus, the Canary Islands

and Spain (Motiee *et al.*, 2006). It is known in Iran, South Asia, and northern China as Karez. (Cressy, 1958; English, 1968; Rahman, 1981; Khan and Nawaz, 1995; Hussain *et al.*, 2008), Aflagg in Arabia (Wilkinson, 1977; Al-Nasif, 1981; Sutton, 1984; Al-Tikriti, 2002), qanat Ronumi in the Levant (Lightfoot, 1997), Foggara in Tunisia and Algeria (Cressy, 1958), Khettara in Morocco (Lightfoot, 1996), and mina and Yafuga in Spain (Barnes and Fleming, 1991; Beekman *et al.*, 1999). qanat/ Karez is one of the most important and profound inventions of the Iran's Hydraulic engineering. Use of this technique to utilize the underground water resources can be aged to more than 3000 years (Zarabadi and Haeri, 2011). The term qanat, deriving from an ancient Semitic word meaning "to dig", describes an underground water channel, consisting of vertical shafts connected at their bottom with a sub-horizontal tunnel. Its function is to exploit a certain aquifer pierced by a main well and convey water to villages in the desert at distances of 2 - 80 km (Stiros, 2006) which yields water by gravity (Kazemi, 2011). In the headspring region, water is infiltrated from aquifer into the subterranean channel. The rate of inflow to the channel depends on the hydraulic gradient between water table in aquifer and water surface in subterranean channel, and hydraulic conductivity of porous media (Robati and Barani, 2009). Since the qanat that used groundwater table in shallow underground water and this was not a rich resource, had high swing, it is very sensitivity with level changes of underground water. Qanat became low-water in hot and dry year that plant require more water. It is vulnerable compare to the well in the face with a flood and sometimes failure in qanat is the form so that reviving them again is not possible or it is not economically affordable.

Near to the thousands of years that Iranians have invented new ways for forwarding of subsurface water resources under mountain and used them in the dry plains; Annual rainfall in most parts of Iran is 250-150 mm; but it is more than three thousand years that Iranians have been successful in cultivating dry areas by an accurate system with high performance, called qanat, imitation of this system happen in many regions of the world, especially the arid regions of the Middle East and developing countries around the Mediterranean.

Group of archaeologists with the discovery of a groundwater drainage in some parts of ancient Rome they thought Roman have been the inventor of the qanat system, But the next excavations and according to documents obtained proved that the ancient Persia (Pars) was the real inventor of qanat.

In this article try to pay historical reviews qanat as an Iranian invention, also study important Iranian qanats including qanat of Ferdows.

Research method

The methodology in this article based on descriptive – analytic and for gathering information at the course of research try to use documents, library and fieldwork method.

Background research

Gobolo the French scientist about 20 years of stayed in Iran and has been working in the field of Iranian qanat. He selected his PHD thesis about qanat, A book wrote entitled (qanat a technical

to achievement water in Iran). He said in his written that qanat is the invention Iranians and the first qanat has been in Iran.

Necessity of research

The people of Ferdows and the its villages used the water of Balade in the past which its headspring is the northern mountain of Ferdows after routing about 35 km irrigating the plains and lush gardens. Today irrigate about two thousand and 328 hectares of land in this area. In the past have mentioned that the number of qanat and springs in Baladeh were 72 that because of inattention and over time and a lot of them has been dry. In the past for lack of safety Baladeh owners before their death dedicate water to Owghaf (charitable organization). Therefore, now from 72 qanat, 44 cases of them are dedicated some of them are in the hands of private individuals and some of them are in the hand of Owghaf.

According to expression of the head of the Agriculture Ferdows, Baladeh in the past had 32 main qanat but now have 16 canals due to droughts of the past few years they have reduced the water discharge so that in the past the discharge of water was 70 liters per second, and now in this spring the discharge of water is 150 liters per second(Yazdani, 1986).

Baladeh aqueduct water through the channel length of approximately 15 km to the construction of the subterranean history of gardens in this region appears to be about 600 years ago.

Theoretical study

Digging canals usually started from span qanat where ground is dry, continued to aquifer where there is water. Thus, the first digging part of span qanat next digging the first wells or bars that are too dry and don't have any water and finally continued to the part have water or to aquifer.

How to extract water from the aqueduct

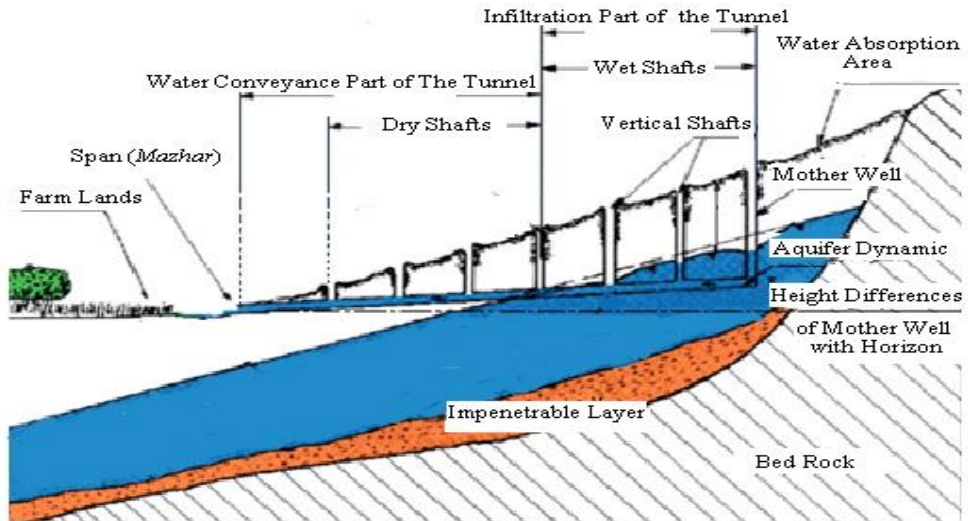
The water extraction system is a form that does not need to pay any costs for exit water from aquifers. According to existing qanats and wells, the water of qanat is cheaper than the water of wells and canals, Subterranean in the water that is extracted from wells, is cheaper. The water in qanat is permanent and in times that need to water for cultivating is vital, the water does not discontinue. Underground water supplies of qanat used by a long time(Pirnia, 2009).

An example of a qanat, and how its wells in this area:

Figure-1. Features and Specifications a qanat.



Figure-2. Structure of a qanat



Limitations in this area

1. Successive droughts, especially in recent years and its consequences.
2. Decreasing fresh water and underground water resources became salty due to successive droughts.
3. In this area happen earthquake and context of cities and village in this area is old.
4. Instability in population and sources due to lack of needed infrastructure to produce.
5. The traditional methods of uses of resources and facilities of production.
6. Distribution of population in area and distance from the centers province.

RESULTS

Water of Baladehqanat arrived to the gardens of this area through channels with an approximate length of 15 km. history of the construction of this qanat was around 600 years ago. The local people, with bemiring of water try to reduce the waste of water because:

1. Important factors that could control osmosis to the ground in old muddy channels was surface muddy layer channels.
2. With the passing muddy water in channels for 8 hours, amount of osmosis decrease from 15 percent to 5 percent.
3. Waste water in the irrigation channels was very much.
4. The amount of osmosis when the muddy water passing in the channel of Baladeh was 71 times little than the other channels.

Profile of city

Ferdows has three cities: Ferdows, Boshruyeh and Eslamieh and contains six rural districts with names: Baghestan, Buroon, Homeh in the central district and Arask, Reghe and Ali Jamal in Boshruyeh. In addition, this region has 162 villages. According to General Census and housing in 2006, its population is approximately 63497 people (The website www.Ferdows.ir).

Climatic characteristics

This regional district due to the Geographical position and the lack of wet climatic masses and lack of Proper Mountain and due to the proximity with the two central deserts and salt desert has arid weather. Average amount of rain in this district is 155 mm in a year. This district has two different climatic areas due to its large extent.

Agricultural situation

The major agricultural farms are facing too many problems in irrigating due to low rainfall. The totality of cultivation in this district is approximately 57000 hectares which about 27000 hectares are in the central area and the rest are located in Boshruyeh. Of these, only close to 8000 hectares that located in the central area, is the form of home bred and the rest are irrigated.

Vegetation

According to low rainfall, high temperatures, soil material and other natural and geographical conditions, in Ferdows, its vegetation is a type of Steppe that varies based on the amount of moisture. Moreover, this vegetation cover is mass in the northern areas and converted to pasture. The most important plants include: Kharshotor, Gavan, Tamarise, Ghich, Tagh, Trikh, Spand and Shoorkadeh, often these kinds of plants are compatible with salt. A major feature of this area is sparse vegetation that rare these plants cover more than a third of the area. In between the plant that they naturally grow, there are the plants that consuming in production of drug, some of these plants includes Khatmi, Badiyan, Toranjabin, Zeresheq, caraway, Kharkhesht, Shavid, Golpore, Kasni and Barhang (Pirmia, 1983).

Table-1.Ferdows cityweathers chart

Month	December	November	October	September	August	July	June	May	April	March	February	January
Average	26	27	35	39	42	44	43	39	34	30	24	21
Warmest	12	18	35	32	35	36	35	30	24	17	12	10
Coldest	9	9	8	3	2	6	7	3	7	3	7	3
Average coldest	0	4	9	14	19	21	19	14	10	4	0	1
coldest	-	-	-	3	5	7	9	12	2	1	-	-
	14	11	7	6	2	4	2	4	2	2	7	14
	8	5	2								8	8
Precipitation	14	26	6	2	0	0	0	5	18	34	28	26
	8		5	4	4	1	4	1	2	6		

Source: October 2008

The main potentials of development in Ferdows

1. The existence of sources of water, using qanat, springs and deep well and the possibility of increasing the land for cultivation.
2. Ability of livestock products: milk, meat and eggs.
3. The existence of medicinal plants with high quality and essential oils (60 types of medicinal plant).
4. Having tourist attraction and pilgrimage places.
5. Having farmed crops (wheat, barley and fodder crops) and having garden crops (saffron, pistachio and pomegranate).
6. The existence of mineral reserves.
7. The existence of higher education, technical and professional and research centers.
8. There are 5% of Tagh jungles of Iran in this district.
9. Locating Ferdows in the communication path of South Khorasan, and Razavi Khorasan Province.
10. Having several thousand years old of historical background.
11. Having special crafts.

Table-2.distribution of qanat in Khorasan Province

Name Of Qanat	Position	District	Rural	Length Of The Qanat	Depth Of Mother Well	Total	Flow
Karim aqueduct	Mashhad	Ahmad Abad	Karim Abad	2000	22	50	200
Ali abad	Mashhad	Ahmad Abad	Ali	1100	18	42	0
Anbosansofla	Mashhad	Ahmad Abad	Abdol majid	800	10	100	250
Anbosanolya	Mashhad	Ahmad Abad	Fakhr Davod	210	12	11	5
Fakhrdavod	Mashhad	Ahmad Abad	Fakhr Davod	2200	18	60	5
KhinGow	Mashhad	Ahmad Abad	Fakhr Davod	1700	15	10	50
Farzni	Mashhad	Ahmad Abad	Farzni	1400	12	50	0

Source:Khorasan province census portal

Strategies

Avoid becoming water wasted in water aqueduct:

Most of the water aqueducts of Khorasan are open and the water of this qanat crosses from sandy canals for this a major part of this water penetrate to the earth. For avoiding penetrate of water to underground when the water exit outside ofqanat should be added some clay to it until the water became dark and bemired and create a dam from osmosis water to the ground.

CONCLUSION

Technical measures to prevent deterioration of the aqueduct

- The important factor that could control osmosis to the ground in old muddy channels is a surface of muddy layer with channels.
- With the passing muddy water in channels for 8 hours, amount of osmosis decrease from 15 percent to 5 percent.
- Amount waste water in the channel of qanat is 0/034 percent and in other irrigation channels is 0/115 percent in a meter.
- The amount of osmosis when the muddy water passing in channel of Baladeh was 71 times less than the other channels.
- The most positive impact of making muddy the water of Baladeh is close all the pores of the water seams that have the potential for leakage.
- Preventing exploitation of wells that have been drilled in the space of subterranean or hadn't any permission.
- Exploitation of the wells in accordance with the water balance in region.

- Using new methods to prevent wasting of water in dry area of qanat.
- Using new technology for maintaining and digging of qanat.
- Store water of qanat in the seasons which doesn't need to water.
- Preventing destruction of qanat by flood.
- Artificial feeding the groundwater.
- Space of qanat should be identified and protected.
- Implementing urban and rural sanitation projects and filtering wastewater and controlling water of qanat from pollution of agricultural pesticides.

Social measures to prevent deterioration of the aqueduct:

- Grant loans with easy repayment conditions for the restoration or dredging canals.
- The government should take charge of dedicated and personal qanats which had been abandoned.
- Compilation effective legislation for qanat.
- Facilities for workers and pitman qanats.
- Encourage farmers to grow crops in accordance with local water conditions Insuring qanat.
- Concentrating all the affairs and funds payments to create, restore and other operations of qanats in an organization.

Suggestions

- Integrating the management of this structure and the assigning trustee for them by the government.
- Increase the annual allocation of funds for maintenance of qanat.
- Prohibiting drilling deep and half deep wells in the qanat space and training exploiters.
- Proper planning to prevent loss of qanat water in winter, such as storage, fish farming, mushroom production and water injection into underground aquifers.
- Carry out the necessary measures for the efficient use of qanat water such covering surface of streams, proper distribution of water and improve irrigation methods.
- Installing devices and vent discharge control in the qanats that it is possible and storage water in non-agricultural seasons.
- Maintaining rules of division and distribution of qanats water which had been implemented since a long time in different regions that it is very accurate.
- The use of surface waters in winter and spring, to feed the farm lands fallow which programs are performed in them.
- Change in type and style cultivation

REFERENCES

- Al-Ismaily, H. and D. Probert, 1998. Water-resource facilities and management strategy for oman. *Journal of Applied Energy*, 61: 125-146.
- Al-Nasif, A., 1981. Al-'ula (saudi arabia); a report on a historical and archaeological survey. *Journal of Bulletin of the British Society for Middle Eastern Studies*, 8: 30-32.
- Al-Tikriti, W.Y., 2002. At-aflaj fi' dawtat at-imarets al-'arabia almutahida: Dirasat fi anzimat at-rayy al-qadima. Abu Dhabi. Ministry of Information and Culture.
- Balooni, K., A.H. Kalro and A.G. Kamamma, 2010. Sustainability of tunnel wells in a changing agrarian context: A case study from south india. *Journal of Agricultural Water Management*, 97: 659-665.
- Barnes, M. and D. Fleming, 1991. Filtration-gallery irrigation in the spanish new world. *Journal of Lettin American Antiquity*, 2: 48-68.
- Beekman, C.S., P.S. Wiegand and J.J. Pint, 1999. Old world irrigation technology in a new world context; qanats in spanish colonial western mexico. *Journal of Antiquity*, 73: 440-446.
- Boustani, F., 2008. Sustainable water utilization in arid region of iran by qanats. *Journal of World Academy of Science, Engineering and Technology*, 43: 213-216.
- Cressy, G., 1958. Qanats, kareez and foggara. *Journal of Geo physical Review*, 48 27-44.
- De Bustamante, I. and J.M. Sanz, 2003. Some examples of spanish qanat. –international frontinus-symposium “was server sorgung aus qanaten – qanate als vorbilder im tunnelbau. Walferdange, Luxemburg: 173-186.
- English, P.W., 1968. The origin and spread of qanats in the old world. *Journal of Proceedings of the American Philosophical Society*, 112: 170-181.
- Hussain, I., O.S. Abu-Rizaiza, M.A.A. Habib and M. Ashfaq, 2008. Revitalizing a traditional dry land water supply system: The kareezes in afghanistan. *Pakistan and the kingdom of saudi arabia. Journal of Water International*, 33: 333 -349.
- Joffe, G., 1992. Irrigation and water supply systems in north africa. *Journal of Moroccan Studies.*, 2: 47-55.
- Kazemi, G.A., 2011. Impacts of urbanization on the groundwater resources in shahrood, northeastern iran: Comparison with other iranian and asian cities. *Journal of Physics and Chemistry of the Earth.*, 36: 150-159.
- Khan, M.F.K. and M. Nawaz, 1995. Kareez irrigation in pakistan. *Geo Journal*, 37: 91-100.
- Lightfoot, D.R., 1996. Moroccan khattara: Traditional irrigation and progressive desiccation. *Journal of Geo forum*, 27: 261-273.
- Lightfoot, D.R., 1997. Qatiats in the levant: Hydraulic technology at the periphery of early empires. . *Journal of Technology and Culture*, 28: 432-451.

- Motiee, H., E. McBean, A. Semsar, B. Gharabaghi and V. Ghomashchi, 2006. Assessment of the contributions of traditional qanats in sustainable water resources management. *Journal of Water Resources Development*, 22 (4): 575–588.
- Pirnia, H., 2009. Persia or iran's ancient history. Negarestan golden book. Fifth Printing, Tehran.
- Rahman, M., 1981. Ecology of kareez irrigation: A case of pakistan. *Geo Journal.*, 5: 7-15
- Robati, A. and G.A. Barani, 2009. Modeling of water surface profile in subterranean channel by differential quadrature method (dqm). *Journal of Applied Mathematical Modeling*, 33 1295–1305.
- Stiros, S.C., 2006. Accurate measurements with primitive instruments: The “paradox” in the qanat design. *Journal of Archaeological Science*, 33: 1058-1064.
- Sutton, S., 1984. The falaj ; a traditional co-operative system of water management. *Journal of Waterlines*, 2/3: 8-11.
- Trombert, É., 2008. The kareez concept in ancient chinese sources myth or reality?. . *Journal of T'oung Pao*, 94 115-150.
- Wilkinson, J., 1977. Water and tribal settlement in south-east arabia: A study of the aflaj of oman. Oxford; clarendon.
- Yazdani, L., 1986. Qanat characteristics and challenges of proration water in south khorasan province.
- Zarabadi, Z.S.S. and N. Haeri, 2011. Qanat as the sustainable sign in during time. *Journal of academic research*, 3(5): 425-429.

Views and opinions expressed in this article are the views and opinions of the author(s), International Journal of Geography and Geology shall not be responsible or answerable for any loss, damage or liability etc. caused in relation to/arising out of the use of the content.