

### Correspondence

**Frishta AKBARI**

Faculty of Medicine and Health Care, Al-Farabi Kazakh National University, Almaty, Kazakhstan

Non-resident Research Assistant at the University of Central Asia, Kyrgyzstan.  
E-mail: farishta.akbari1512@gmail.com

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## Architectural Analysis of Water Supply Cisterns in the Old City of Herat, Afghanistan

**Frishta Akbari<sup>1,2</sup>, Abdullah Yazdan Panah<sup>3</sup>, Ahmad Suhaib Umrani<sup>4</sup>**

<sup>1</sup>Faculty of Medicine and Health Care, Al-Farabi Kazakh National University, Almaty, Kazakhstan

<sup>2</sup>Faculty of Engineering, Balkh University, Afghanistan

<sup>3</sup>Department of Environmental Engineering, Chandigarh University, India

<sup>4</sup>Civil Engineering, Kabul University, Kabul, Afghanistan

### Abstract

*The old city of Herat is an oasis located on the ancient silk road (trade route) in Afghanistan and has historically been replete with water supply cisterns. Using existing literature and interviews with residents, the paper attempts to reproduce the spatial analysis of water supply cisterns in the city and explain how the cisterns and their architecture developed. The typology of architectural forms is analysed for each of the three case studies of cisterns to clarify their historical development. Documents in Persian (Dari), satellite photographs, historical maps, and field surveys were used for the research.*

### Introduction

Herat lies on the ancient trade route, the Silk Road, that connects India and Iran (Fig. 1). A lack of water has always been an issue in the region due to the dry weather. Water management has been an essential component of planning since the beginning of the city's existence. According to documents, canal digging, Kariz (Qanat) construction, and water laws have been implemented here for at least 3,000 years [1]. In the 15th century, Hafiz Abru, a geographer, stated there were nine main canals called Bolook on two sides of the Hari-Rud or Hari-River [2], while Abu Nasr Heravi said there were ten Bolook [1]. Among them is the Injil Canal, which provided water to the old city of Herat (hereinafter the Old City) and its nearby villages. The Old City was supplied with water from the Injil Canal. Foreigners visiting Herat are fascinated by the significant buildings, including water supply cisterns dating back to ancient times [3].

Herat is well known for its cultural heritage and diverse architecture, both of which incorporate the city's unique architecture and history. Islamic urbanism has left its traces on the city's historical boundaries and properties [4-8]. The architecture and architectural styles used in Herat have evolved over the centuries. In addition, Herat City is considered one of the few remaining historic towns in the Islamic world as well as one of the models for Islamic towns in Khurasan [7]. The medieval Old City of Herat is the finest example of a traditional urban form still in operation, and it flourished as a typical Islamic city even till today [9,10].

Herat serves as a good example of how ancient architecture has survived and been preserved till today. According to UNESCO

(United Nations Educational, Scientific and Cultural Organization), Aga Khan Development Network, Sam, Norfolk, and Podelco, historic structures and urban design in the Old City of Herat have been identified as potential to become world cultural heritage site [11-16]. In recent years, uncontrolled expansion has threatened Herat Old City's traditional historic fabric. Increasing urban populations have led to the demolition of many traditional structures because of the dramatic transformation of Herat's traditional image, landscape, and identity by modern urban growth and housing [17-19]. In spite of the struggle that AKTC (Aga Khan Trust for Culture), UNESCO, the Turkish government, etc., have undertaken to preserve the architecture and landscape of the area, few studies have been conducted on traditional houses, cisterns, and mosques [5,4,20-23].

There has been very little research on cisterns in Herat, even though they have always been an essential facility. In 1916-17, German officer Oskar von Niedermeyer made a map of the Old City that marked 20 cisterns [24]. Heravi (1927-the 1980s) did the second comprehensive study of cisterns. In the 1970s, he completed a book about cisterns, but it was not published until 2005 after he had passed away [25]. In the book, 86 cisterns are mentioned in Herat province, and 16 are in the Old City. In addition, the book discusses where the cisterns are located, their origins, shapes, and how they were constructed. This book does not contain maps or photos. In 1984, Masoud Rajayee, a historian and poet, published in Herat-e-Bastan magazine an article demonstrating 16 cisterns with maps, explanations, and drawings, concentrating exclusively on the cisterns of the Old City [3]. An extensive study of Herat was

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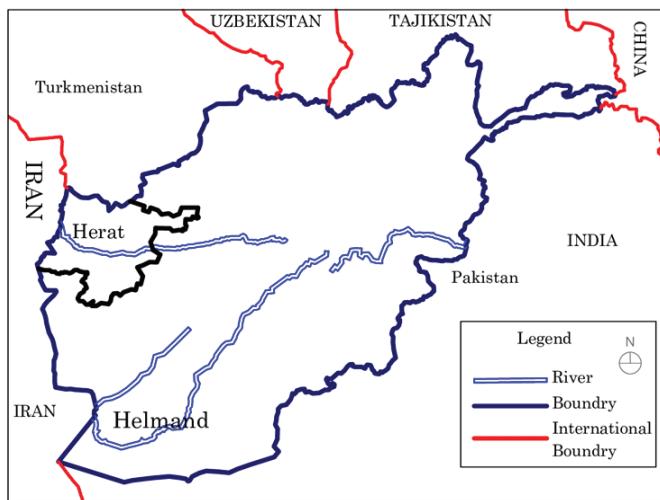


Figure 1. Study area, Herat on map of Afghanistan, by; AKBARI 2022.

conducted by Abdul Wasay Najimi in 1988, and a book called "Herat: The Islamic City" was published. Based on his map, he identified 22 cisterns [7].

In the 2000s, the Aga Khan Trust for Culture (hereafter AKTC) restored the Old City extensively. A major component of the project was the Herat citadel (Arg or Qala-e Ekhteyaruddin), the Gazergah Mausoleum, alleyways, houses, mosques, and cisterns. In the Old City, eight cisterns were restored by the AKTC, and they have all been well-maintained ever since. As a result of their research, a book entitled "Afghanistan: Preserving Historic Heritage" was published in 2017. This book includes information about the Malik, Wazir, Qazi, and Chaharsuq cisterns, including their history, characteristics, restoration processes, plans, and sections [26].

There have been a few studies on the architecture and typology of houses in Afghanistan, for instance has extensively analysed the typology of houses in terms of function of spaces and gathering places like Gozar centre, Mojama, and Takhtabam of a house, or a mosque [5]. Asim has comprehensively studied the architecture, and preservation of mosques, but has not focused on preservation of cisterns though his study on cisterns is very comprehensive and concise [27].

Although much research had been done on mosques [4,7,20,22], traditional houses, monuments, urban issues and management but no study had focused comprehensively on cisterns [5,18,19,23,28,29]. Finally, Asim and Ando 2020 conducted a comprehensive study of Herat's cisterns and located 26 cisterns on the map of the old city. The research included the historical background of all the cisterns and drawings of 11 existing ones. The study found a typology of cisterns as well as restoration of water supply networks in the old city of Herat.

This research aims to provide an overview of physical and architectural features. In determining the distribution, we use old Persian literature, historical maps, and satellite images; in determining the typology, we use measurements, photographs, and literature reviews. A major difference between these papers and previous ones lies in their comprehensive coverage of water cisterns in the Old City, which is accomplished by referring to previous studies and conducting field surveys and interviews. As a result of the establishment and restoration of these water cisterns and the development of water networks, this paper

discusses the Old City development process. In addition to maps of existing cistern locations and structures, this research also produced drawings of the cisterns themselves.

### Spatial analyses of cisterns

The Old City cisterns have been studied by several researchers previously described. A total of 26 cisterns were identified inside the Old City after combining, unifying, and mapping the findings [27].

A map of the Herat Old City by Niedermeyer shows 20 cisterns. In the Old City, Heravi discovered 16 cisterns without plotting them on a map. The hand-drawn map of Rajayee also produced the Old City map and illustrated 16 cisterns. According to Najimi's map of the Old City of Herat, there are 22 cisterns [7]. Based on Asim's comprehensive study, 26 cisterns were found in the old city map [27]. Among the 26 cisterns, eleven exist today (42%) and 15 have been destroyed (58%) as shown in Figure 2. Asim found details and historical information (text) on background of 18 cisterns, and only names for three cisterns numbered as 24, 25, 26 and no information or text for other five cisterns 13, 14, 15, 20, 21, and they are referred as unknown as shown in figure 2 [27].

### Case studies of cisterns in the study area

For the case study analysis, we selected three case studies of cisterns in the study area, which included the greatest number of components and demonstrated the most important dynasties of Herat. Malik cistern is constructed by Kurt Kings, Naqqashi by Timurids, and Chaharsuq by Safavids.

#### Case 1. Malik cistern

It is a brick-made structure with a domical vault roof located right in front of the western gate of the Ekhteyaruddin citadel, known as Arg-e Herat, in the Quzzat quarter. The cistern can be traced back to the citadel's construction in the 330s BC based on oral stories. Heravi [25] claims it dates to the era of the Kurt Kings, but other writers claim it originated during the Ghurid Dynasty (1149-1212). It was also reported that the Kurt Kings reconstructed it with their engineering skills. It was restored by Sadullah in 1485 after it was damaged during an earthquake that year (Heravi 2005). As a result of the restoration work

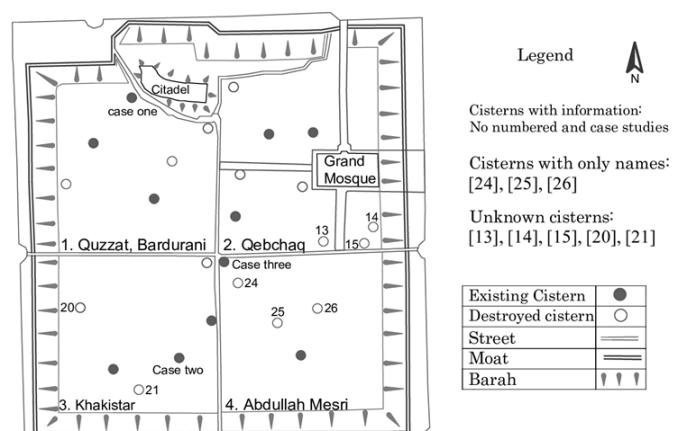
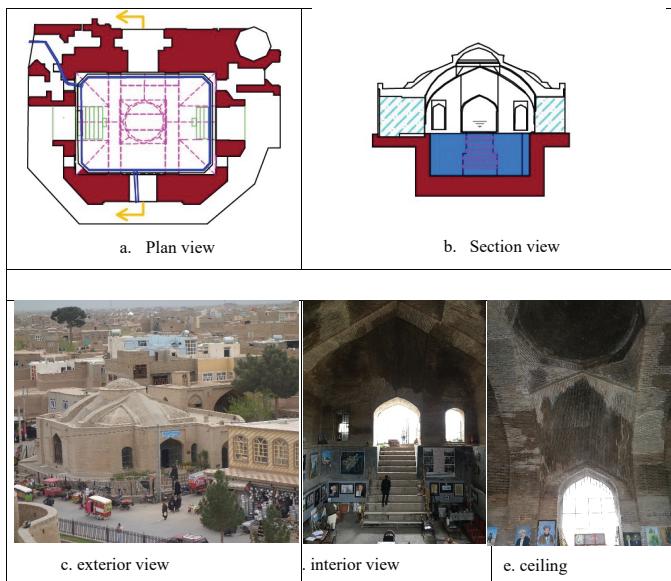


Figure 2. cisterns in the old city of Herat, source: Asim et. al 2020, reproduced with permission, 2023



**Figure 3.** Malik cistern, Source; Asim et. al 2020

performed by AKTC during 2005-2010, the structure is in good condition today.

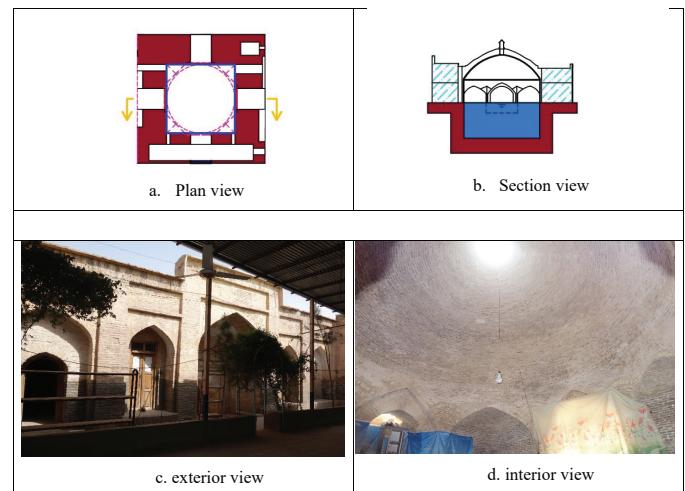
The roof has domical vaults supported by arches along its span length. There is a cupola on top of the roof of the Malik Cistern. For the Malik cistern, the cupola lacks openings for daylighting. Three-dimensional Muqarnas (vaults with ornament in Islamic architecture) and gypsum decorations are not observed in the ceiling. Among the building's features is a low-elevated Iwan (gate) with a vaulted roof, a characteristic of Kurt Kings or earlier structures.

The cistern has four entrance gates, two of which are used for lighting and two as entrances. In summer, the entrances of structures provide a continuous flow of air that keeps the water cool. Additionally, there are four tall shelves at the corners that serve as windows. There is a main entrance (main gate) on the northern side of the building, facing Malik Road (Jaddah). This water cistern (Fig. 3) has been the primary source of water for residents of Darb-e Malik [26]. The cistern is connected to Malik Road in the east by a mosque in the west. The reservoir is dug under the ground and is bordered by a 40 cm sidewalk, which is not observed in other types of cisterns in Herat (Rahraw). Stairs descend deep into the bed of the reservoir from both north and south directions, possibly for the convenience of residents in both alleys on both sides. Unlike other cisterns in Herat, the reservoir is elevated around 1.5 meters above ground level on the east side of the structure. As a result of the restoration work performed by AKTC in 2005-2006, the structure is in fair condition today.

### Case 2. Naqqashi complex

It is a brick-made, domed structure, located in the southeastern part of the Khakistar quarter, and originated during the Timurid dynasty. This cistern was built by Baisanqar Mirza (1435-50) during the Timurids. It is transformed into a mosque for educational purposes.

There are four Iwans in the cistern, of which two are closed and two are utilized for taking water, one for the mosque users and the other for the residents in the North of the building. During summer, the entrances of structures provide a smooth and continuous flow of air that keeps the water cool. The roof



**Figure 4.** Naqqashi cistern, Asim et. al 2020,

of the Malik Cistern contains a Bad-gir on its top. The roof is pendentive domed roof supported by circular belt which is lay on four arches of the four Iwans and four arches of the four pendentive corners.

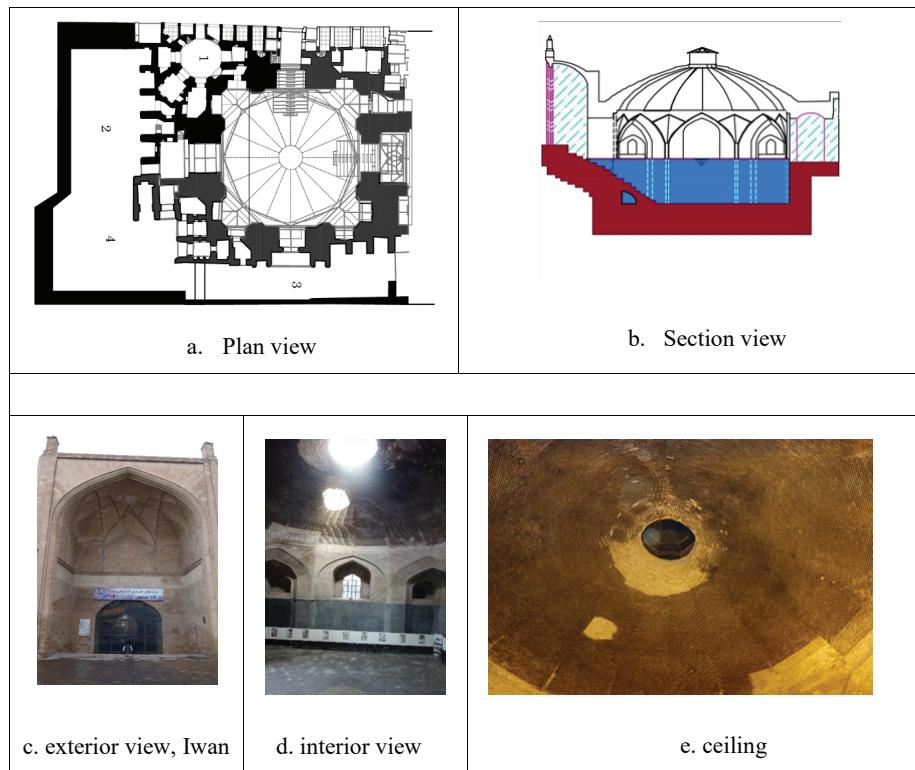
As the cistern is constructed during the Timurids, and the Timurids used Muqarnas and paintings a lot, three-dimensional Muqarnas and gypsum decorations were reported to exist even 50 years ago [25]. Images of government ceremonies were depicted on the ceiling and interior walls [25]. Among the building's features is a medium-elevated Iwan (gate) with a vaulted roof, a characteristic of Herat's Timurid structures. The surrounding residents have relied mainly on this water cistern (Figure. 2) as their main source of water [26].

### Case 3. Chaharsuq or Chaharsoo Complex

It is a brick-made, domed structure, located right at the centre of the Herat old city in the northwestern corner of the Abdullah Mesri quarter, and originated before Kurt Kings or Timurids, and modified during the Safavids [27]. Inscriptions indicate that Hasan Khan built this cistern during the Safavid dynasty in 1634. According to Heravi, this cistern was built on the site of an older one by Hasan Khan [25]. Before the Mongolian attack, according to some writers, a deep cistern existed in this place, which was later rebuilt by the Timurids [25]. According to Asim, Ando 2020, Among the cisterns in Herat, it is the largest based on volume, area, dome, and functionality. A rocket missile hit the cistern and caused a hole in the roof during the internal wars. In 2004-10, the Chaharsuq cistern was completely restored with traditional materials, and the structure is in good condition today [26,27].

The complex consists of a main building, a cistern and its equipment, Abresham Bazaar, and Qannad Bazaar. A large bazaar called "Abresham Bazaar" was built in the second quarter of the 19th century. This covered bazaar was constructed on the northeastern side of the Chaharsuq cistern, replacing an older construction [26].

The cistern has two entrances, one in the west and one in the north, from which water can be taken, whereas two entries in the south and east provide wind flow and observation spots. On the northern side of the structure is its main entrance (main gate). Cool air flows continuously through the entrances of the structure during the summer. Malik Cistern has a Bad-gir on top of its roof. The roof has pendentive domes. A pendentive domed



**Figure 5.** Chaharsuq cistern, Asim et. al 2020, Jodidio 2017

roof is supported by a circular belt laid on four arches of the four Iwans and four arches of the four pendentive corners. Unlike previous cisterns, this one has three-dimensional Muqarnas and a high elevated Iwan. This kind of Iwan according to Asim et. al [27] is a feature of the Safavid buildings. This water cistern (Figure 2) has been the main source of water for residents, shopkeepers, and caravanserais nearby [26]. A reservoir is dug beneath the ground, with stairs leading deep into its bed.

#### Typologies of the cisterns

As observed in the maps and mentioned explanation above, the typologies of the case studies based on their architectural features in the study area can be classified into two types and three periods (Fig. 3).

Cisterns of the first type have rectangular plans with domical vault roofs, dating from before the Timurid era (the Kurt Kings or earlier). Regarding the top of the roof, Cupolas appear to have been used before the Timurids and Bad-girs appear to have been used since the Timurids.

Cisterns of the second type have square plans with pendentive or squinch domed roofs which are features of the Timurids. The Timurid rulers brought the western (Nowadays Iran and Turkey) model of structures, squinch and the pendentive domes, to Herat, (Nowadays Afghanistan). Naqqashi shows characteristics constructed during the Timurids. Its square plan and ribbed, octagonal domed-roof features are from the Timurids. Another cistern of second type has a square plan with a domed roof with Bad-gir which is a feature from the period of the both the Timurids and the Safavids.

Kurts's dynasty cistern does not have elevated Iwan, Timurid

cistern has medium sized elevated Iwan, Safavids added large and high elevated Iwan. Compared to the Kurts, the cisterns from the Timurids and Safavids have more complex designs, used more artistic elements. It is due to the fact that the Timurids chose Herat as their capital for a long time, while the Safavids moved the capital to Isfahan and concentrated on its development. In addition, during and after the Timurids, suburban development in Herat advanced, and the urbanization of the Old City had reached its saturation point.

During the field survey, we took the photos of all the cisterns as much as possible. Even though the cisterns were demolished, damaged, or transformed to another shape, their photos were taken. Figure below shows the photos of each cistern in the study area, just added to record them for future generations to explore and do research, analyze, and understand using these figures.

#### Conclusion

There are two types of cisterns which come from three periods of dynasties. Cisterns of the first type are rectangular in shape and have domical vault roofs, a feature dating back to before the Timurids (the Kurt Kings). The second and third case studies belonged to the second type have a square plan with a domed roof which is a feature of the Timurids and also the Safavids. Another second type of cistern has a square plan with a domed roof with Bad-gir which is a feature from the period of the both the Timurids and the Safavids whereas this type of cistern is much larger than the Timurids, the capacity, dimensions, Iwan, rooms, dome, etc. are larger in size. It is possible to say that this kind of cistern is an enlargement of the Timurid cisterns. On the other hand, we can say that the Chaharsoo cistern is built

1. Malik cistern, constructed before Timurids	2. Naqqashi, Const.: Timmurids
Kashmariha	Pahawan
Wazeer cistern ceiling	Chaharsuq cistern interior
Sultan Sayed Ahmad Kabir cistern gate	Rokhband Facade
Shahzada (Zolfaqar Khan) cistern facade	Sarwar Cistern

Figure 6. Different views of cisterns, 2023

just during the Safavids but with Timurid engineering skills, masons, artisans, labors, etc. as the Safavids could construct in larger scale.

The Chaharsuq cistern is architecturally a Timurid structure although it was built during the Safavids, as it features resemble the Timurid architecture in Herat. The Safavids had come to power just after the Timurids and used Timurid engineering and also the technicians.

Herat requires further research on the preservation of its cisterns, mosques, and cultural landscape, as well as urgent studies on flood management and water supply needs. A study like that of [5] conducted in Kabul is proposed to address the pressing water supply challenges facing Herat, Afghanistan.

## Declarations

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

The authors have equally contributed to the paper.

All author(s) read and approved the final manuscript.

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