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QANATSCAPE RESTRUCTURING AS GREEN-BLUE-CULTURAL INFRASTRUCTURE OF HISTORICAL CITIES IN THE ARID REGION OF IRAN

Introduction. – Qanat is an ancient Iranian water supply system with an excavated underground canal conducting water from aquifers to cities and villages on dry, flat lands. The importance of the qanat system lies in how it organizes territory by canalizing the water table and revealing it on the surface, thereby providing the possibility for human habitation and greenery, especially agriculture. The oasis-like "cultural landscape" created by qanats is characterized by a typical pattern: located far away from natural rivers, the «hidden water» (Al-Karaji, 1994) infrastructure of the qanat dictates a regional order and structure to the arid lands and settlements. It establishes a system of landscape hierarchy through water cycles and a social human organization, collaboration, responsibility, cohesion, identity, and, as a result, the sense of belonging to a place.

Constructed generation by generation and operating centuries, the qanat system discharge in Iran was reported in 1960 to be around 20,000 cubic meters per second out of Ca. 21,000 branches of qanat. (Goblot, 1992). The function and flow of hundreds of qanats have dramatically fallen during the last half-century. In metropolitan cities such as Tehran and Mashhad, no trace of qanats and the dependent cultural landscapes could be identified or vastly disappeared under highways, metro tunnels, and industrial and residential zones. However, in the arid region of Iran, the greenery and main non-potable water resources of the middle and small size cities such as Yazd, Naieen, Gonabad, Joopar, etc, depended on qanats until deep wells with electrical pumps were introduced after World War II. (Semsar Yazdi, Labbaf Khaneiki, 2017).

Recent studies of the Qanat system first focused on the technology's functionality and the justification for continuing to use it to manage water. (Jomehpour, 2009) In the last three decades, scholars have also addressed its history and importance in different regions (Hu and others, 2012;

Lofrano and others, 2013; Martínez-Santos, Martínez-Alfaro 2014) and expressed concern about its preservation and protection (Yazdi, Khaneiki 2017; Ghasemi and others, 2013; Jomepour, 2009; Harand, de Vries, 2014). More recently, scholars have emphasized the importance of developing a broader cultural understanding of the qanat system and the role of its heritage in urban planning (Agah, 2014; Safi Nezhad, 2017; Beheshti, Najar Najafi, 2017; Labbaf Khaneiki, 2020). The social cooperation and "virtual water" (Labbaf Khaneiki, 2019, 2022), social ecosystem (Salek, 2019), and water organization of qanats make an understanding of sustainable water system usage by locals in this area.

In 2016, eleven distinctive qanats of Iran were inscribed on the UNESCO World Heritage List (UNESCO, 2016) to be protected and regularly monitored as valuable objects like historical monuments. Besides being on the UNESCO list, the Cultural Landscape of Bam, a series of Persian Gardens (UNESCO, 2011), and the Historical town of Yazd are also recognized as World Heritage, the vast vernacular landscape of Iran. The Persian Garden's elaborate structure represented a close relationship between cultural and natural landscapes and revealed an alignment between human needs and nature. However, there remains a lack of a comprehensive approach and criteria for the qanat system involving the structural, hydrological, social, and aesthetic aspects of the qanat canal, the resulting landscapes, and the other impacted areas. Similarly, the qanat system is considered a landscape character and element.

As a method and tool, adopted by the General Conference of UNESCO at its 36th session on 10 November 2011, the Recommendation on the Historic Urban Landscape (HUL) calls on Member States to integrate conservation and management of cultural heritage in cities and settlements with policies and practices for sustainable urban development. This innovative standard-setting instrument embraces the power of cultural heritage to make cities and settlements culturally vibrant, economically prosperous, socially inclusive, and environmentally sustainable. The HUL approach embodies the urban environment, resulting from a rich overlay of cultural and natural values that extend beyond the traditional concepts of a "historic center or ensemble" to encompass the broader urban context and its geographical surroundings. This wider context encompasses various elements such as topography, geomorphology, hydrology, natural features, built environment (both historical and contemporary),

above and below-ground infrastructure, open spaces, gardens, land use patterns, spatial organization, climate, visual connections, as well as social and cultural practices, economic processes, and intangible aspects of heritage like diversity and identity. This comprehensive definition is the foundation for a holistic approach to identifying, evaluating, conserving, and managing historic urban landscapes within a sustainable development framework. (HUL, 2019).

Identifying character-defining features [of qanat and its landscape], those visual aspects, and physical features that individually and cumulatively help define a historic resource's distinctiveness, is a critical step in heritage protection. (Hunter Burkett, 2020). Contribution to conservation, transformation and «critical reconstruction» (Schöbel-Rutschmann, 2018) of qanat landscape by employing HUL as well as the "Conzenian" (Conzen, 1960) and "Palimpsest" (Corboz, 1983) method to underlying the original layer of historical urban landscape which made based on qanats in Iran, would be addressed for future sustainable landscape development to a blue-green infrastructure in combination with cultural landscape perspective.

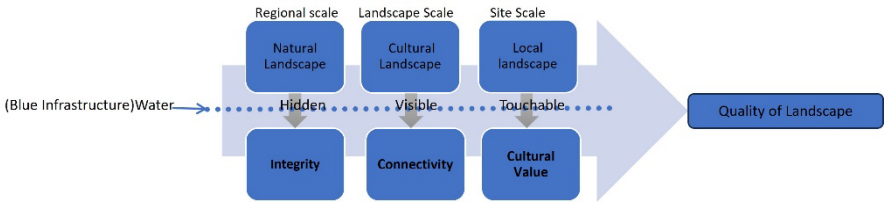
Like Conzen, Hägerstrand, the Swedish geographer, emphasizes the need to "integrate" the various components distinguished in the landscape for analytical purposes. Two significant elements in Conzen's methodology are the historical expressiveness of an urban landscape, which he meant to realize the potential of appreciating societal activities to uncover historical and geographical order. The second element in his argument refers to the "morphogenetic priority" of the different form complexes as a contribution to the landscape. (Whitehand, Kai Gu, 2010).

Qanatscape: Landscape Character of Qanat. – Since the mid-nineteenth century, there has been a noticeable emergence of a landscape-oriented approach in geographical studies, particularly gaining traction within heritage contexts from the 1990s onward (Redford and others, 2003; Veldpaus, Pereira Roders, Colenbrander, 2013). The preservation of heritage landscapes is often characterized by three key dimensions (Ginzarly, 2018). Firstly, it encompasses a holistic viewpoint, considering various facets of the landscape, including its physical elements, psychological aspects, and functional processes (Spirn, 1998; Terkenli, 2001; Tress, Tress, 2001). Sec-

ondly, it adopts an integrative stance, promoting interdisciplinary collaboration, drawing insights from scientific and humanities disciplines and cultural and natural heritage perspectives (Tress and others, 2001; Fairclough, Londen, 2010). Thirdly, it is grounded in values, underscoring the significance of involving and collaborating with communities linked to the landscape. This engagement aims to grasp diverse values and heritage significance, fostering cross-cultural discourse among stakeholders in decision-making processes regarding the conservation of specific assets (ICOMOS Australia, 1999; Mason, Avrami, 2002; de la Torre, 2005).Landscape characteristics made and affected by qanats dominantly involve multiple dimensions, from heritage aspects to environmental importance, from infrastructure role to cultural and identity value, and from regional hydraulic capacity to gardening style. Therefore, contrasted with known landscape movements such as Xeriscape, the term "Qanatscape" (Chamani, 2022) has been introduced to categorize and reveal the iconic Qanat-based landscape character. This frame of view implicitly and explicitly expresses visual and formal networks, regional integrity, landscape interconnectivity, orientation and compositional, cultural value, and social nods. It would be applied and understandable first by underlying the way of evolution by the crafted hydraulic system in such dry nature, further by discovering the logic of organically created landscape in its context, and finally by the human organization and intervention in the landscape by the development of lands. An analytical framework like the "polder grammar" method (Nijhuis, 2016; Steenbergen, and others, 2009) has been employed through the study of historical maps, the development of aerial photos, and photographs to identify the constructive characteristics and the expressive characteristics of the form (Nijhuis,2020).

Taking all the natural conditions, territory ordering, building techniques, inner logic form, and spatial effects of both agricultural land and settlements into account, the Qanatscape needs to be explained across three scales: the regional scale (Macro landscape), the landscape scale (Middle landscape) and the scale of the site (Micro landscape).

Fig. 1 – *Character of Qanatscape ordering in scales. The quality balance of Qanatscape is disrupted if every part of this three-scale model is overlooked*



Source: Author, 2024

Macro Landscape: Airplane View of Qanatscape. – The Persian landscape face has been widely changed through the settlements of Indo-Iranians transitioning to agriculturists around the sixth century BCE (Semsar Yazdi, Labbaf Khaneiki, 2017). When flying over central Iran, one can discern various qanat territories through the stark contrast between verdant and arid landscapes between the towering Alborz and Zagros Mountain ranges and the expansive deserts of Dasht-e-Kavir and Dasht-e-Lut (fig. 2).

Fig. 2 – *Regional view of a Qanatscape, Joopar city and Goharriz Qanat*

Source: copyright: S.H. Rashedi, UNESCO Nomination file of the Persian Qanat, 08.12.2014, https://whc.unesco.org/en/list/1506/gallery/

A Qanatscape territory is recognized as having four primary segments:

1. Natural water resource location: high mountains whose stones are mixed with mud [and] are likely to contain groundwater as the ancient scholar Karaji noted (Al-Karaji, 1994);

2. An iconic landscape element is chains of circular heaps encircling the tops of the vertical shafts manifest on the surface as a series of wells in an alluvial fan, representing the water tunnels identifying kilometers away from the created green landscape;

3. Settlement and orchards: Man's dwellings are located near mountains on the main routes or flat lands where fertilization is done for agriculture, the leading destination of qanat canals;

4. Farmlands: Beyond settlements are rectangular fields of farmlands that fade into surrounding desert areas where no more water reaches, where water finally partially absorbs the earth and partially evaporates. (Chamani, 2022).

A German scholar, Erich Schmidt, conducted a captivating study that integrated aerial photos, drawings, sketches, architectural descriptions, and archaeological findings. This comprehensive approach enabled him to explore the intricate relationships among topography, roads, water infrastructures, agricultural practices, and settlements. His book, Flights over Ancient Cities of Iran (1940) constantly «shifts between scales and between history, geography and anthropology» (Sanaan Bensi, 2020). It relies on critical geographical histories of the medieval Islamic period «to render the multiplicity and interconnection of settlements with their immediate landscape and large region» (Sobti, Hosseini, 2016). For example, his aerial photograph of Turut village (or Torud), a typical Qanatscape settlement, «captures a clear border between inhabited territory and the desert that absorbs the hidden underground water from the heart of the mountains» (Schmidt, 1940).

Together, these images visualize the Qanatscape territory character as an iconic landscape pattern across barren drylands, which "integration of landscape elements" guarantees the Qanatscape system works based on ecological capacity and environmental contexts.

Fig. 3 – *Regional view to Qanatscape: a) A qanat-based village near Isfahan, 1926; b) Schematic profile of Qanatscape from mountains to the city and desert; c) Inside a qanat canal near Kerman; d) qanat shaft wells chain; e) Yazd city skyscape seen background high mountains*

Source: The University of Chicago. Oriental Institute https://oi-idb.uchicago.edu/id/e1a304c6-8acb-4a8b-868f-76a5cf67ec00, Access, January 2024: Visual Documents Knowledge Base of Iranian Urban and Architectural Heritage http://www.negarestandoc.ir/documentdetail.aspx?id=106898

Middle Landscape: Bird's-eye Perspective to Qanatscape. – By Zooming the lens to the parts of the Qanatscape territory, where fresh water from the Qanat canal emerges on the surface, becomes accessible by humans, and provides prosperity, reveals a discernible connected hierarchy and order. Greenery and culture rise from this point, which is called farhang in Persian, meaning culture. The root of the word in Persian refers to dragging, training, and education, the mouth of water. (Dehkhoda, 1998) Therefore, the farhang (culture) originates from the first place in which people touch the water; they begin to organize collectively, create public spaces, distribute and share water, and tructure the landscape.

Fig. 4 – *Farumad village houses, qanat, farmlands and an archaeological site of a castle taken from an altitude of ca. 2000 meters on May 12, 1937 by Boris Dubensky for the university of Chicago.*

Source: The University of Chicago. Oriental Institute https://oi-idb.uchicago.edu/id/e1a304c6-8acb-4a8b-868f-76a5cf67ec00, Access, January 2024: Visual Documents Knowledge Base of Iranian Urban and Architectural Heritage, http://www.negarestandoc.ir/documentdetail.aspx?id=106898

Spatial structure: In 1979, Heinz Gaube studied the spatial pattern and physical morphology of the Iranian cities of Herat, Isfahan, and Bam. (Gaube, 1979). These cities' spatial patterns and landscapes have been developed based on qanats to respond to the cultural needs of inhabitants and, at the same time, to adapt to their surrounding environment. (Kheirabadi, 2000). Therefore, the landscape "form orientation," land organization, and spatial structure of a Qanatscape unit are affected entirely by the entry axis of water and appearance on the surface and distribution of water flow on the topography and crafted conduction for land use purposes.

Water network: This hierarchical order is imprinted into the landscape around the main watercourse of the qanat (Shahjub) and subordinate channels (Jub), which lead water outward from the distribution pond (Maqsam) into water storage cisterns (Ab-anbar) generally located in the main square of a village or neighborhood[1] (Semsar Yazdi, Labbaf Khaneiki, 2017). These "historical landscape elements" (Shahjub, Maqsam, Jub, and Ab-anbar) create one unit of the blue Qanatscape infrastructure. Their network and connectivity are the central considered part of this scale.

Green patch: Cultivated land and settlements are situated downwards from the water's surface. Water runs downstream of the Qanat mouth (Mazhar) through open or covered ditches with lateral branches to the dwelling, orchards, and fields. Cisterns, icehouses, public baths (Hammam), pools of mosques and schools, and watermills were built along the route of the water canals in suitable locations (Zargar, 2007). After these communal needs have been met, the water is collected from ditches in unique pools and then distributed to the farms (Rafiee Fanood, 2014) by determined schedule.

Cultural landscape: A cultural landscape is defined as an area, as perceived by people, whose character results from the action and interaction of natural and/or human factors, according to the Council of Europe 2000 (Nijhuis, 2020). The beauty of human genius coexistence in the harsh con-

[1] These so-called neighborhoods or today's districts were rural areas (*Abadi*) surrounding the town, which every village had own water order, and organization. Dominant area by gardens and farmlands, there were a core of settlements in every village. However, they were connected together to produce fresh food and to make a convenient microclimate and green area for the hot and dry town.

ditions of hot and dry environments attracts the concept of a cultural landscape that was the first time in Iran after the Bam earthquake to inscribe that vernacular city with surrounding gardens and farmlands survived by qanats in the World Heritage List (Corfield and others, 2008).

In the qanat case, the cultural landscape would be defined not only as its body, which is a hand-made water infrastructure of cities and villages, but also as a leading creator of landscape and agricultural fields of hot and dry regions of Iran and part of some other countries such as Oman, Spain, Morocco, China and so on.

Man's Eye View, Micro Landscape. – A closer examination of the Qanatscape's local scale reveals historic Persian gardens' dominant quadrilateral landscape form, central courtyards (Hayat), and squares (Meydan). All these parts are based on the central qanat water axis, a channel leading from the central qanat canal into the settlement, organizing open spaces to define their function and optimal water distribution. For instance, the symmetry around the water axis of the Shahzadeh Persian Garden is an outstanding example of how the Qanatscape defined architectural form. It provided comfortable, cool air compared to the hot and dry climate outside. The same pattern can be seen in traditional Iranian houses, mosques, schools, and other architectural typologies.

In Iranian culture, a "rectangular" water pool (Hoz) is always a central element of the landscape, from private spaces to public buildings and open spaces. They have framed water (a rare resource) to watch, touch, make ablution, moderate harsh climates, store for dried days, water trees and planets, etc.

A Qanatscape unit consists of hierarchical water places and networks; in every neighborhood, a place of water access (payable) was usually located at a public plaza where drinking water was available to the entire community and served as an essential place for social interaction. Payabs, which are sloping corridors with steps leading from the surface to the qanat's canal beneath residential areas, were also built along the line of the qanat for direct access to the freshwater of a qanat (Semsar Yazdi, Labbaf Khaneiki, 2017) is beside qanat outlet (Mazhar) an honorable place in a community belief and collective memory.

In the past, each Qanatscape community had its own leader and social organization to manage and count "every cup of water" (Semsar Yazdi, Labbaf Khaneiki, 2017), overseeing and regulating water distribution.

These organizations were essential to the community and facilitated cultural events such as fire ceremonies, nature and spring celebrations, or religious and sacred rituals. The cultural sense cultivated distinct written and spoken language modes that differed slightly in each Qanatscape neighborhood. Such peculiar cultural characteristics highlight the potential of Qanatscapes to rehabilitate social qualities that could enhance the daily life of the landscape for people living in climatically challenging cities and villages.

As part of the sustainable practices of Qanatscape principles, social cohesion could help bring prosperity, a sense of belonging, and identity back to the region. The planning principles could be developed based on environmental characteristics, traditional cultural knowledge, the integration of the landscape into a broader context, and the appreciation of qanats as a socio-cultural heritage that is deeply embedded in the natural environment, creating an adequate, landscape-informed infrastructure that had been collectively crafted and operated over hundreds of years.

Tab. 1 – *Summary of Qanatscape*

	Landscape Character	Landscape elements	Significant Feature
Macro Scale	Natural landscape, Hidden water, Oasis Pattern	Mountains, Chain of donut-shape heaps, Settlements, Green Patches	Integrity, Environmental compatibility
Middle Landscape	Cultural Landscape, Visible and flow water	Water Network (*Shahjub, Jub, Maqsam, cistern, mill)* Orchard area, Settlement location, Farmlands	Orientation, Connectivity, Hierarchy, Water cycle
Micro Landscape	Geometrical landscape, Touchable water, Persian Garden model	Water Bodies (Pool, *Hoz, Payab),*	Optimizing, Authenticity

Source: Author

Qanatscape of Yazd City, Old Town, and Surrounded Green Communities. – One of the well-preserved qanat-based cities in Iran is Yazd, located on the edge of a desert and 1,216 meters above sea level (Wikipedia). The territory of Yazd's Qanatscape is bordered by the western Shir-Kooh mountains, which rise to a tower of 4,100 meters-located 40 kilometers away from Shir-Kooh, this town where the location for trading and governing was surrounded by green qanat-based communities. Approximately 300 qanat fountains across the Shir-Kooh aquifer irrigate and bring prosperity (Abadani[2]) to many villages and cities.

Before the construction of fossil-fuel-powered deep wells for industry and agriculture, the Yazd urban landscape served as an environmentally harmonic model that utilized renewable resources of groundwater and wind to make a micro-climate condition.

The oldest available maps of Yazd (Mehreyar and others, 2000) back to 1859 and 1897, drawn by two Russians named Khanykov and Shetalov, show a few qanats and organic urban structure as a cultural landscape according to the Qanatscape pattern (fig.5). The orientation of the created landscape is toward the southwestern mountains until around 1980, according to the periodic aerial photos.

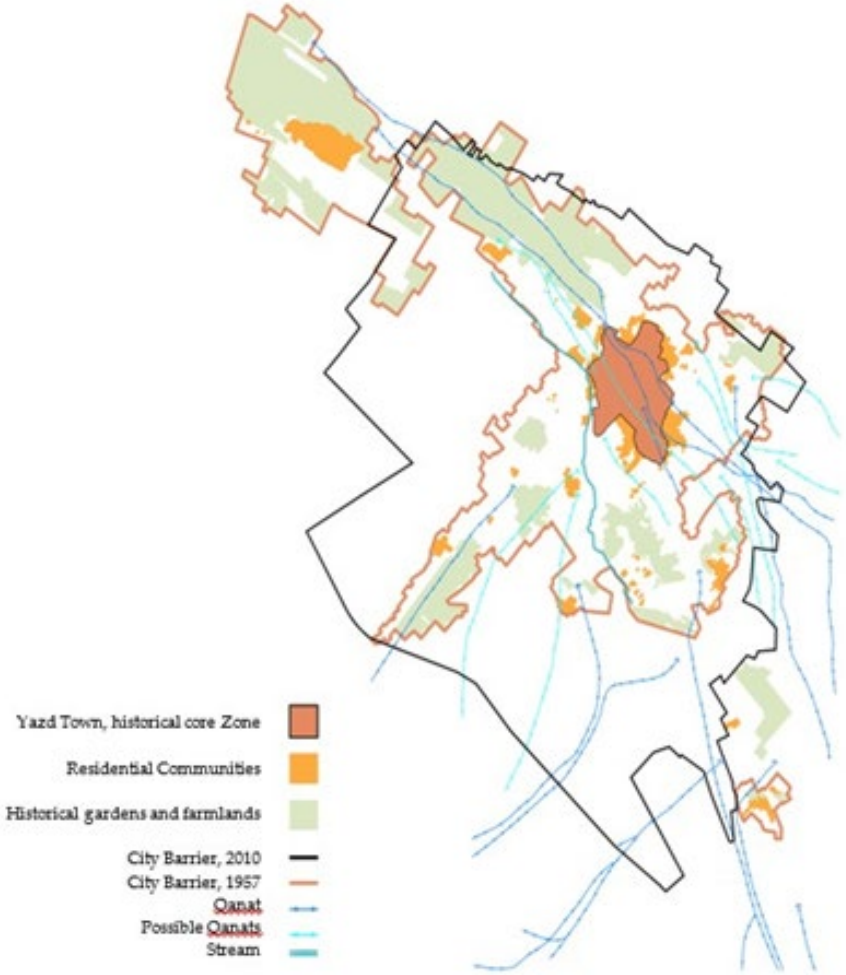
For today and the future, Yazd's Qanatscape must be interpreted and analyzed in the time around the nineteenth to mid-twenty century when the spatial model and urban landscape of the city evolved and worked for hundreds of years according to the Qanats system, environmental conditions, and cultural activities. Based on that time evidence, Yazd's Qanatscape consisted of satellite green qanat-based communities （Labbaf Khaneiki, 2024） (called in Persian Abadi) around the town where its primary role was trading in bazar and green spaces limited to the central yards of houses, mosques, and so on. The flourishing and greenness have been oriented along the qanats, reaching a community around the town and making its distinctive Qanatscape unit.

[2] Literally meaning «turning a dry land to green by [a conducted] water» in old Persian language (Avestan) (Wikipedia, wikipedia.org n.d.). "Ab" means water and "Ab-adi" means a community as a "rural district".

Fig. 5 – *Old map of Yazd. Moreover, qanat routes, gardens, organic landscape form and orientation of Yazd are visible*

Source: Scan of "Visual Documents of Iranian cities in Qajar Dynasty" Book, The second Chapter: Maps of Iranian Cities, pages: 186-187. Access in Shahid Beheshti University library

Fig. 6 – *Schematic map of Qnatscape model of Yazd according to 1957 aerial photos, satellite rural communities around the town of Yazd*



Source: Drawn by Author, 2023, The location of gardens is surveyed by Arseh consulting engineers for a Comprehensive Plan Study, and the location of settlements and qanats was taken from a map by Shamseh Consulting Engineers for the Cultural Heritage Organization of Yazd in 2010

The role of these satellite Qanatscape units was *i)* to moderate harsh hot and dry weather by creating micro-climates around the town, *ii)* to preserve food and fresh agricultural products, *iii)* to protect the soil and water for agriculture, and *iv)* to act as an energy-food-water nexus (Labbaf

Khaneiki, 2020). The form and location of these green satellite communities are shown in a map of Yazd from 1957 (fig. 7). The map reveals how the Qanatscape units enriched the natural landscape structure before modern urban development began to crosshatch the city.

Fig. 7 – *Qanatscape traces in Yazd*

Source: Author, 2020

To explore Qanatscape traces in Yazd, ten old districts (former satellite rural communities) are examined through different methods employed during some surveys, interviews, and videos from old locals to match discovered blue-green traces in the temporal satellite photos, texts, and inherited documents (endowments) with the current situation. The result revealed an integrated network of the main watercourse, cistern, local plaza, old pools, and trees to a qanat in every neighborhood. In addition, traces of still-existing gardens or dried ones as abandoned lands in a water-sharing geometry are extracted from the same methods and captured by many photos. In some old neighborhoods, there is evidence such as Persian gardens, orchards, dried farmlands, and old trees to represent the way

of qanat water as landscape lines of the district. For example, in the collective memory, some mulberry trees adjacent to a creek are known as Vaqf-Abad qanat. The Municipality conserves them by placing metallic plates and an attribute code. (Karimian, Semsar Yazdi, 2021).

Referring to the four historical books[3] and narratives about Yazd, which was installed four gates far away from water sources in the eleventh century, the greenery and landscape of Yazd formed when Vaqf-Abad qanat was conducted to town from the mountains. Passing through all iconic monuments such as *Jami Mosque* (the Great Mosque), *Garshasb garden*, *Rokniyya madrasa* (school) and *Dar-al-Shifa complex* (treatment center) the landscape of Yazd developed along the direction of Vaqf-Abad and its water distribution structure. In the History of Yazd, «Ayati (1938) introduces Vaqf-Abad qanat as the most fertile qanat of the city », that its water is open to public use and makes landscape of the city green and alive. Eleven watermills and cisterns places for public water access, a significant Persian Garden and vast area of orchards are evidence of qanat passed through them and could be recognized and rehabilitated as blue-green infrastructure of this ancient city.

«This [urban] qanat is a well-known example of water-oriented interactions between humans and nature» (Karimian, Semsar Yazdi, 2021, p. 474). This qanat has had a significant role in the landscape of the city's evolution in the last 40 years.

Mapping and recording the route of Vaqf-Abad qanat is considered necessary «as a safeguard of both qanat and the characteristics of the city» (*ibidem*) on a larger scale. This qanat represents the history of Yazd from the fourteenth century up to the late 1980s. The studied database consists of endowment deeds (1331, 1843, 1905), historical texts (1442, 1468, 1679) and travelogue, contemporary books and research (1877, 1938, 1995, 2009, 2016), aerial photos from 1956, and two old maps, and still-alive oral knowledge (Karimian, Semsar Yazdi, 2021). By studying the qanat endowment documents, conducting field observations, and conducting interviews with qanat local masters Karimian, the exact route of qanat in Yazd is identified and drawn on a map. The function of the Aharestan, Kheyr-Abad, and Khurram-Shah neighborhoods around Yazd

[3] Jami al-Khayrat, Tarikh-i Yazd, Tarikh-I Jadid Yazd, and Jami-I Mufidi.

town was agricultural use and potable usage in the bazaar, mosque, madrasa, and some houses of central town. However, the Vaqf-Abad branch dried out in 2016 after six hundred years of flow; its discharge fell from 42 l/s in 1980 to 3 l/s in 2009 (Karimian, Semsar Yazdi, 2021). Overcatchment of groundwater by electrical pumps in the upstream-built deep wells and global droughts have stopped water delivery.

Qanatscape as Green-Blue-Cultural infrastructure of Yazd: treatment of landscape. – Today, without the vital, multi-functional Qanatscape role, landscapes of cities that are far away from permanent sources of surface water are either limited to low-yielding greenery or have been completely abandoned. Modern urban and rural development and the introduction of gray infrastructures detached the city from the context of its natural environment. All urban and rural households of Yazd are today supplied with drinkable water by conventional water pipes. However, Aerial photos from 2002 indicate that green structures and the cultural landscape of qanats across Yazd have nearly vanished. As residents have reported, this has resulted in the city becoming climatically less comfortable, especially in times of global warming. In addition, the construction of dams on another basin for landscaping in arid lands has wholly ignored the qualities of the Qanatscape, cutting through the original flow and inner logic of the Qanat system.

Blue-green infrastructure refers to a network that offers the "ingredient" for addressing urban and climatic challenges by integrating built natural solutions (Pötz, Bleuze, 2011). In landscape architecture, blue-green infrastructure, which generally includes stormwater management, climate adoption, the reduction of heat stress, increasing biodiversity, food production, improved air quality, energy production, and healthy soil, is more involved in anthropocentric functions such as increased quality of everyday life landscape through recreation and the provision of shade and shelter in and around cities as well as an ecological framework for social, economic, and environmental health. (Chiesura, 2004) (wikipedia n.d.)

«On the Iranian Plateau, reliance on qanats has promoted high levels of social and ecological adaptation» (Labbaf Khaneiki, 2020, p. 42) through time. To implement historical values of landscaping and Traditional Ecological Knowledge (TEK) (Watson, 2019) in new intervention, Qanatscape serves as a kind of «land strategy» (Labbaf Khaneiki, 2020) that has been

able to adapt to environmental change over time while balancing societal demands and climatic conditions. The Qanatscape pattern, as a typical landscape in central Iran, can be « critically reconstructed and cautious renewed» (Schöbel-Rutschmann, 2018) in future landscape planning and design. As a sustainable infrastructure that uses the natural water cycle and ensures the renewability of natural resources, it not only plays a formative and vital role in the landscape structure but also comprises an important cultural heritage conservation and promotes quality of life quality.

Overall, of these potentials, Qanatscape could function and be reconstructed in the role of "Blue-Green-Cultural infrastructure" of the historical qanat-based cities in terms of not only protection of a vital heritage infrastructure as hidden and visible blue network and greenery creator but also renewing the sense of belonging among locals and improve the quality of everyday landscape in neighborhoods. Heritage makes the ongoing historical dynamics of a water-based community and the ecological conditions recognizable. When a historical perspective is valued, it will manifest in tangible heritage such as the HollandRoute Polderland Network for citizens and visitors (Boer, 2020). The Europolders Program is an integrated policy that fosters the preservation, transformation, and adaptive reuse of historic water-related structures to economically strengthen communities and help sustain a unique and historically significant landscape type (Boer, 2020).

"Research by design, exploring possibilities by spatial design, can help developers and planners explore the possibilities for spatial development, generating proposals or potential solutions for design problems (Nijhuis & Bobbink, 2012)." This knowledge-based design leads to innovative, balanced, and coherent landscapes with their own identity and spatial qualities.

Tab. 2 – *Qanatscape as Green-blue-cultural infrastructure*

	Qanatscape as Green-blue-cultural infrastructure		
	Protection and Conservation	Transformation	Critical Reconstruction and Cautious Renew
Regional Scale	Conserve the historical iconic landscape of donut-shape chains on the bare lands • Prevent more urban development on the orientation and connection of qanats to mountains • Protect of the [UNESCO] landscape zone of Qanats	• Plan and manage landscape based on ecological and hydraulic capacity • Integrate mountains, settlements, and green patches based on a qanat route • Implement and involve Tradition Ecological Knowledge (TEK)	• Rehabilitate the natural location of green infrastructure made by qanats • Plan and design Water cycles • Plan and design flood control for the treatment of the basin • Recreate microclimate zones on historical *Qanatscape* units • Plan Low Impact Development (LID) of landscapes
Middle Scale	• To Prevent underground public transport • Protection of the legal (Harim) of qanats • Regular protection and dredging of qanat canals • Conservation of Persian gardens boundary and location and connection with qanat • Considering the cultural landscape	• Interconnection of vernacular energy systems and underground water in urban landscape structure • Rehabilitation of Historic Urban Landscape (gardens, orchards, possible farmland) based on the blue infrastructure of qanats • Reactivation of water-based open spaces by social organization	• Orient urban landscape based on the dictates of green-blue infrastructure • Reconstruct creeks, ditches, pools, and cisterns as a historical blue network in old districts • Climatically adopt zero-energy and resilient landscape design • New landscape development
	protection and monitoring based on UNESCO principals	• Keep qanat stories and collective memory	in the connection and cautious structure following
Local Scale	• Recovering of ditches and water spaces in *Qanatscape* units • Keep linear and rectangular forms of green-blue spaces • ….	• Empowerment of identity of locals by celebrating the rituals and events in HUL of qanats • Rehabilitation design based on rectangular water spaces • Restoration of landscape with vernacular material • …	• Re-activation and enhancing the local social hubs • Reconstruct and redesign according to quadrilateral form (*Chahr-Bagh*) • Reconstruction of qanat access stairs *(Payab*) and cisterns as everyday landscape and social nods • New landscape design based on local Qanatscape criteria to make sense of belonging • Reconstruction of landscape based on maximum shading and cooling and less evaporation • …..

Source: Author

Conclusion. – While the qanat formed the basis for settlements, construction of landscapes, and prosperity (abadani), it is also a key to understanding the culture and civilization of the Iranian Plateau. It has evolved as a form of cultural landscape. Therefore, preserving this heritage requires protecting old technology and understanding the territory where the qanat operated and its limitations and possibilities. Qanats defined the village lifeworld on the plateau by (1) determining the location of settlements (English, 2011); (2) structuring built environments within settlements (Ghobadian, 2009); and (3) organizing social cohesion in water allocation,

distribution, and maintenance of qanats (Labbaf Khaneiki, 2020).

The structure of a Qanatscape's unit is essentially the result of a conscious spatial ordering through the hierarchical distribution of water. This process created organic lines across the territory, guiding the view to human-made structures, making the water visible, and developing a culture, identity, and sense of belonging. The Qanatscape broadly defined as a term in landscape planning and architecture, involves all iconic characters that must be considered in protection plans, transformation, critical reconstruction, and even future development plans.

These outdated forms of urbanism and landscaping in Iran have gradually worsened the quality of everyday landscape since around 50 years ago. So:

The era of constructing dams on permanent rivers must be ended due to the transportation of water from a reservoir to provide a water source to green patches and urban landscapes. The transport of potable water is above the ecological capacity of watersheds. Many lakes, rivers, and dependent ecosystems have dried up during the current century.

The era of development based on the global crosshatch pattern urban design and planning the relative area of green spaces within a city is over because these development methods did not work with the natural morphology and historical landscape structure.

The era of harmonization in spatial functional planning and urban landscaping, which represent non-vernacular anonymous open spaces, has been over for several decades

The era of synchronization of leisure time in open spaces with globalized activities is over to feel a sense of belonging in a space.

Today, the urban landscape comprises the historical, structural connections between the natural landscape, cultural landscape, and the city, emphasizing that every city has its specific character, culture, and context. Shöbel-Rutschmann's (2018) "lines of force" in the context of the historical city cores carry essential aspects of identity and social and cultural values that must be reconstructed as a green-blue-cultural infrastructure.

REFERENCES

AL-KARAJI A., *The excavation of hidden water (Estekhraj-e Ab-ha-ye Penhan, 1010)*, Tehran, Iranian National Commission for UNESCO Pres, 1994.

BEHESHTI S.M., NAJAR NAJAFI E., "Teshnegi Servat-e Mast! or Thirst is our wealth!", *Andisheh iranshahr*, 2017, 24-25, pp. 8-14.

CHAMANI M, *Qanat and Ecology*, Interview with Labbaf Khaneiki Majid, Yazd, 2020.

CHAMANI M., "Qanatscape, Revealing the historic water landscape of the Qanat to inform future green infrastructure in cities of arid Iran", in ZANDER H. (ed.), *Landscape Approach, From local communities to territorial systems,* Gordon Goff, 2022, pp. 127-135.

CHIESURA A., "The role of urban parks for the sustainable city", *Landscape and Urban Planning*, 2004, 68, 1, pp. 129-138.

CONZEN M.R. G., *Alnwick, Northumberland: A study in town-plan analysis*", London, Institute of British Geographers Publication, 1960.

CORBOZ A., "The land as Palimpsest", *Diogenes*, 1983, 31, 121, pp. 12-34.

CORFIELD M., FARDANESH F., *Bam and its Cultural Landscape World Heritage Property Comprehensive Management Plan (2008-2017)*, Tehran, Iranian Cultural Heritage, Handicraft and Tourism Organization & UNESCO Tehran Cluster Office, 2008.

DE BOER H.P.G., "Europolders a European Program on Polder Landscape, Heritage, and Innovation", in HEIN C. (Ed.), *Adaptive Strategies for Water Heritage, past, present and future*, Springer 2020, pp. 230-249.

DE LA TORRE M. (Ed.), *Heritage Values in Site Management: Four Case Studies,* Los Angeles, The Getty Conservation Institute, 2005.

DEHKHODA A., *Dehkhoda Encyclopedia*, Tehran Universit, 1998, https://dehkhoda.ut.ac.ir/1998.

ENGLISH P. W., *Qanats and Lifeworlds in Iranian Plateau Villages,* Report of the Decisions Adopted at the Thirty-fifth Session of the World Heritage Committee, Paris, UNESCO World Heritage Center, 2011.

FAIRCLOUGH G., *The Heritage Landscape: Reflections on Landscape Archaeology in Europe*, London, Routledge, 2010.

GAUBE H., *Iranian Cities,* New York, New York University Press, 1979.

GHASEMI H., VALIPOUR E., MORAD D.H., "Application of traditional architectural structure as sustainable approach to mitigation of shortage water supply in desert regions", *Academic Journal of Science*, 2013, 2, 1, pp. 125-132.

GHOBADIAN V., *Iran climate condition*, Tehran, Tehran University, 2009.

GINZARLY M., HOUBART C., TELLER J., "The Historic Urban Landscape approach to urban management: a systematic review", *International Journal of Heritage Studies*, 2018, 25, 10, pp. 999-1019.

GOBLOT H., *Les qanats: une technique d'acquisition de l'eau*, Paris, Le Haye, 1992.

HARANDI M.F., DE VRIES M.J., "An appraisal of the qualifying role of hydraulic heritage systems: a case study of qanats in central Iran, *Water Science and Technology: Water* Supply, 2014, 14, 6, pp. 1124-1132.

HEIN C. AND OTHERS, "Connecting water and heritage for the future", in Hein C. (ed.), *Adaptive Strategies for Water Heritage Past, Present and* Future, Technical University Delft, Zuid-Holland, The Netherlands Springer, 2020.

HU W., ZHANG J., LIU, Y. (2012). "The qanats of Xinjiang: historical development, characteristics and modern implications for environmental protection", *Journal of Arid Land*, 2012, 4, 2, pp. 211-220.

HUL UNESCO RECOMMENDATION, *The UNESCO Recommendation on the Historic Urban Landscape Report of the Second Consultation on its Implementation by Member* States, France, UNESCO World Heritage Center, 2019.

HUNTER BURKETT M., "Silent and Unseen: Stewardship of water infrastructure heritage", in HEIN C. (ed.), *Adaptive Strategies for water heritage past, present, and* future, New York, USA, Springer, 2020.

JAFARI H., *Tarikhe Yazd (the history of Yazd)*, Tehran, Bungahi Tarjumah va Nashri Kitab, 2005.

JOMEHPOUR M., "Qanat irrigation systems as important and ingenious agricultural heritage: a case study of the qanats of Kashan, Iran", *International Journal of Environmental Studies*, 2009, 66, 3, pp. 297- 315

KARIMIAN A., SEMSAR YAZDI A. A, "Mapping Vaqf-Abad Qanat watercourse in the urban landscape of Yazd city in two distinct periods: fourteenth and twentieth centuries", *Water History*, 2021, 13, pp. 473-491.

KHADEM ZADEH M.H., *The historical communities of Yazd city*, Tehran, Sobhane-Nour for Cultural Heritage Organization of Yazd, 2007.

KHEIRABADI M., *Iranian cities: Formation and Development*, Syracuse University Press, 2000.

LABBAF KHANEIKI M. AND OTHERS, "Urbanization, proto-industrialization, and virtual water in the medieval Middle East*", Journal of Hisorical Geography*, 2024, 84, pp. 139-149.

LABBAF KHANEIKI M., *Cultural dynamics of water in Iranian civilization*, Springer, 2020.

LAMPTON A.K.S., "The Qanāts of Yazd", *Journal of the Royal Asiatic Society*, 1992, 2, 1, pp. 21 - 35.

LOFRANO G. AND OTHERS, "Water collection and distribution systems in the Palermo plain during the middle ages", *Water*, 2013, 5, 4, pp. 1662-1676.

MARTÍNEZ-SANTOS P., MARTÍNEZ-ALFARO P.E., "A priori mapping of historical water-supply galleries based on archive records and sparse material remains. An application to the Amaniel qanat (Madrid, Spain*)", Journal of Cultural Heritage*, 2014, 15, 6, pp. 656-664.

MASON R., AVRAMI E., "Heritage Values and Challenges of Conservation Planning", in DE LA TORRE M. (Ed.), *Assessing the Values of Cultural Heritage*, (pp. 13-26), Los Angeles, The Getty Conservation Institute, 2002, pp. 13-26.

MEHREYAR M., *Pictorial Documents of Iranian Cities in the Qajar Period*, Tehran, Shahid Beheshti University, National Cultural Heritage Organization, 2000.

NIJHUIS S., "The Noordoostpolder: A landscape planning perspective on preserving and developing twentieth-century polder landscapes in the Netherlands", in Hein C. (ed.), *Adaptive Strategies for Water Heritage, Past, Present and Future*, Springer, 2020, pp. 213-229.

PÖTZ H., BLEUZE P., "Urban green-blue grids for sustainable and dynamic cities", *Delft*, *Coop for life*, 2011.

RAFIEE FANOOD M., "The role of four critical structures in the creation and survival of cultural landscapes in the desert environment of Iran", *Journal of Architectural Conservation,* 2014, pp. 184-196.

REDFORD K. H. AND OTHERS, "Mapping the Conservation Landscape. Clasificando los Enfoques Utilizadas en la Conservación", Conservation Biology, 2003, 17, 5, pp. 1167-1175.

SAFI NEZHAD J., *Kariz dar Iran va shivehaye sonatiye bahregiri az an or Kariz in Iran and the traditional ways of its using*, Tehran, Pouyeh Mehr Ishraq Cultural Institute, 2017.

SALEK A., "Rediscovering community participation in Persian Qanats: An actor-network framework", *European Journal of Creative Practices in Cities and Landscapes*, 2019, 2, 1, pp.153-172.

SANAAN BENSI N., "The Qanat system: A reflection on the heritage of the extraction of hidden waters", in Hein C. (ed.), *Adaptive strategies for water heritage past, present, and future*, The Netherlands, Springer, 2020, pp. 41-56.

SCHMIDT EF., *Flights over ancient cities of Iran*, University of Chicago Press, 1940.

SCHÖBEL-RUTSCHMANN S., *Interview with Löwe Martina.*

SEMSAR YAZDI A., LABBAF KHANEIKI M., *Qanat Knowledge, Construction and Maintenance*, Springer.

SHÖBEL-RUTSCHMANN S., *Landschafts Vertrag zur Kritischen Rekonstruktion der Kulturlandschaft*, Berlin, jovis Verlag GmbH, 2018.

SOBTI M.P., HOSSEINI S., "Re-examining 'Persianate Civitas': networked urbanities and suburban hinterlands in Erich Schmidt's flights", in Mohammad G. (ed.), *The historiography of Persian architecture*, New York-London, Routledge, 2016.

STEENBERGEN C., REH W., NIJHUIS S., POUDEROIJEN M.T., *The Polder Atlas of the Netherlands. Pantheon of the low lands*, Bussum, Thoth, 2009.

TRESS B., TRESS G., FRY G., *Integrative and Participatory Geography: A Framework for the Future of Landscape Studies*, Cambridge, Cambridge University Press, 2001.

UNESCO, "Bam and its Cultural Landscape", *World Heritage List*, https://whc.unesco.org/en/list/1208.

UNESCO, "The Persian Qanat", *World Heritage List*, https://whc.unesco.org/en/list/1506/.

VELDPAUS L., PEREIRA RODERS A., COLENBRANDER B. J. F., "Urban heritage: Putting the past into the future", *The Historic Environment: Policy & Practice*, 2013, 4, 1, pp. 3-18.

VERSCHUURE-STUIP G., "Hold the Line: The transformation of the New Dutch Waterline and the Future Possibilities of Heritage", in Hein C. (ed.), *Adaptive Strategies for Water Heritage, past, present and* future, Springer, 2020, pp. 251-269.

WATSON J., *Lo-TEK Design by Radical Indigenism*, TASCHEN, 2019.

WHITEHAND J.W.R., "Conservation Urban Landscape Heritage: a Geographical Approach", *Procedia Social and Behavioral Sciences*, 2007, pp. 6948-6953.

Wikipedia, https://en.wikipedia.org/wiki/Avestan.

Wikipedia, https://en.wikipedia.org/wiki/Green_infrastructure.

Wikipedia, https://en.wikipedia.org/wiki/Yazd.

ZARGAR A., *An introduction to the Iranian Rural Architecture*, Theran, Shahid Beheshti University, 2007.

La ristrutturazione del qanatscape come infrastruttura verde-blu-culturale delle città storiche nella regione arida dell'Iran. – Un'infrastruttura rispettosa dell'ambiente ha creato la civiltà delle terre aride dell'Iran circa 3000 anni fa, il sistema idrico Qanat, una struttura creata dall'uomo che consiste in tunnel sotterranei che partono da falde acquifere alluvionali alla testa delle valli e che conducono l'acqua su lunghe distanze usando la gravità per irrigare le terre aride e piatte. Una visione olistica di un paesaggio basato sui qanat crea il termine "Qanatscape" per concettualizzare le caratteristiche paesaggistiche uniche dei qanat, dalla scala del sito alla scala intermedia, il tutto nel contesto della scala regionale. Rivitalizzare il modello del Qanatscape significa scavare nell'ordine, nella gerarchia, nell'uso del suolo e nel ciclo ottimale dell'acqua e trovare un modo per migliorare lo sviluppo sostenibile e la qualità del paesaggio quotidiano.
Yazd è un caso di studio degno di nota in quanto si è evoluto dal modello del Qanatscape. Il paesaggio di Yazd è stato esaminato attraverso narrazioni orali e analisi/interpretazione di immagini di vecchie mappe, foto aeree e immagini satellitari periodiche per scoprire il modello. Infine, attraverso una ricostruzione critica, il Qanatscape viene proposto come infrastruttura "verde-blu-culturale" di città e villaggi storici aridi dell'Iran. Il modello può servire come modello per un uso più sostenibile dell'acqua in Iran, producendo cibo, qualità della vita e un senso di appartenenza e identità, soprattutto di fronte al cambiamento climatico.

Keywords. – Sistema idrico dei qanat, Paesaggio dei qanat, Paesaggio di Yazd

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