

The Traditional Kahriz (Qanats) Water Management System

How Preserving Cultural Heritage Can Support Water Efficiency

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Kahriz (also known as *qanat* and other terms) is a traditional resource-efficient water transport and management system used for millennia in arid and semi-arid regions. This underground water system has been employed for centuries in Iran, Azerbaijan, and other parts of the Silk Road region, the Middle East, and North Africa. It is an underground facility system created to collect aquifer and groundwater sustainably and bring it to the surface naturally, with its own flow.

Traditional systems of this nature, employing an integrated approach to water resources management, were used in agricultural cultivation and aimed to achieve food self-sufficiency in arid regions. They were implemented to preserve biodiversity in ecosystems and promote balanced living in environments highly susceptible to rapid environmental changes.

The core of a kahriz system is an underground network of tunnels and galleries. These tunnels are typically excavated horizontally from the side of a hill or mountain, following the natural slope of the terrain. The tunnels are designed to tap into underground aquifers or other water sources. The slope helps the water flow through the tunnels via gravity. At regular intervals along the length of the tunnel, vertical shafts are dug from the surface down to the tunnel. These shafts serve ventilation, access, and extraction point purposes.

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Kahriz systems are climate resilient and, as noted above, are well-suited to arid and semi-arid climates, where surface water sources may be scarce or unreliable. They also serve water conservation efforts by reducing water loss due to evaporation and seepage. Moreover, the use of gravity for water transport eliminates the need for pumps or other energy-intensive methods, making kahriz systems energy self-efficient. Overall, kahriz systems are a testament to human ingenuity and adaptability in harnessing natural resources to meet the water needs of communities in water-scarce regions. In 2016, UNESCO inscribed the kahriz system—termed the “Persian Qanat”—onto its list of World Heritage, indicating that it “provides exceptional testimony to cultural traditions and civilizations in desert areas with an arid climate” by managing precious groundwater sustainably.

The Practices and Current Conditions of Kahriz Systems in Azerbaijan

As per the Kahriz Research Information Center, the origin of these water systems in Azerbaijan can be traced back to 2000-2200 years. According to Amelioration JSC, in 1938, Azerbaijan had 885 kahriz systems, collectively consuming 13,354 m³/s. The total length of these systems was 1450 km, equivalent to the distance between Baku and Ankara. The expansion of agriculture and the heightened utilization of artesian waters since 1970 have contributed to the decline of kahrizes. Knowledge and skills associated with the drilling and maintenance of kahrizes largely disappeared during the Soviet era, as authorities chose a systematic strategy of drilling deep sub-artesian wells and employing electric pumps to bring water to the surface. Recently, within the framework of a project led by the UN’s International Organization for Migration and funded by the Korean International Cooperation Agency (KOICA), a map of extant kahrizes in Azerbaijan was developed (exempting liberated Karabakh). Currently, the total number of existing kahrizes is 635, a majority of which are inactive: for the past 40-50 years, they have not been maintained and are thus in danger of being abolished.

Following extensive agricultural activities during the Soviet era, most kahriz systems sustained damage and currently remain unconnected to any water resource management institution. Unfortunately, it appears that the kahriz systems in Karabakh were almost all destroyed (i.e., not just neglected) during the period of Armenian occupation. Presently, the issues associated with kahrizes in Azerbaijan primarily stem from a gap in legislation and government policies.

All in all, this suboptimal situation has had significant repercussions for these systems. Adverse effects like environmental degradation, contamination risks, absence of institutional accountability, lack of maintenance, and sustainability concerns stem from the absence of a proper regulatory framework.

The non-affiliation of kahriz systems with any water resource management institution means that there is no designated authority responsible for overseeing their preservation

and utilization, which in turn leads to challenges in addressing issues promptly and efficiently. The absence of a clear legal framework contributes to uncertainties regarding ownership and access rights to kahriz water. This ambiguity has led to disputes and conflicts among users and stakeholders. The absence of legislation and institutional affiliation also results in a lack of financial and technical support for the maintenance of kahrizes, which results in neglect and deterioration of its infrastructure, reducing the effectiveness and lifespan of these systems.

The lack of legal guidelines leaves kahriz systems vulnerable to environmental degradation—the absence of regulations leads to uncontrolled practices, waste disposal, and other activities that may harm the ecosystem around kahriz wells whilst increasing the risk of contamination. Solid household waste and pollutants degrade the quality of water that these systems provide.

Additionally, unregulated usage, inadequate maintenance, and the absence of oversight lead to the depletion of water resources, hindering the long-term viability of these traditional water supply systems. All this puts the sustainability of kahrizes into question.

Nakhchivan as a Case Study

At its peak usage, there used to be 407 kahriz systems in operation in Nakhchivan (Azerbaijan's largest exclave), with a total consumption of 3 m³/s; according to research conducted by Safarali Babayev, 353 of these remained in operation in 1999. However, since the turn of the century, the number of operational kahrizes had decreased twice, and the water extracted from them amounted to only 20-25 percent of the quantity recorded in 1938.

In the first years following the collapse of the USSR, a significant portion of Azerbaijan's infrastructure, including its electricity grid, deteriorated. Consequently, sub-artesian wells ceased to function, leaving villages without a reliable water supply. In the subsequent years, the impact of drought forced tens of thousands of Azerbaijanis to leave affected villages, seeking employment in urban areas (or abroad). It became imperative to restore water supplies to prevent further migration and address the pressing needs of the affected communities. Therefore, Nakhchivan has taken a proactive approach to the management and revitalization of kahriz systems. In 2004, the region established a dedicated Kahriz Department under the Amelioration Committee of the Autonomous Republic. This strategic step aimed to address the challenges faced by kahrizes and played a vital role in sustaining and rejuvenating these traditional water supply systems. The establishment of the Kahriz Department signaled a commitment to reversing this decline and ensuring the continued functionality of kahrizes in the region. Currently, there are 388 functioning kahrizes in Nakhchivan.

Another positive aspect of kahriz management in Nakhchivan is the grass-roots engagement of the local community. Residents play a hands-on role in the management of kahrizes, actively participating both in water provision schedules and contributing to the costs associated with the maintenance of these systems. This community engagement reflects a collaborative approach, where the beneficiaries of the water systems take responsibility for their upkeep and sustainability. The participation of water users in scheduling demonstrates a shared commitment to efficient water allocation and usage. Additionally, the collective effort in gathering maintenance costs ensures a sustainable financial model for the ongoing care and preservation of kahriz systems. This community-driven approach not only fosters a sense of ownership, but also enhances the resilience and longevity of the kahriz infrastructure.

Challenges and Recommendations

Recently, a number of kahriz systems have been restored with the support of international grants; that being said, there are no established rules, regulations, environmental requirements, and enforcement agencies overseeing these systems due to the lack of institutional affiliation and legislative framework.

The lack of legislation on kahriz systems exposes them to environmental threats, compromises water quality, hinders sustainability, and creates challenges related to maintenance, ownership, and access. In this regard, establishing a comprehensive legal framework is essential to ensure the protection, sustainable management, and continued functionality of these traditional water supply systems. Therefore, the case of kahriz management in Nakhchivan, in terms of affiliation and community involvement, can be reviewed, improved, and scaled up for other regions of Azerbaijan.

Within the aforementioned KOICA-funded IOM project, an electronic map of the kahrizes in Azerbaijan was established, however it does not contain the kahrizes in the liberated areas; therefore, there is a need to update and render interactive a complete electronic database of kahrizes with more parameter inputs, such as conditions of the kahrizes, water provision capacity, geographic conditions, settlement, surrounding economic activities, etc. This would help to understand the dynamics of the existing wells and provide immediate support when needed. It is also necessary to better understand the extent of the role that kahrizes can play in Azerbaijan's overall water consumption.

As the system and practices have been deteriorating for years, the overseers and engineers of kahrizes—known as “kankan”—are also disappearing, therefore there is a need for capacity-building activities.

Kahrizes are typically (and traditionally) managed and maintained by local communities. Community-based organizations or institutions oversee the distribution and equitable sharing of water among local users. These institutions play a crucial role in

resolving conflicts and ensuring that water resources are used sustainably and equitably. These systems encourage local community involvement in managing water resources, fostering a sense of ownership and responsibility. During and after the rehabilitation of kahrizes in a local community, there will also be a need for public awareness campaigns and continuing education efforts.

The revitalization of these systems holds significant importance, particularly in the context of ongoing climate change and rising water demands in conditions of scarcity. Moreover, it can serve as a crucial measure to avert the migration of individuals from rural to urban areas, driven by water shortages and consequent challenges.