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The Role of Water and Traditional Water-Supply Systems in Shaping the Howz-khaneh of Qajar Houses in Shiraz and Isfahan: A Comparative Architectural Analysis

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ABSTRACT

The howzkhaneh a semi-subterranean, pool-centered summer chamber is among the most distinctive spaces of the traditional Iranian courtyard house, and its very existence depended on a reliable supply of running water delivered by the pre-modern hydraulic infrastructure of the city. The central problem addressed in this study is that the howzkhaneh is usually analyzed as an isolated architectural or thermal element, detached from the urban water-supply system that made it possible, so that the formative influence of differing hydraulic regimes on its architecture has remained largely unexamined. The objective of this research is therefore to analyse, comparatively, how the contrasting traditional water-supply systems of Shiraz and Isfahan shaped the architecture of the howzkhaneh in the Qajar-era houses of the two cities. Adopting an analytical-applied design within an interpretive-historical paradigm and a documentary and library method of data collection, the study reconstructs the water-supply context of each city the qanat-and-reservoir regime of Shiraz and the Zayandeh-Rud and Mādi canal network of Isfahan and relates it to the position, depth, water configuration, cooling function, and ornamental treatment of the howzkhaneh through a structured comparative framework. Findings indicate that the intermittent, depth-dependent qanat supply of Shiraz is associated with deeper, more strongly evaporative and ornamentally emphatic howzkhaneh chambers, whereas the more continuous surface flow of the Isfahan Mādi network is associated with shallower chambers more directly integrated with the city's open-channel hydrology. The study concludes that the howzkhaneh is best understood not as an autonomous architectural type but as the domestic terminus of an urban hydraulic system, whose form is legible only in relation to the water regime that sustained it.

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INTRODUCTION

Water occupies a position in Iranian architecture that is at once practical, climatic, social, and symbolic. In the hot, arid and semi-arid plateaus of central and southern Iran, the management of scarce water through millennia-old hydraulic technologies above all the qanat, the underground gallery that conveys groundwater by gravity from the foothills to the settlement was the precondition not only of agriculture and urban life but of architecture itself. (Wonders, 1979, Simmons, 2014, Hasehzadeh Haseh, 2018) Within the traditional courtyard house, water was gathered, displayed, and put to environmental work in courtyard pools, fountains, and, most elaborately, in the howzkhaneh: a semi-subterranean chamber built around a central pool, used as a cool retreat during the fierce heat of summer. The howzkhaneh is a sophisticated piece of passive environmental design. Sunk partly below ground to exploit the thermal stability of the earth, lit and ventilated through a skylight, and organized around a pool fed by running water, it cooled its occupants through the evaporation of water and the circulation of air, providing thermal comfort without any mechanical means (KeyNezhad et al., 2023; Soflaei et al., 2017, Cheng, 2022). Yet the howzkhaneh could not exist without a dependable delivery of water to its pool, and that delivery was the function of the city's traditional water-supply system. The architecture of that part was therefore conditioned, at the most fundamental level, by the hydraulic regime of the city in which it was built. This dependence has been insufficiently examined. The substantial literature on the Iranian courtyard house and its water elements tends to treat the howzkhaneh either as an architectural-decorative type or as a thermal device, analysed in isolation from the urban hydrology that supplied it (Memarian & Brown, 2006; Mahmoudi Zarandi, 2016). Where water supply is discussed, it is generally at the scale of the city or the agricultural region rath-

er than in terms of its formative effect on domestic architecture. The comparative dimension how differing water-supply systems produced differing howzkhaneh architectures has been largely neglected. Shiraz and Isfahan cities in Iran, offer an instructive comparison precisely because their traditional water-supply systems differed fundamentally while their architectural culture, climate type, and Qajar-era prosperity were broadly comparable. Isfahan was supplied by the perennial Zayandeh-Rud and the dense network of mādis¹ that distributed its water through the city, a regime of relatively continuous surface flow (Fadaei & Esfanjary, 2017). In Shiraz, lacking a comparable river, depended on qanats tapping the aquifer of its surrounding plain, supplemented by covered reservoirs (Ab-anbar), a regime of intermittent, depth-dependent supply. (Fig. 1) The present study asks how these contrasting hydraulic regimes shaped the architecture of the Qajar howzkhaneh in the two cities, analysing the relationship in general typological terms rather than through named individual houses.

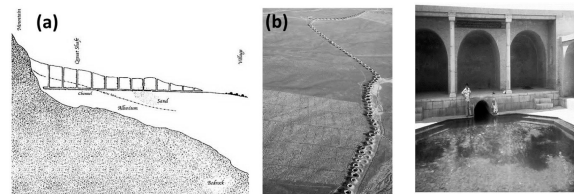


Figure 1: (Left), (a) A scheme and (b) a typical image Qanat or Kārīz, A system for transporting water from an aquifer to the surface, through an underground aqueduct. Originated approximately 3,000 years ago in Iran. With permission from: Khakzand, Mehdi & Tabatabaee, RS. (2013). Investment Methods in Sustainable Water Resource Management using SAW Method. *Journal of Arma-Shahr*, 11-25. (Right), A Qanat's Outflow, Soleymaniyeh Fountain, Fin Garden, Kashan, Iran. With permission from: Torabzade, A. (2018). Traditional irrigation system of Sulaymaniyah spring in Fin of Kashan. *Kashan Shenasi*, 10(2), 158-171. (Source: Esmailpour et al., 2025)

¹Open canals

MATERIALS AND METHODS

Water in Iranian architecture and the Howz-khaneh

Water is a structuring element of Iranian domestic architecture, valued simultaneously for cooling, for visual and acoustic pleasure, and for its cultural and religious associations with purity and paradise (Ardalan & Bakhtiar, 1973; Faghhi & Sadeghy, 2012, Zhou et al., 2025). In the courtyard house of the hot-arid zone, the central pool (Howz) is the focal point of the courtyard, while the howzkhaneh internalizes this water-centered logic in a roofed, semi-subterranean room used in the hottest months. Studies of the howzkhaneh emphasize its role in passive cooling: the evaporation of water from the pool, combined with the thermal inertia of the surrounding earth and the stack ventilation provided by a skylight or windcatcher, lowers the interior temperature substantially below the exterior (KeyNezhad et al., 2023; Soflaei et al., 2016). The space is thus a hybrid of architecture and environmental technology, and its performance depends on a continuous presence of water. The Howz is one of the most important water elements in traditional Iranian architecture, which is specifically used in hot and dry areas. People gradually stored water in big pools, and used its water for the irrigation and other purposes. Evaporation of the water in the pool helps the ventilation in the garden by developing desirable cool weather. This function was considered in its best forms in the design of pools, in a way that a part of water of the pool and its fountain

was evaporated and the air stream containing the water entered the building through the ground floor windows and flew out through the small openings in the dome-shaped ceiling above the pool-house or other windows of the pool-house which caused a cooled air in effect (Soltanzadeh. H & Soltanzadeh. A, 2017). (Fig. 2)

Traditional water-supply systems: qanat, river, and mādi

The qanat is the foundational hydraulic technology of the Iranian plateau, a gently sloping underground gallery that conveys groundwater from a mother-well in the foothills to the surface at the settlement, accessed and ventilated by a line of vertical shafts (Goblot, 1979; English, 1968). Qanat supply is gravity-driven, relatively constant in the long term but limited in volume and dependent on the depth and yield of the aquifer; in cities without a perennial river, such as Shiraz, it was the principal source of domestic and garden water, frequently stored in covered reservoirs (Ab-anbar) to buffer supply (Beaumont, 1971). Isfahan, by contrast, possessed the Zayandeh-Rud, a perennial river whose waters were distributed through an elaborate, centuries-old system of Mādis open canals governed by codified water rights traditionally attributed to the Shaikh Bahā'ī scroll that carried surface water through the city's gardens, houses, and public spaces (Fadaei & Esfanjary, 2017). The two regimes differ in the dimension most relevant to architecture: the continuity, accessibility, and depth at which water becomes available.

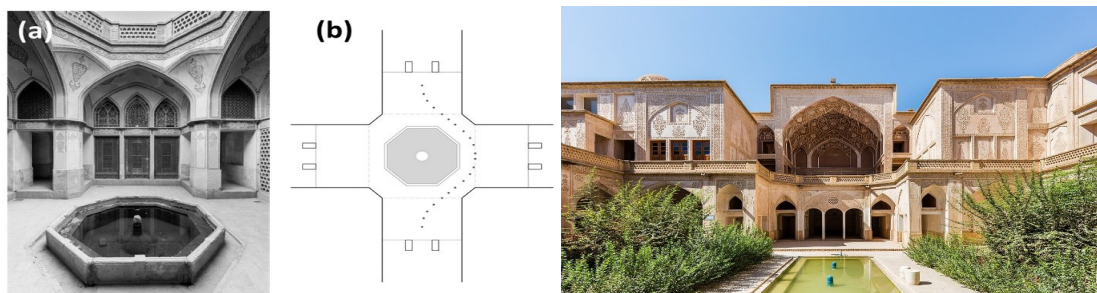


Figure 2: (Left), (a) An image and (b) a sketch of the central presence of water and human path, located in Abbasian House, Kashan, Iran. (Source: Esmaeilpour et al., 2025) (Right), Abbasian House, Kashan, Iran

Comparative architectural analysis as method

Methodology

Comparative architectural analysis, in the tradition of typo-morphological study, examines how a recurring architectural type varies across contexts in order to isolate the contextual factors that shape it (Memarian & Brown, 2006; Farahbakhsh et al., 2018). Applied to the howzkhaneh, this approach allows the architectural consequences of differing water-supply regimes to be distinguished from the constants of climate, construction technology, and cultural convention shared by the two cities. The present study adopts this framework, treating the water-supply system as the principal variable and the howzkhaneh's architecture as the dependent outcome. This study adopts an analytical-applied research design within an interpretive-historical epistemological paradigm. Consistent with the historical and qualitative nature of the subject, data were gathered through documentary and library methods historical sources, travelogues, scholarly studies of Iranian domestic architecture, and technical literature on Qanats, Mādis, and the howzkhaneh and analyzed qualitatively. The analysis proceeds in three stages. First, the traditional water-supply context of each city is reconstructed from the literature:

the qanat-and-reservoir regime of Shiraz and the Zayandeh-rud and Mādi network of Isfahan. Second, the general architecture of the Qajar howzkhaneh is characterized through its constituent attributes position within the house, depth below ground, water configuration, cooling mechanism, and ornamental treatment. Third, a structured comparative framework relates the water-supply attributes of each city to the howzkhaneh attributes, allowing the formative influence of the hydraulic regime to be identified. The analysis is conducted at the level of the general type rather than through named individual houses, so that the conclusions concern the typology of the Qajar howzkhaneh in each city rather than particular surviving examples. The architectural relationships analyzed are represented through schematic diagrams: a longitudinal section showing the connection between the qanat and the howzkhaneh and the resulting cooling mechanism; a schematic plan locating the howzkhaneh within the Qajar courtyard house (Fig. 3); and a comparative diagram of the two water-supply regimes feeding the domestic howzkhaneh (Fig. 4). These diagrams are analytical abstractions of the general type, not measured drawings of specific buildings.

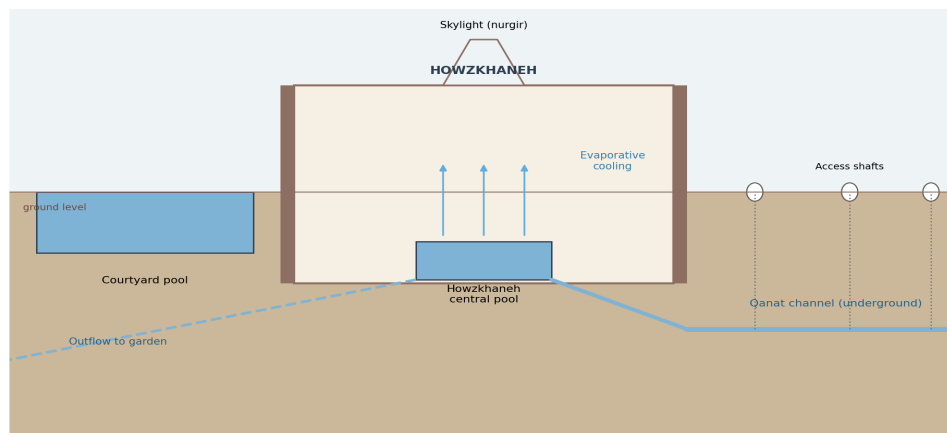


Figure 3: Schematic longitudinal section of a Qajar howzkhaneh, showing the qanat channel feeding the semi-subterranean central pool, the skylight, and the evaporative-cooling mechanism (Source: Authors).

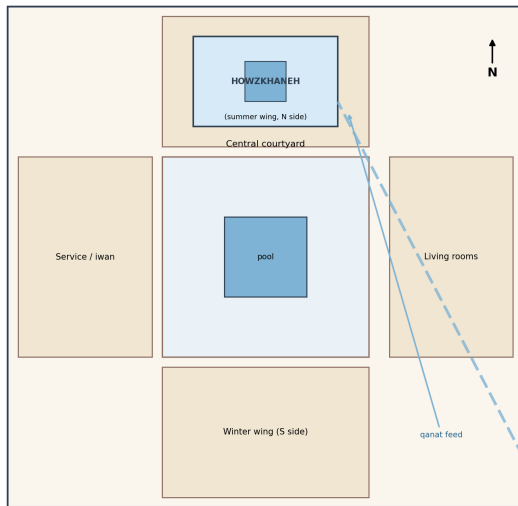


Figure 4: Schematic plan of a Qajar courtyard house, locating the howzkhaneh within the summer wing and its connection to the qanat feed (Source: Authors).

The reconstruction of the two water-supply regimes establishes the principal contrast on which the analysis rests. Isfahan’s supply was dominated by the Zayandeh-Rud and its Mādi network: a system of open canals carrying perennial surface water through the urban fabric under a codified regime of water rights, delivering water at or near ground level and in relatively continuous flow during much of the year (Fadaei & Esfanjary, 2017). Shiraz, without a comparable river, depended on qanats conveying groundwater from the surrounding plain, with covered reservoirs buffering the intermittent and volume-limited supply; water became available at the depth to which the qanat gallery descended beneath the city, rather than as surface flow (Beaumont, 1971; English, 1968). The contrast continuous surface flow versus intermittent, depth-dependent groundwater is summarized in Table 1 and represented schematically in Figure 6. (Tab. 1 and Fig. 5 and 6)

FINDINGS AND DISCUSSION

The water-supply context of the two cities

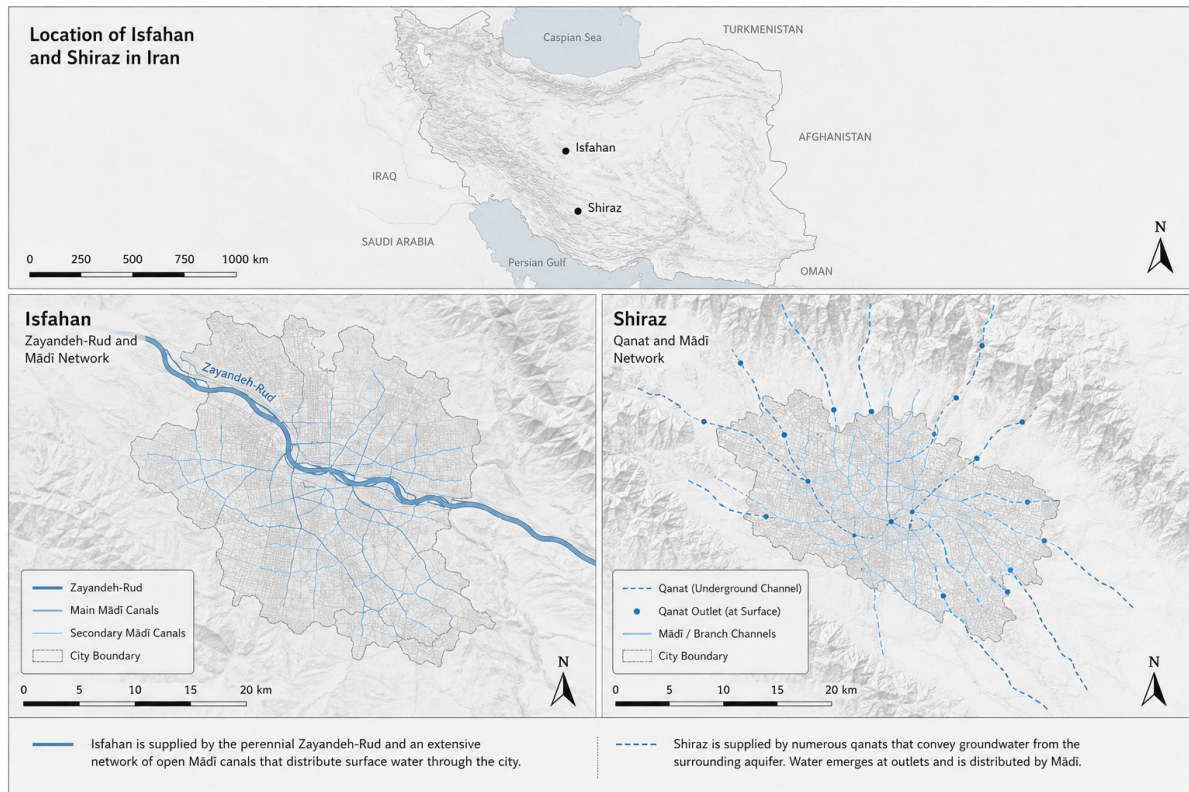


Figure 5: Location of the study cities and schematic representation of their traditional urban water-supply systems. The upper

panel shows the location of Isfahan and Shiraz within Iran. The lower left panel illustrates the Zayandeh-Rud and its network of Mādi canals that distributed surface water throughout Isfahan, while the lower right panel presents a schematic representation of the traditional qanat network of Shiraz, showing the underground water-conveyance system and its surface outlets supplying the urban fabric. The maps are analytical illustrations synthesized from historical and geographical sources and are intended to highlight the contrasting hydraulic contexts that shaped the architecture of the Qajar howzkhaneh in the two cities rather than to represent precise engineering or cadastral maps. (Source: Authors).

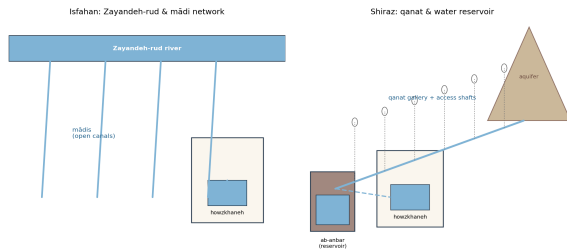


Figure 6: Comparative schematic of the two domestic water-supply regimes: Isfahan’s river-fed Mādi network (left), and Shiraz’s qanat-and-reservoir system (right), each terminating in the howzkhaneh (Source: Authors).

Howzkhaneh attributes and their relation to water supply

Relating the howzkhaneh's architecture to these regimes reveals a coherent pattern. In Shiraz, where water was reached at qanat-gallery depth and arrived intermittently, the howzkhaneh

tended to be set deeper below ground both to meet the water and to maximize the thermal inertia that compensates for a less continuous flow and to place strong emphasis on the evaporative-cooling and water-display function, since the pool was the precious terminus of a hard-won supply. The depth and the preciousness of the water are associated with elaborate ornamental treatment of the chamber, which became a showpiece. In Isfahan, where Mādi water flowed more continuously at shallower levels, the howzkhaneh could be shallower and more directly connected to the open-channel hydrology of the house and city, with the water element read as part of a continuous flowing system rather than a stored, depth-bound resource. These relationships are set out in Table 2. (Tab. 2)

Table 1: Comparison of the traditional water-supply systems of Isfahan and Shiraz (Source: authors, synthesized from the literature).

Attribute	Isfahan City	Shiraz City
Principal source	Zayandeh-rud (perennial river)	Qanats tapping the plain aquifer
Distribution	Mādi network of open surface canals	Underground galleries + reservoirs (ab-anbar)
Flow regime	Relatively continuous surface flow	Intermittent, volume-limited, buffered
Level of availability	At/near ground level	At qanat-gallery depth below ground
Governance	Codified mādi water rights (Shaikh Bahāṭ tradition)	Qanat ownership shares and reservoir endowments

Table 2: Comparative architectural attributes of the Qajar howzkhaneh in Isfahan and Shiraz in relation to their water-supply regimes (Source: Authors).

Howzkhaneh attribute	Isfahan city (Mādi / river-fed)	Shiraz city (Qanat / reservoir-fed)
Depth below ground	Shallower; close to surface flow	Deeper; reaching gallery level
Water configuration	Through-flowing, connected to channels	Pool-centred, fed and buffered
Cooling emphasis	Moderate; aided by airflow	Strong; reliant on evaporation + earth inertia
Relation to city network	Directly integrated with mādi flow	Mediated by qanat/reservoir, more self-contained
Ornamental emphasis	Present, integrated with courtyard	Pronounced; chamber as a showpiece
Continuity of supply	Relatively continuous (seasonal)	Intermittent; buffered by storage

A synthetic comparison across six analytical dimensions water-source reliability, continuity of flow, evaporative-cooling role, depth below ground, ornamental emphasis, and integration with the city network is presented qualitatively in Figure 6. The profiles diverge in a theoretically interpretable way: Isfahan scores higher on continuity of flow and integration with the urban network, reflecting the Mādi regime, while Shiraz scores higher on evaporative-cooling role, depth, and ornamental emphasis, reflecting the qanat-and-reservoir regime. The qualitative scoring is the authors' interpretive synthesis of the documentary evidence, not a quantitative measurement, and is offered as an analytical summary rather than an empirical dataset. (Fig. 7 and Tab. 3)

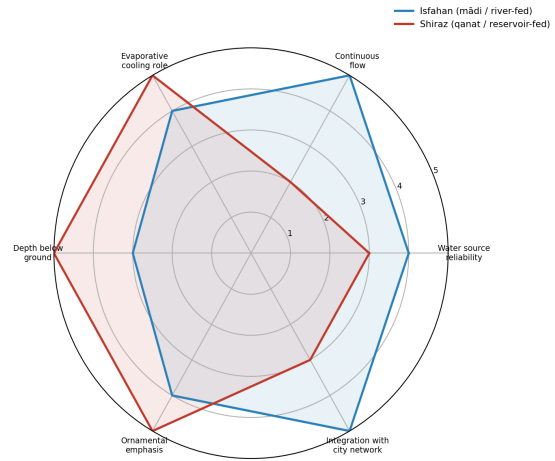


Figure 7: Qualitative comparative profile of the howzkhaneh in the two cities across six analytical dimensions (authors' interpretive synthesis; 1 = low, 5 = high) (Source: Authors).

Table 3: Summary of how specific water-supply factors shaped specific architectural consequences in the howzkhaneh (Source: Authors).

Shaping factor	Architectural consequence	More pronounced in
Depth of water availability	Depth of the howzkhaneh chamber	Shiraz city
Continuity of flow	Through-flow vs. stored-pool configuration	Isfahan city (through-flow)
Scarcity / preciousness of water	Ornamental emphasis on the water chamber	Shiraz city
Surface-canal urban hydrology	Integration with city water network	Isfahan city
Need for thermal compensation	Reliance on earth inertia + evaporation	Shiraz city

The comparative analysis supports a single overarching interpretation: the howzkhaneh is the domestic terminus of an urban hydraulic system, and its architecture is legible only in relation to the water regime that sustained it. The differences between the Shiraz and Isfahan howzkhaneh are not stylistic accidents but coherent architectural responses to differing conditions of water availability. Where water was deep, intermittent, and precious the qanat-and-reservoir regime of Shiraz the howzkhaneh descended to meet it, leaned heavily on evaporation and earth inertia for cooling, and celebrated the water it contained through ornament. Where water flowed more continuously at the surface the Mādi regime of Isfahan the howzkhaneh sat higher, connected more directly to the flowing network, and treated

water as part of a continuous urban hydrology. This reading aligns with the broader literature on Iranian water architecture, which emphasizes the inseparability of building and hydraulic infrastructure in the pre-modern city (Ardalan & Bakhtiar, 1973; Goblot, 1979), and it extends that literature by demonstrating, comparatively, that variation in the hydraulic regime produces systematic variation in domestic architecture. The finding also carries a contemporary implication: as both cities now face acute water stress the Zayandeh-Rud running dry for extended periods and the qanats of the southern plateau in decline the howzkhaneh stands as a record of a sustainable, supply-responsive architecture whose logic of matching built form to available water merits renewed attention (KeyNezhad et al., 2023; Soflaei et al., 2017).

RESULTS AND CONCLUSION

This study analyzed, comparatively, how the contrasting traditional water-supply systems of Shiraz and Isfahan shaped the architecture of the Qajar-era howzkhaneh. Four conclusions follow. First, the two cities represent fundamentally different hydraulic regimes: the intermittent, depth-dependent qanat-and-reservoir supply of Shiraz and the relatively continuous surface flow of Isfahan's Zayandeh-Rud and Mādi network and this difference is the principal variable distinguishing their domestic water architecture. Second, the howzkhaneh of Shiraz tends to be deeper, more strongly evaporative, more self-contained, and more ornamentally emphatic, as a coherent response to deep, intermittent, and precious water. Third, the howzkhaneh of Isfahan tends to be shallower and more directly integrated with the flowing Mādi hydrology of house and city. Fourth, across all the attributes examined, the architecture of the howzkhaneh varies systematically with the water-supply regime, supporting the interpretation of the howzkhaneh as the domestic terminus of an urban hydraulic system rather than an autonomous architectural type. The theoretical contribution of the study is to reframe the howzkhaneh as a hydraulically conditioned architecture, linking domestic form to urban water infrastructure through a structured comparison. The methodological contribution is the application of a comparative typo-morphological framework that isolates the water-supply regime as the formative variable. The practical contribution lies in recovering, for contemporary sustainable design under conditions of water scarcity, the principle that built form should be matched to the character of the available water supply. The study is subject to limitations inherent in its scope and method. The analysis is conducted at the level of the general type and synthesized from documentary sources rather than from systematic fieldwork on a sample of surviving houses; the qualitative comparative profile represents the authors' interpretation of that evidence rather

than measured data; and the schematic diagrams are analytical abstractions rather than measured drawings. Future research should test the typological relationships proposed here through measured survey of a documented sample of Qajar houses in each city, incorporate dynamic thermal simulation to quantify the cooling differences implied by the comparative analysis, and extend the comparison to other Iranian cities with distinct water-supply regimes in order to generalize the relationship between hydraulic context and domestic water architecture.

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