

**Qanat Systems and Relationships with Landscape: Van City Example (Türkiye)**

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**Highlights:**

- Traditional water management
- Protection of cultural heritage
- Water problems

**Keywords:**

- Qanat
- Landscape architecture,
- Traditional irrigation
- Water management

**ABSTRACT:**

Water has played a vital role in the establishment and development of civilizations, particularly in arid and semi-arid regions. Among ancient water management systems, the qanat (kehriz) represents one of the earliest and most effective engineering solutions for sustainable irrigation and drinking water supply. This study examines the qanat systems in Van, Türkiye, through a comprehensive literature review, oral interviews, and archival documents—including 1:25000 scale maps—obtained from the State Hydraulic Works (DSİ) Van Regional Directorate. Historical evolution, technical structures, and landscape impacts were analyzed in detail. Fieldwork was conducted on April 29, 2025, at the Bostaniçi Pond, which hosts the spring points of two potentially restorable qanat systems. In addition to providing water transport without evaporation or pollution, these systems shaped settlement patterns, agricultural land use, and the formation of green infrastructure. Research indicates that qanat systems in Van, dating back to the Urartian period (9th century BC), once numbered approximately 54 (30 of which are documented, and only 5 remain partially functional), playing a crucial role in both sociocultural development and ecological sustainability. Although many have lost functionality due to the introduction of modern infrastructure, they still exhibit strong potential for integration into contemporary landscape planning and sustainable water management strategies. Traditional knowledge and community-based management associated with qanat systems offer valuable insights for sustainable design models. The study concludes that these structures require urgent measures for restoration, legal protection, and integration into climate-resilient rural and urban landscapes. Reuse as low-energy green infrastructure and within ecotourism frameworks is recommended, emphasizing their importance as key components of cultural landscapes.

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## INTRODUCTION

More than 6000 years ago, as nomadic communities began moving toward agricultural settlements, people developed various methods to harvest natural water resources more efficiently and to regulate the timing and amount of water according to crops, animals, and personal or ritual needs (Lightfoot, 2000; Demirağ, 2017). Societies living in arid and semiarid regions where access to water is difficult have aimed to protect and use resources efficiently by building various water management systems such as dams, springs, collection reservoirs, aqueducts, galleries, transmission systems, cisterns, and tunnels (Abudanh and Twaissi, 2010; Boccaletti, 2020; TEMA, 2025). Water conservation is a product of a society's water security, landscape, infrastructure, and institutions (Boccaletti, 2020). Among these water management systems, qanats (underground water transmission systems) have played a critical role in water supply for centuries and continue to do so wherever they operate today (Kılıç, 2023). Qanats are not only important engineering structures developed for the efficient use and management of water (Lightfoot, 1996), but also serve as a type of "land strategy" that can adapt to environmental changes over time by establishing a balance between social demands and microclimate conditions (Chamani, 2025).

Chamani (2025) classifies the concept of "Qanatscape" into macro, meso, and micro scales, arguing that qanats are not merely engineering structures but also multilayered cultural landscape systems. In this study, in the case of Van city, the macro scale represents the hydrological and topographic structure of the Van basin; the meso scale represents rural settlement and irrigation patterns; and the micro scale represents the physical traces of individual qanat systems within the landscape and their current functionality. Thus, the "Qanatscape" conceptual framework was used as a tool to define the study's spatial scales of analysis.

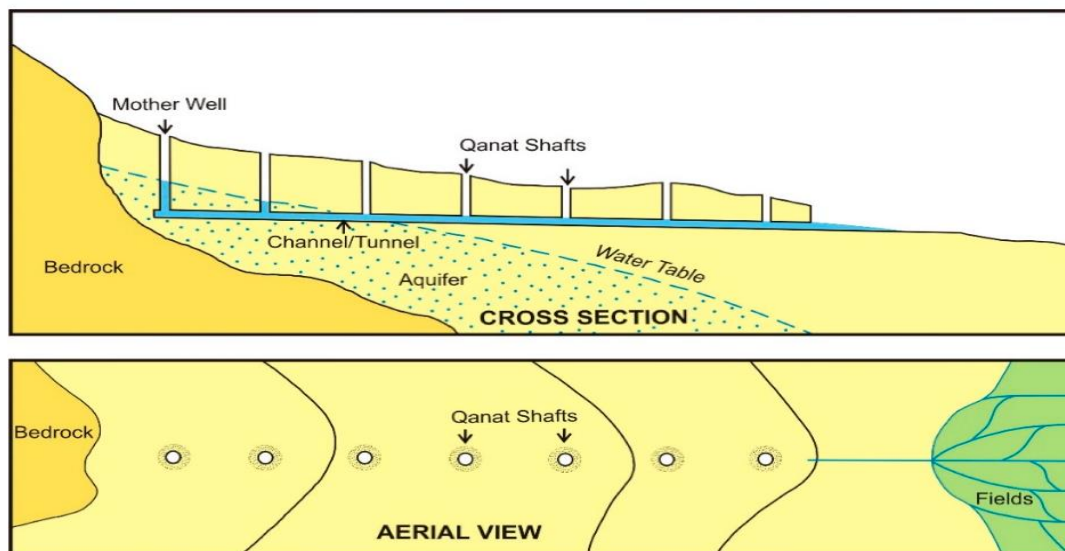
In addition to maintaining ecological balance, qanats play a critical role in agricultural irrigation (Beaumont, 1968; English, 1998) and, consequently, in the sustainability of the natural landscape. The characteristic pattern based on qanats is an expression of the "cultural landscape"—the evolution of a human society over time, shaped by the physical constraints and possibilities of the natural environment (Chamani, 2025). The literature review revealed that landscapes in Van are generally studied in the context of parks and transformation, while qanats, a cultural landscape heritage, are not considered within the landscape context.

### **Qanat, Structure and Geo-Hydraulic Properties of Their Systems**

Traditional water conveyance systems, qanat, are generally built on sloping lands to bring underground water resources to the surface and distribute them. The master is called "kenkan" in Turkish (Özden, 2025), and the engineer is called "muqanni" in Persian. In the qanat system, water is transported from a water source or the groundwater table through underground channels, preventing water loss due to evaporation and pollution caused by external factors, especially in arid regions (Bildirici, 2009; Alemohammad and Gharari, 2017). The part where water comes to the surface (mansab) in qanat is called "ferhang", which also means "culture" in Persian, and this is not a coincidence (Bensi, 2020). Society and water landscapes are deeply connected to each other in a dialectical way (Boccaletti, 2020). Qanat systems are generally applicable in regions with low annual rainfall, around 100-300 mm (Abudanh and Twaissi, 2010). In order to determine the appropriate size and slope, land measurement, geology and hydrology knowledge should be at a sufficient level, and in order not to be exposed to negative hydraulic effects, it should not be too steep (Gholikandi et al., 2013) and the slope ratio should be around 5% (Nasiri and Mafakheri, 2015; Bensi, 2020). According

to as demonstrated (Bensi, 2020), the etymological origin of geometry science (geo-soil+metry-measurement) also arose from such land management needs.

It is a structure where the underground water level must be horizontal depending on the geological structure, and before its construction, the water tables are determined with test wells and a main well (Persian: gamaneh) is dug and the first process is started. Since water is more abundant in the mountains due to orographic elevations, the alluvial fan is dug more easily and it is more appropriate to start the search from there (Gholikandi et al., 2013). Then, additional wells are dug at certain distances and connected to each other from the bottom, the material excavated from the sections opened wide enough for one person to pass is discharged through vertical wells (shafts) and a coating is applied to the tunnel depending on the structure of the land (Bildirici, 2009). This coating can be made of a hard material such as mortar, but it can also be supported by using baked clay rings to prevent collapses in loose soils (Nasiri and Mafakheri, 2015) (Figure 1). In general; open waterway, small water collection pond, vertical wells dug at intervals of 20-35 meters and soil extracted from the irrigation areas are discharged from the vertical wells with a reel.



**Figure 1.** Schematic Diagram of Qanat System in Rough Terrain (Soroush et al., 2020)

Qanat systems can extend from hundreds of meters to several kilometers (Nasiri and Mafakheri, 2015). Although their length generally varies between 3.5 and 13 km, there are exceptions that can reach up to 100 km (Özkan, 2022) and can reach as deep as 110 meters (Mistepe, 2025). Since they affect settlements, agricultural lands and therefore the evaluation, planning, decision-making and design stages of the landscape pattern in an integrated sense, as demonstrated (Chamani, 2025) named qanat as “qanatscapes” and made a classification as macro, medium and micro scale (Table 1).

In a hierarchical order, the main waterway and the secondary channels that carry water from the distribution pool to the water storage pools in each settlement are processed into the surrounding landscape, these landscape elements come together to form the green qanat landscape, a unit of the landscape infrastructure network (Chamani, 2025). The medium-scale qanat landscape pattern is based on the green, vegetated parts of the landscape, and consists of a water-based, cultural landscape approach that ensures the continuous distribution of water throughout the system in order to preserve the landscape character. As a result of a conscious spatial arrangement by distributing water in a hierarchical manner, organic lines are formed throughout the region. This process directs the gaze to

man-made structures, makes water visible, and as a result, a sense of culture, identity and belonging is developed (Chamani, 2025).

**Table 1.** A systematic hierarchy of Qanatscapes focusing on three different scales (Chamani, 2025)

Qanat Landscape	Landscape Principles	
<b>Macro Landscape</b>	Especially after floods, the cays should be cleaned regularly.	
Hidden Water	Development based on the ecological capacity of water resources.	Protection
Green Infrastructure	Protection of cays according to legal and land boundaries.	
Oasis Model	Putting Traditional Ecological Knowledge (TEK) into practice.	
<b>Medium Landscape</b>	Connecting clean air corridors, underground and surface waters with the urban landscape. Rehabilitation of qanat as blue infrastructures that are cultural heritage. Reuse of water based on traditional ecological knowledge and minimization of evaporation.	
Visible Water	Zero energy vision in landscape urban architecture. Increasing thermal comfort (qanat-microclimate-base design).	Repair and Development
Cultural Landscape	Increasing the durability of blue-green landscape systems.	
Water Network	Optimization of agricultural irrigation systems. Consideration of cultural landscape protection principles based on UNESCO Convention. Preservation of social memory and revival of traditional events and customs.	
<b>Micro Landscape</b>	Use and recycling of local materials. Attention to traditional climate principles of urbanism and architecture.	
Contactable Landscapes	Adoption of the quadrangular (Charbogh) garden form. Redesign and strengthening of water storage systems as both landscape and social areas.	Development and Construction
Sense of Identity	Strengthening of local social centers. Preservation of the linear position of water in the main urban spaces. Construction of site landscape based on the principles of maximum shading and cooling.	

It should not be thought that the qanat that control the flow of underground water levels harm the groundwater. Because this system does not drain an aquifer, it facilitates the passage of water from the source to the target (English, 1998). In summary, qanat are a low-tech system based on the interaction of gravity, minimum material waste, water resources and labor (Bensi, 2020) and are quite durable. In fact, if periodic maintenance is carried out, a qanat built once can serve for centuries, as has been demonstrated in Jordan when some qanat were put back into service after necessary maintenance in the 1900s (Lightfoot, 2000).

### History of Qanats

Qanats are considered to be one of the most important engineering marvels used for water supply in arid and semi-arid regions for thousands of years. These water conveyance systems, which ensure the continuous and regular transportation of water, have been adopted and developed by different civilizations throughout history. In ancient Iran, due to the lack of rainfall, water was obtained from qanats or high snowy mountains. Open channels or pools in gardens, used for show purposes in pools, were generally placed on the axis of the garden (Çınar et al., 2024).

While the exact origin of qanats is unknown, it is widely accepted that they spread from Iran to the rest of the world; however, recent research suggests that these systems first developed in Eastern Anatolia, with the Urartian aqueducts being the precursors of qanats (Bildirici, 2009). Furthermore, as has been proven (Abudanh and Twaissi, 2010), some qanats discovered in Southeastern Arabia are at least 200 years older than those in Iran. Tunneling techniques developed by Urartian miners and later

by the Achaemenids allowed qanat systems to become more precise, and these structures began to exhibit a wide variety in depth, length, and shape (Lightfoot, 2000; Gholikandi et al., 2013). Such findings in the literature support the notion that qanats did not originate in Iran. The Urartians were a society with advanced mining activities, and these systems developed in Eastern Anatolia, thus supporting their Urartian origin.

The qanats have spread over a wide geography. They are widely used in countries such as Turkey, Iran, Iraq, Syria, Jordan, Afghanistan, Pakistan, India, China, Kazakhstan, Azerbaijan, Armenia, Morocco, Tunisia, Algeria, Libya and Oman (Kozanoğlu, 2013). It is stated that some qanats in Iran have been active for more than 2500 years, that there were approximately 50000 qanats at the beginning of the 20th century, and that a qanat in the city of Gonabad, which had been active for 2700 years, provided water to 40000 people (Fattahi et al., 2015; IDEASS, 2025).

Figure 2. shows a Persian garden landscape with a typical central water axis, which reveals the first layer of the Qanatscape, outside the city of Mahan, Iran, with mountains up to 4000 m high in the background, which are the source of the water that feeds the qanatscape (Chamani, 2025). According to as demonstrated (MEI, 2025), qanat systems are currently used in more than 30 countries. This wide spread is thought to have been achieved through migrations and transfers of technological knowledge (Lightfoot, 2000). There is a tablet of the Assyrian King Sargon (722-705 BC) stating that he learned this system from the Persians during a campaign, and his son Sennacherib used the qanat system to provide water for the palace he built in Nineveh (Lightfoot, 2000). The Romans also constructed qanats in their own arid regions by digging into the alluvial and rock layers using techniques learned from the Persians. Through the Andalusian Umayyads, qanat systems were brought to Spain (Spanish: “rñayr” or “galeria”) and reached as far as Mexico during the Spanish colonization process (Lightfoot, 2000).



**Figure 2.** Bagh-e Shahzadeh (UNESCO World Heritage) in Mahan, Iran (Chamani, 2025)

In India, qanats have been used for irrigation purposes for viticulture and wine production (Mustafa, 2025). In the Xinjiang Autonomous Region of China, qanat systems have been actively operating for over 2000 years. According to 2003 data, there are over 1700 qanats in the region with a total length of 5272 km (Abudu et al., 2025). These systems are of vital importance in arid regions where the temperature reaches 38°C in summer and the annual rainfall is only 9-25 mm. There is also



## RESULTS AND DISCUSSION

The Urartians demonstrated the level of their technology in water engineering with the Menua (Şamran) Canal, which was built to carry water to a distance of approximately 57 km, named after him during the reign of King Menua, and a canal that carried water to a water cistern built by carving the main rock in Toprakkale through another irrigation canal where the Bostaniçi (Sihke) Reservoir originates, according to archaeological findings, and the water canal (Rusahinas Canal) built during the reign of King Rusa to carry water to Toprakkale and the plains where the Turna (Keşiş) Lake originates (Yoğurtçuoğlu, 1966). According to the as demonstrated (Belli, 1996), the Urartian kings constantly used sentences in their inscriptions such as:

*“...The land was empty, nothing had been built there...”*,

*“...The land was dry and desolate, no one lived there...”*,

*“...The land was like a desert...”*,

*“...The land was uncultivated, nothing was there...”*,

*“...The land was like a desert, nothing had been there before, no crops, no vineyards, no canals had been opened there...”*.

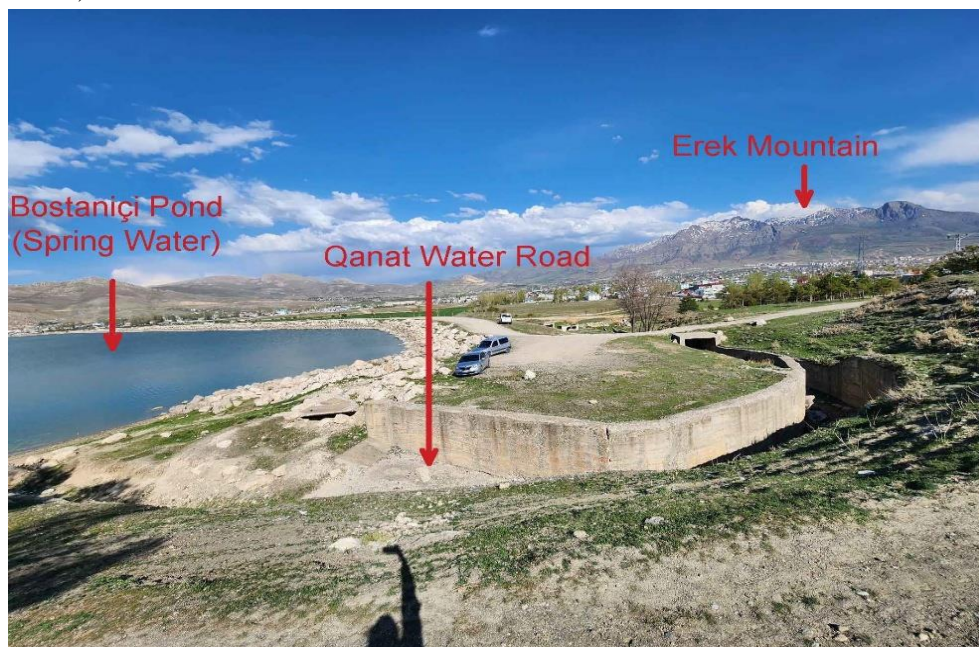
In Eastern Anatolia, there are many canals, dams and qanats from the Urartian period (Öziş, 2002). Among the more than 63 canals, dams and reservoirs built by the waters of large and small partially closed basins flowing from the areas of plateaus with an altitude of approximately 1700 meters around Lake Van and flowing into the Euphrates and Tigris, the most important structures are Keşiş Lake, Kırca Dam Lake and Menua (Şamran) Canal, which still exist today (Katar, 2014). Thanks to the systems established considering the material livelihoods of the people, vineyards and gardens were established in areas close to irrigation areas (Sevin, 2000). In addition, according to as demonstrated (Belli, 1996), there were also dense forests in the region after the Urartians.

As a result of intensive mining activities in the region and the need for fuel being met from the forests due to the long winter, the region has been deforested and barren for the last three hundred years. It has been determined that 65% of the water bodies found so far have been affected by erosion, the main reason for which is the destruction of these forest areas in the region (Belli, 1996).

There are over 1000 qanats in Anatolia, a significant portion of which is thought to have been left by the Urartians, and 54 of them are within the borders of Van City (Bildirici, 2009; Düzgüner, 2025). According to as demonstrated (Özkan, 2022), during the Ottoman period, all the water needs of the Van Plain were provided by qanats. With 37 of these qanats, all the water needs of Van were met until 1960 (Öztürk and Yeğın, 2022). According to as demonstrated (Top, 2025), 22 qanats were recorded in the center of Van. Of these 37 qanats, 6 are in Old Van (near Van Castle) and 24 are in the current center (Mistepe, 2025). As demonstrated (Bildirici, 2009), during field studies conducted in Van in 2006, qanats and other water structure remains were encountered together, especially in places where there were ruins of places of worship from the Armenian period.

The qanat systems, which are seen in many parts of the world and most probably inherited from the Urartians (according to the records of the State Hydraulic Works, the Vakıf and Yeni qanat were built during the Ottoman period), are seen in many areas where the Urartians dominated and still exist in some places in Van. The names of some of the qanat in Van are Askeri Mektep, Avsikoğlu, Büyük Kendirci, Çalık, Dilenci, Erek, Hacıbekir, Hamdi Bey, Hamur Kesen, Hasan Bey, Herkesek, İshak Bey, Kara Mehmet, Kör, Pembeci Mirze, Şahak Bey, Şengüloğlu and Yeni Qanat (Öztürk, 2003; Özden, 2025; Top, 2025). There are also qanats that are only recorded and for which there is no information. These are the Ab-1 Samet, Akköprü, Galip Paşa, Gümrükçü, Hacı Mustafa, Hacı

Numanoğlu, Hakkesen, Havşikoğlu, Kemer, Küçük, Mercimek, Şahbender and Şahak Bey Qanat (Top, 2025; Öztürk, 2003). The Çavuşbaşı Qanat, Kendirci Qanat, Vakıf Qanat, Eski Yengi-Sofuoğlu Qanat and Taze Qanat water channels, which were used until recently, provided water for drinking, usage and agricultural purposes to the central districts of Van and other areas (Özden, 2025). The Eski Yengi-Sofuoğlu (Figure 4) and Çevikoğlu qanat have lost their functions today but still continue to exist (Top, 2025), (Table 2).



**Figure 4.** Eski Yengi-Sofuoğlu Qanat Spring Point (Original, 2025)

**Table 1.** Known Qanat in Van (Created by transposing Yoğurtçuoğlu, 1966; DSI, 2002; Öztürk, 2003; Bildirici, 2009; Özden, 2025; Top, 2025).

The Unexisting Qanat	Only the Qanat Exist in Records	The Qanat That Continues to Exist	Qanat in Need of Repair or Restoration
Askeri Mektep	Ab-ı Samet	Çevioğlu	Çevioğlu
Avsikoğlu	Akköprü	Eski Yengi-Sofuoğlu	Eski Yengi-Sofuoğlu
Büyük Kendirci	Galip Paşa		Hacıbekir
Çalık	Gümrükçü		Kör
Çavuşbaşı	Hacı Mustafa		Taze
Dilenci	Hacı Numanoğlu		Vakıf
Erek	Hakkesen		
Hacıbekir	Havşikoğlu		
Hamdi Bey	Kemer		
Hamur Kesen			
Hasan Bey			
Herkesek			
İshak Bey			
Kara Mehmet			
Kör			
Pembeci Mirze			
Şahak Bey			
Şengüloğlu			
Yeni			

According to information obtained from the most recent technical report available on qanats in Van, DSI (2002), the registered qanats and their characteristics are listed in Table 3, classified according to their state of repair. DSI (2002) also classified them according to their restorability, and Table 3 was created based on this classification. Among these qanats, the first 1000 meters of the Eski Yengi-Sofuoğlu Qanat were reported to have been repaired in 1998-1999, as stated in DSI (2002)

(Figure 5). Oral interviews with retired qanat master Eşref Tuci revealed that these qanats and the Vakıf qanat were the most suitable for repair. The New Qanat is the newest, built in 1914-1915.

**Table 3.** Situation of Qanats Known in Van (Created by transposing from DSI, (2002))

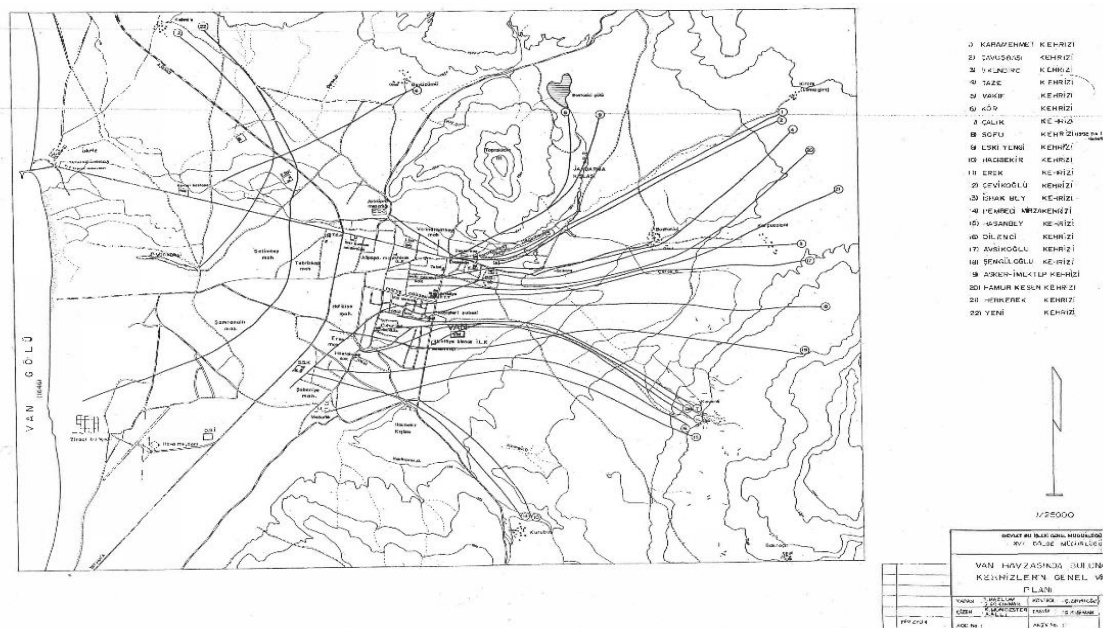
Qanat Name	Lenght (km)	Depth (m)	Debisi (lt/sn)	Repair Status
Askeri Mektep	8-10	No Information	20-25	Impossible
Avsikoğlu	6-7	No Information	25-30	Difficult
Büyük Kendirci	6-7	10-12	25-30	Impossible
Çalık	8-9	10-12	20-25	Impossible
Çavuşbaşı	3-4	10-12	25	Difficult
Çevikoğlu	7-8	No Information	30-35	Possible
Dilenci	10-12	10-12	20-25	Difficult
Erek	7-8	8-10	20-25	Impossible
Eski Yengi-Sofuoğlu	5-6	10-12	100	Possible
Hacıbekir	4-5	10-12	25-30	Possible
Hamdi Bey	No Information	No Information	No Information	No Information
Hamur Kesen	8-10	20-25	10-12	Impossible
Hasan Bey	8-10	No Information	20-25	Impossible
Herkesek	7-8	No Information	25-30	Impossible
İshak Bey	7-8	8-10	30-35	Impossible
Kara Mehmet	4-5	10-12	20	Impossible
Kör	4-5	7-8	25-30	Possible
Pembeci Mirze	6-7	8-10	25-30	Difficult
Şengüloğlu	8-10	No Information	20-25	Difficult
Taze	4-5	10-12	25	Difficult but Possible
Vakıf	1.5-2	7-8	25-30	Possible
Yeni	10-12	No Information	25-30	Impossible



**Figure 5.** A fragment from the Repaired Section of the Eski Yengi-Sofuoğlu Qanat. (The Other Repaired Sections Were Underground and Could Not be Photographed) (Google Earth, 2025)

The qanats, which also provide drinking water and are mostly sourced from Mount Erek with a height difference of about 50 meters in the east of Van, are the first water network drawn to houses in the Ottoman Empire (Mistepe, 2025). According to information learned from retired qanat master Eşref Tuci, it was learned that the efficiency of the water was the same in all 12 months of the year.

Vineyards and gardens were irrigated by the qanats directed into the city (Top, 2025). Until recently, the qanats, which were active, decorated the streets and avenues (such as Eski İskele Street) with willow and poplar trees (Mistepe, 2025). Until the 1980s, the water of some baths and some coffeehouses in Van was provided by the qanats and these businesses were the most preferred businesses by the public (Mistepe, 2025). In the Ottoman Empire, foundations were established for the maintenance of qanat, monthly and annual maintenance was done by qanats, with the transfer of water foundations to municipalities in 1920, the municipalities took over the maintenance until 1965, and the maintenance was done by DSI until 1985, but when the last qanats retired, the qanats were completely abandoned (Mistepe, 2025). As reported by as demonstrated (Yoğurtçuoğlu, 1966), there were only 8 qanats (Eski Yeni-Sofuoğlu, Çavuşbaşı, Büyük Kendirci, Vakıf, Hacıbekir, Taze, Kara Mehmet and Çalık Qanats) when they were transferred to DSI, although there were around 40 (Figure 6). Retired qanat master Eşref Tuci, who worked on all 8 qanats, aimed to ensure continuity and for this purpose, he paved the tunnels with 0.5x1 meter stones in places that were in danger of collapse. The points of the tunnels that are not in danger of collapse have been left stable as soil. In addition, as learned from him, the tunnel dimensions are generally 130 cm high and 60-70 cm wide.



**Figure 6.** Van City Qanats Map (DSİ, 2002)

Because qanats use gravity to lift water to the surface, they do not require electrical power, fuel, pumps, lubrication, or spare parts, nor do they require maintenance, resulting in energy savings and lower costs. Compared to pumped systems, qanats also contribute to reducing greenhouse gas emissions (Venkatesh & Brattebø, 2011; Nasiri & Mafakheri, 2015). Venkatesh & Brattebø (2011) reported that the average energy required per person for water pumping in piped systems is 220–260 kWh per year, resulting in greenhouse gas emissions of around 70–80 grams per cubic meter of water supplied. Table 4. Reflects the potential energy savings of a qanat by showing the energy consumption of electric and diesel water pumps (ALizadeh, 2008; Nasiri & Mafakheri, 2015). As can be seen in Table 4, the low labor costs of modern pipe systems, which require energy and consume groundwater, have prevented the use of qanats (Mustafa, 2025) (Table 5). The lack of a zoning plan for city protection and extensive infrastructure work have led to most qanats being abandoned to deterioration and destruction (Öztürk and Yeğın, 2022). According to information provided by retired qanat master Eşref Tuci, after the construction of the Aydın Talay Underground Bazaar, the functioning of the

qanats in these areas was disrupted due to the deterioration of the elevations. The fact that Urartian water structures are still operational today is thanks to the maintenance and repair work carried out during the Ottoman period (Belli, 1996).

**Table 4.** Comparison of Typical Qanats and Deep Wells (Alizadeh, 2008; Nasiri & Mafakheri, 2015)

Technology	Power need <sup>a</sup>	Water withdrawal cost <sup>b</sup>		
		Interest rate = 10%	Interest rate = 15%	Interest rate = 20%
Qanat	–	41.2	56.3	71.5
Diesel deep well	4.24	89.6	103.7	118.9
Electric deep well	2.60	67.5	88.8	111.4

<sup>a</sup>Horse power (Hp) for extracting 1 liter of water per second.

<sup>b</sup>266.65 US Dollars per 1 cubic meter of water. (Calculated for October 2025)

**Table 5.** Calculated amounts for 1-m pipe laying (Haidery & Baş, 2020)

Pipe Diameter (mm) and Pressure Class (PN)	Excavation Amount (m <sup>3</sup> )	Soil Compaction Area (m <sup>2</sup> )	Backfilling Amount (m <sup>3</sup> )	Required Filling Material Amount (m <sup>3</sup> )	Amount of Excess Soil to Landfill (m <sup>3</sup> )
Φ110, PN10	0.64	0.51	0.66	0.31	0.35
Φ110, PN12.5	0.64	0.51	0.66	0.31	0.35
Φ110, PN16	0.64	0.51	0.66	0.31	0.35
Φ125, PN10	0.67	0.53	0.68	0.33	0.35
Φ125, PN16	0.67	0.53	0.68	0.33	0.35
Φ125, PN25	0.67	0.53	0.68	0.33	0.35
Φ140, PN10	0.70	0.54	0.71	0.35	0.36
Φ160, PN10	0.73	0.56	0.74	0.38	0.36
Φ160, PN16	0.73	0.56	0.74	0.38	0.36
Φ 225, PN10	0.86	0.63	0.85	0.49	0.36
Φ225, PN12,5	0.86	0.63	0.85	0.49	0.36
Φ250, PN10	0.91	0.65	0.89	0.54	0.36
Φ280, PN10	0.97	0.68	0.94	0.59	0.35
Φ315, PN10	1.05	0.72	1.01	0.66	0.35
Φ355, PN10	1.14	0.76	1.08	0.74	0.34

## CONCLUSION

While the average annual amount of water per person in water-rich countries is 10000 cubic meters, the fact that this amount is around 1800 cubic meters in Turkey shows that areas irrigated with artesian systems, especially in regions with water shortages, are under threat and in this context, it reveals the importance of systems such as qanat (Kozanoğlu, 2025). Even irrigation systems such as Faruk Dam, built in the Roman and Byzantine periods in Van, which is located in an earthquake zone, bear the traces of earthquakes (Belli, 1996), while the fact that Urartian qanat, which was also developed in mining, has continued to exist for approximately 2800 years is an indication that they took security measures considering negativities such as earthquakes and that they were a highly advanced civilization in terms of engineering in the conditions of that day (Katar, 2014).

Water management in landscape architecture is a critical factor in terms of the sustainability of ecosystems. Although studies on qanats are rarely encountered within the discipline of landscape architecture, when considered from this perspective, qanat systems are thought to play a critical role in shaping the water landscape in urban and rural areas. Qanats, one of the traditional water management systems, make significant contributions to the protection and sustainable use of natural water resources

in arid and semi-arid regions such as Van. Qanats have been used for agricultural irrigation and drinking water supply by carrying underground water resources to the surface, and in this respect, have directly affected the shaping of traditional landscapes. They have made significant contributions, especially to the irrigation of viticulture, gardening and agricultural areas, and have enabled the development of sustainable landscapes by preserving the ecological balance of these areas. Qanat systems prevent excessive water evaporation on the surface, allowing for more efficient use of water. According to as demonstrated (Bensi, 2020), academics have recently emphasized that the broader cultural context of the qanat system and its heritage values should be increased in urban planning and design.

Water resources provided by qanats in and around Van have enabled the survival of certain plant species and increased agricultural diversity in the region. Zhang et al., (2021) also referred to the water element as "waterscapes", they noted that water has positive psychological effects and the potential to play an important therapeutic role in mental and social health. Similarly, Langie et al., (2022) discussed the positive social and aesthetic effects of water in public spaces. From these perspectives, during periods when the qanat, a water element, was actively used, it had positive aspects such as psychological effects due to its sound and refreshment, sociological effects due to its effects on conversation and solidarity, and urban planning effects due to its beauty and cleanliness (Mistepe, 2025).

As as demonstrated (Mistepe, 2025), China's re-functioning efforts for these systems show their importance. Carrying out such functionalization studies in our country and in Van, which is prominent in terms of qanat, will be a pioneering study in terms of reviving traditional and efficient irrigation systems. In this sense, it was seen that retired qanat master Eşref Tuci was ambitious in putting the Eski Yengi-Sofuoğlu qanats into operation, and it was learned that if the functionalization work was carried out, repair work should be done in March and they could be put into operation in a short period of 11-12 months. In this context, the current status of the qanats in Van, the threats they face and suggestions for their protection were also discussed in the study.

Today, traditional water systems can be re-evaluated by integrating them with innovative approaches in modern urban planning and landscape design. A literature review revealed similar studies on puquios, structures similar to qanats, conducted by Valipour et al. (2020), and 22 of the 46 puquios recorded are still functioning. Using these studies as an example, the qanats in Van can be integrated into modern landscape design to both ensure cultural heritage preservation and create an important model for water management. Planning principles can be developed based on environmental characteristics, traditional cultural knowledge, the integration of the landscape within the broader context, and the consideration of qanat systems as a socio-cultural heritage deeply embedded in the natural environment, creating effective and landscape-focused infrastructure that has been collectively designed and operated for centuries (Chamani, 2025). For ecological landscaping applications, water from qanats can be used to create biological ponds, wetlands, and green corridors. In this way, low-maintenance landscapes resilient to arid climate conditions can be created in the region.

Restoring qanats in urban landscapes, in harmony with existing infrastructure, and incorporating them into urban landscape projects can also contribute to effective water management and the preservation of groundwater-using piped systems. Qanats for cultural landscapes can be incorporated into landscape architecture projects aimed at preserving cultural heritage. Revitalizing historical qanat systems and creating recreational areas around them offers significant opportunities for both ecotourism and preserving cultural landscapes. Designating pilot qanats with UNESCO support, maintaining and repairing these systems, and reopening them would be highly beneficial in terms of both cost and promotion.

To ensure that the qanats in Van are preserved for future generations within the context of landscape architecture, efforts should be undertaken to record, map, and protect them. In this context, collaboration with local governments and academic institutions should be undertaken to determine the most appropriate route changes, if necessary, based on hydrological analyses, water quality controls, and economic and ecological cost-benefit analyses. Restoration projects should be developed in light

of these analyses and controls, and the most aesthetically appropriate form should be evaluated within the context of ecotourism and promoted to visitors.

As Van's landscape infrastructure, qanats represent a specific pattern that can be rethought and reshaped in future landscape planning and design. Incorporating these systems into the modern urban landscape can ensure the sustainable water needs of urban green spaces. Offering a rich knowledge base for both landscape research and practice, qanats constitute a remarkable landscape typology with their holistic understanding encompassing landscape, natural environment, and social factors. However, they remain an under-researched area of research, from their infrastructural features to their social sensitivities (Chamani, 2025). From another perspective, qanats, which should be evaluated within their historical context and in the field of water architecture, should be developed for aesthetic as well as functionality. They not only have the potential to rehabilitate a large and effective heritage infrastructure, but they can also inspire new research and landscape systems through design and planning principles. For these reasons, efforts should be initiated to ensure that relevant institutions are responsible for the restoration of qanats in need of repair or with the potential to be reactivated (Çevioğlu, Eski Yengi-Sofuoğlu, Hacıbekir, Kör, Taze, and Vakıf Qanats), and implementation efforts should be initiated as soon as possible in the next stages.

With the development of modern water supply systems, a decline in the use and presence of qanats has been observed (Kozanoğlu, 2013; Öztürk and Yeğın, 2022; Kılıç, 2023). These structures need to be preserved and integrated into sustainable water management policies. The technical structure and operation of qanats should be examined in more detail, and the historical development and application of these systems should be emphasized in terms of how they fit into the modern world. Integrating traditional water structures with modern technologies can offer an effective solution to today's major environmental problems, such as climate change and water scarcity. Qanat systems constructed in accordance with the natural flow of waterways can facilitate water-focused landscaping in cities. This could present an opportunity to create a sustainable model that can also be used in modern landscape design.

### **Conflict of Interest**

The article authors declare that there is no conflict of interest between them.

### **Author's Contributions**

The authors declare that they have contributed equally to the article.

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