Kariz(Qanat); An Eternal Friendly System For Harvesting Groundwater

An evaluation of the sustainability of Qanats under changing socio – economic and climatic conditions in Iran

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Abstract:

In Iran in the past fifty years, intense socio-economic changes coupling with drought and floods have caused the basic system of Qanats to be laid aside. In place of which, deep wells, semi-deep wells and large dams have dominating. Even though these new methods of water supply have failed to fulfill present demand for water and despite the water crisis that still exists, the said modes have resulted in a severe and serious setback to the Qanat systems.

For example, motor-equipped deep and semi-deep wells have been constructed nearby Qanats and seldom Qanats have been renovated or been dredged. Moreover, the number of skilled manpower in regards the construction and maintenance of Qanats have declined due to reasons such as extremely low wages, poor insurance benefits and a dissatisfaction with the social ranking, and the remaining manpower have sought professions in other fields. As a result of the above, agriculture and participatory productivity systems based on Qanats have been disappearing. . Despite the mentioned negligence in regards to the stand of Qanats that have suffered a downfall from their prior vital position in being the primary source of securing water requirements to the lowest rank, Qanats have still been able to withstand governing policies and socio-economic, and climatic changes in Iran and thus being able to make a relative survival no matter how informally.

Average precipitation in Iran can be said to be similar to that of arid and semi-arid countries of the world. The amount of annual rainfall on average in Iran is approximately 242 mm which is less than one third of the global average annual rainfall (approximately 860 mm) Even this minimum amount of precipitation is not the same throughout the country. Rainfall occurs mostly during the winter, when the colossal water requirement period is imperatively at its peak during the summer months.

A statistical record of 30 years (1970-2000) illustrates the fact that the annual precipitation in the country on an average was 420 billion cubic meters. Within a period of five years that is from 1995 to1999 the total volume of annual rainfall varied from from 330 to 550 billion cubic meters.

Amount of Evaporation of Surface and Ground waters

In general 60-70 percent of the total rainfall per annum evaporates, that is, between 275 to300 billion cubic meters. Between 55 to100 billion cubic meters of the total annual rainfall flows as surface water amounting to approximately 10-20 percent of the total. The remainder of the total volume of the annual rainfall (60-75 billion cubic meters) penetrates into the ground that is approximately 15 percent of the annual precipitation.

Water Usage for Agriculture, Industry and Drinking purposes

The volume of water demand in the country from the year 1960 till the year 2000 has shown an incremental increase from 40 billion cubic meters to 75 billion cubic meters and in other words has doubled. In the 1960's over 97 percent of water was used for agriculture, whereas, in the year 2000 this figure has decreased by about 90 percent. However, industrial and urban usage of water as well as demand for drinking water have increased.

On the other hand, over 80 percent of the flowing surface water in our country is being wasted. Thus, the most vital resource for securing water in Iran is groundwater. As

mentioned previously between 60 to75 billion cubic meters or approximately 15 percent of the total volume of the annual rainfall within the borders of our country penetrates into the ground. Over 90 percent of these ground waters are utilized through wells, Qanats and springs.

What is a Qanat[1]?

A Qanat is an ancient mode of irrigation in Iran that can be affiliated to the Achaemenian period and can be said to have a sustainability of nearly 3000 years. This methodology rests on indigenous knowledge and experimental hydrology. Through this method water present in the acquifers is drawn to the surface in order to be utilized by manipulating a series of vertical wells and one horizontal well. This method uses no electrical or fossil energy

The Role of Qanats in securing water in the country

Since fifty years ago the role of Qanats in securing water in the country has been diminishing. The same has decreased from 70 percent prior to the year 1950, to 50 percent around 1950 and to 10 percent in the year 2000.

According to some, the 'age' of Qanat is over. Studies and experience in Iran have revealed that due to inadequate policies, lack of awareness about the indigenous know-how and poor understanding of the interactions between Qanat systems and the local community and productivity patterns the original and critical role of Qanats have been somewhat neglected.

[1] Qanats are also called "Kariz" in Persian.

Wells as Alternatives to Qanats

Since 1950s wells have succeeded in replacing Qanats. These motor-equipped wells have been excavated without consideration of the original location of Qanats. However, in comparison to Qanats, wells have a shorter life span (that is between 20-50 years) whereas, Qanats hold good for centuries. Excavation of such wells in the past half a century has further led to the drying up of wells and Qanats both, contributing to drought and increasing water shortages.

In Iran, in the year 2000, over 70 billion cubic meters of groundwater has been provisioned. From this amount over 60 percent (42.5 billion cubic meters) have been allotted to wells (both deep and semi-deep wells) and approximately 12 percent (8.6 billion cubic meters) to Qanats.

There is no doubt in the fact that in regions in our country the use of motor-equipped wells are absolutely necessary. But wells must be considered as a complementary feature to Qanats, however, wells have been excavated in exactly the same areas that Qanats had provided water to the community for centuries.

Advantages of a Qanat over a well

- Even though the cost of excavating a Qanat proves to be eight to nine times more than the same for a deep well (with pump fixtures). But if Qanats are regularly dredged and repaired they have an approximately prolonged and unlimited life span. Whereas, life span of a well is about 20 years.
- The water output of a Qanat within a definite period of time is determined and much more reliable. Thus, Qanats prove to be a safer source of water provision safer for agriculture, except in some occasions.
- In case of Qanats there is virtually no reliance on electric power, motor pump spare-parts or oil products that have to be imported and thus require foreign exchange.

- Low expenditure of Qanats in comparison to high maintenance charges of wells and motor pumps is a definite advantage in rural areas.
- Qanats do not impair the quality or quantity of groundwater. This is due to the fact that they are utilized gradually and assist in keeping the balance of ground water in various layers of ground intact. In fact even during periods of severe drought, Qanats are not detrimental to water reservoirs.
- Qanats reflect collective and cooperative work, and in areas where Qanats are constructed labor or work opportunities are provided for the local community. The skills for maintaining Qanats are part of the indigenous knowledge of the country and have heritage value.
- Qanats have the ability to collect wastewater that penetrates into the soil and it is for this reason that the excavation of Qanats in arid regions tends to save more water.
- Moreover, through Qanats freshwater from the mountain plateau is transferred to the lower lying plains that have a saltier soil. Thereby, the salinity of the soil is kept under control which also helps in combating desertification.
- In Iran as water mills were built upon Qanats, hydrological energy was produced.

Dams as an Alternative to Qanats

In Iran the government is responsible on the whole for the construction of dams (whereas wells have been mostly constructed by the private sector). If dams were considered as complementary to the irrigation system that was based on Qanats for the purpose of improving agricultural development (with parallel investments in both areas) we would have had a better vegetative cover in the country and extensive agriculture as well as reduced drought and flood events.

Although the number of dams in Iran till the year 1980 was somewhat limited, ever since dam construction has become a dominant priority of the government policy to fulfill

water demand of the country. In the year 2000 the amount of water that has been secured from dams in the country has been reported as 19.7 billion cubic meters. Most of the water accumulated behind dams has been used for agriculture, however, to date only 20 percent of the water requirements in the agricultural sector has been secured through dams.

A Comparative Case Study on Dams and Qanats

In the province of Khorassan, that is the largest province of Iran and has common borders with Afghanistan, in the year 1990 there was a network of 7388 Qanats with an annual debit of 2.5 billion cubic meters and an output of 77.8 m^3/sec.
In the same year a few large dams were taken advantage of namely "Torogh" and "Kardeh". The Kardeh Dam has an elevation of 67 meters from its foundation and has been engineered to provide 31 million cubic meters per annum, according to which the amount of water to be secured is 1 m^3/sec. If the water output of Qanats of the province of Khorassan was to be compared to the water output of the said dam, it can be noticed that in the year 1990 Qanats of the Khorassan province secured 77.8 times more water than the Kardeh Dam.

Three years later, according to official statistics issued by relative authorities, the water output of the same Qanats showed a reduction. The decline revealed that water output was equivalent to 15 times less the amount of water of the Kardeh Dam. So in the same year, if x billion was spent as investment for the construction of the dam, instead 15 x billion was lost in financing such projects.

Are the Present Policies Sustainable in Long-term?

Under present conditions in Iran policy for securing water depends on motor-equipped wells and dams. In none of the plans for the future has Qanats been taken into account as

a source of water provision. However, Qanats have adapted to present conditions despite being weakened to a great extent.

If macro-planning in regards to securing water in the country was based on all three methods of water provision, there would be no question or concern. But at present replacingQanat systems with Dams and wells that are less than half a century oldoverrules and overlooks the role of Qanats that have made a stand for centuries and survived against droughts and all other threats.

Let's visualize a scenario where there is a drought over a long period of time, and estimate in what state each one of these methods of securing water would be:

It is worth mentioning that Iran from the point of view of flowing surface water holds an extremely poor stand and the majority of the rivers are seasonal. This is the reason why in times of drought, rivers and surface springs dry up rather quickly.

In case of a drought event, wells equipped with motor pumps would be threatened, as they evacuate acquifers quite rapidly. So if the life span of a well does not come to an end in case of a drought, they shall dry up very quickly. Thus said wells are generally useful for short-term usage and alter their surrounding environment very swiftly.

In case of dams, although they are more resistant to droughts, certain conditions are necessary for their long-term sustainability such as their location, the technical engineering details and know-how, as well as their permanent maintenance, especially so, in our country where soil erosion is a serious problem. The primary 'generation' of dams that have been constructed in the 1960s have now a much shrunken water reservoir. Even dams that have been engineered with the utmost detailed precision are apt to suffer damages caused by drought.

It is under these tough climatical conditions that the value of Qanats can be measured. In periods of drought, Qanats are more resilient and do not dry up rapidly, as they have the

capability of evacuating the acquifers slowly. In addition, Qanats are constructed in harmony with human settlement patterns and water requirements for development of agriculture. In a drought situation, when the need for water is critical and every drop in the water table needs to be accounted for, water from Qanats is returned to the acquifers, in addition, the amount of water evaporated is minimal in comparison to that of dams where extremely large quantities of water evaporate.

Therefore, Qanats prove stable in times of drought especially for water supply security. Lastly but not least importantly, the most vital point relative to Qanats is to recognize and understand that Qanat systems are closely linked to the local community and it's ability in planning and management of their own water resources especially for agriculture. The management system is such that the water is distributed equitably. As a result, water security supply and water access equity are supporting the foundations of the local community and agriculture at large.

In brief, Qanat is not only an engineering wonder, but also a social phenomena that has been holding strong in the past centuries despite changing socio-economic, and climatical conditions, even though it has kept a low profile.