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REPRESENTATION OF WATER IN MUGHAL ARCHITECTURE: A CONTEXTUAL ANALYSIS OF SHALIMAR GARDENS, LAHORE FORT GARDENS AND WAH GARDENS

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ABSTRACT

Mughals demonstrated their extraordinary talent for fusing local culture with Islamic thinking. In Asian culture and architectural design, water has long been a key element. Both the Mughal gardens and historic buildings make extensive use of water as an architectural element. On a scorching summer day, water not only provides aesthetic pleasure but also provides isolated cooling. This paper focuses on water as a design element used not merely to make the gardens along the famed Grand Truck Road in Lahore more beautiful, but also to analyse the technological benefits of water. According to design research methods, the water analysis of gardens combines fundamental and applied methodologies. The study in this investigation demonstrate that Mughals used water as a famous representation of their unwavering power to control the temperature as well as for aesthetic purposes by creating lakes, canals, springs, fountains and pools.

Keywords: Shalimar Gardens, Lahore Fort Gardens, Wah Gardens, Water, Mughal Architecture

INTRODUCTION

The Mughal gardens initiated by the Mughal sovereign Babur were created until the late Mughal period. Their structural highlights discovered reverberation during the Sikh ruling period, turning into a part of metropolitan culture, and the convention proceeded in the parks of all little and huge Pakistani towns. These gardens were planned as architectural chefs-d'oeuvre design, yet additionally facilitated exercises that changed the way of life of urban communities across time. In that regard the Grand Trunk (GT) Road assumed a critical role (Wescoat, et. al., 1996). The GT Road extends among Bengal and Kabul, and despite the fact that it has lived in various shapes since vestige, the forerunner to the cutting-edge road was first spread out by the Afghan clan leader Sher Shah Suri in the sixteenth century. It was rebuilt several times by Suri and was extended later on in the time of Mughal and British era along a partly similar route. It begins in Kabul and goes through the Jalalabad and Khyber Passes, before arriving at Peshawar (present Khyber Pakhtunkhwa) (Rehman and Akhtar 2012). Moving south, it crosses the river Indus close to Attock and, going through Rawalpindi and Rohtas, it arrives at Gujrat subsequent to intersection the river Jhelum close to Sarai Alamgir. From Lahore, this magnificent interstate highway enters India, and after contacting Sirhind, it arrives at Delhi and proceeds towards Agra and beyond.

The Mughal emperors passed along it often, and every single one of them improved it by building public structures distinguished from one another at commodious distances. Nevertheless, giving a way to individuals and products/goods, the G.T road served paths for correspondence and transmission of thoughts, starting with one area then onto the next. Its whole length goes through an assortment of atmospheres, landforms, and topographical highlights. It navigates mountains, valleys, fields, and levels with assorted water highlights. Consequently, the presence of wells, normal springs, streams, and waterways gave significant component to the choice of garden destinations, just as a wellspring of life for them (Fatma, 2012) (Figure 1).

LITERATURE REVIEW

Landscape architects and microclimate control specialists, use water features such as water channels and fountains to a control in interior climates. The air temperature in the microclimate is moderated and regulated by water. Water not only adds an aesthetic element, it also passively cools interiors on a hot summer day. Evaporating water, cools the surrounding air, enhancing physical comfort. The precise zoning of the covered spaces, which enables strategically placed strips of water to circle the structure, and the area of water in contact with the air limits the rate of heat loss from moving air (Mittal 2012).

Air travelling over water generates evaporation, which results in heat being absorbed and the air being cooled, raising air humidity. Water features in courtyard, absorb solar energy and lessen summertime heat (Samadi, 2014). The idea is to direct winds away from the water pools and toward the building. Before it reaches the buildings, the breeze is channelled through the water in the fountains, where it picks up heat. Maximum-sized water feature in courtyards stores energy and lessens summertime heat. Additionally, water on a building exteriors has a propensity to evaporate. About 2500 joule of heat energy is lost for every gram of water that evaporates. Water evaporating from fountains in front of buildings dampens the surfaces and dissipates the heat from the sun. Beyond its psychological effects, the sound of water is calming and relaxing and its ability to balance and lower surrounding temperature is significant for human comfort (Fernandes and Correia-da-Silva 2007). Due to its stagnancy, a pool's water also mirrors the sky. Water not only has an impact on a person's psyche or aesthetic sense,

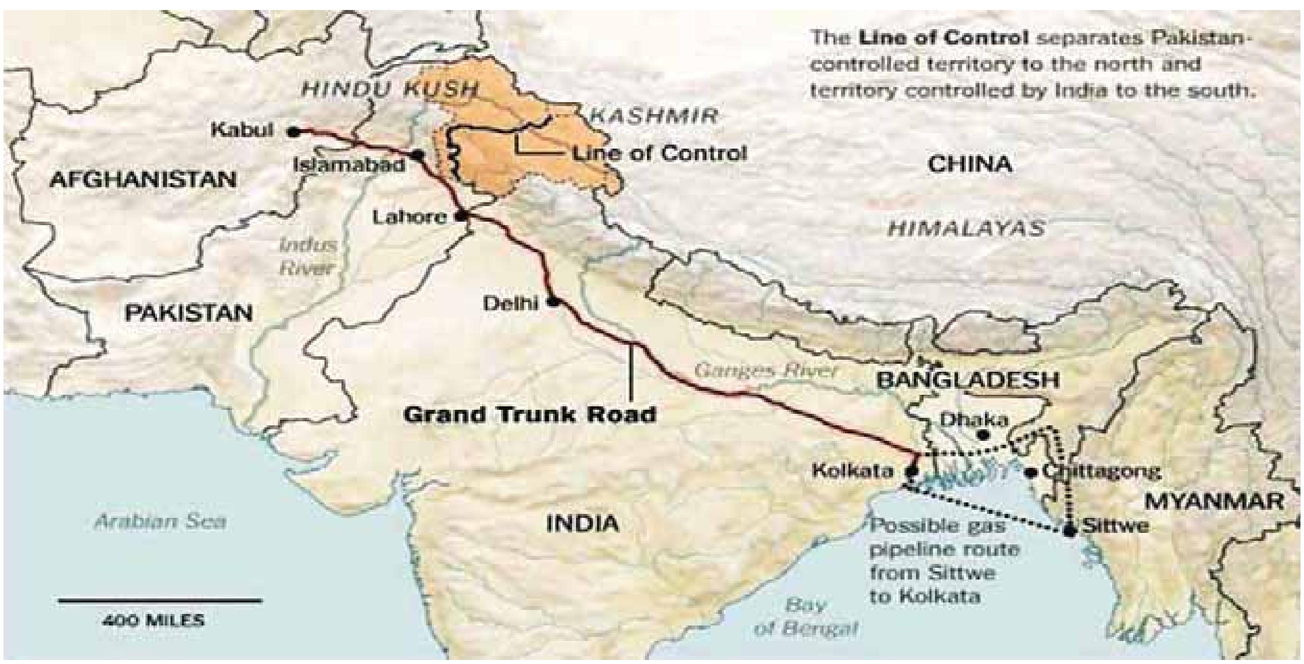


Figure-1: Grand Trunk Road.
Source: Khanna, 2014.

but it also has a notable impact on the hearing and visual sense. Other advantageous and useful elements of pools are their acoustic and aquatic properties. Water is a fluid that can considerably reduce the sonic energy in its variations. The water in a pool serves as a covert barrier that prevents sound from entering the building from the outside. A fountain in front of buildings not merely sets the temperature at a comfortable level and create wind low, but also aids in preserving a tranquil aesthetic and emotional atmosphere. Due to the position between wind directions, these provide their inhabitants with a peaceful and cool environment (Shokouhian, Soflaee and Nikkah, 2007).

METHODOLOGY

The selection of waterworks in the Mughal gardens depends on the past literature on the kinds of Charbagh under various Mughal rulers from the fifteenth to the seventeenth century. The data was assembled through a qualitative research approach and contained literary and visual investigation that enhanced the momentum of research work. The information was gathered utilizing a few field perceptions and condition evaluation studies of the Shalimar Gardens, Lahore Fort Gardens and Wah Gardens of the Mughal period. Qualitative meetings with the administration, experts and caretakers of the monuments were directed in relation to the set of experiences and past protection subtleties by the Department of Archaeology. The information was arranged through books, articles, websites and journals to fortify it further. Guidelines were taken from international charters and contextual analyses to detail an investigation of the chosen sites.

CLIMATE

Lahore has a semi dry climate with infrequent rainy disturbance, with hazy winters (30 November- 15 February). There is also a spell of monsoon in the summers. June is the hottest month, with typical highs that often reach above 40 °C (104.0 °F). The wettest month is July, which experiences heavy rainstorms in the evenings with a probability of downpours. January is the coolest month because of the heavy mist. On June 5, 2003, the city experienced its highest temperature on record, which was 52.8C (127.1F) (PMD., 2018) (Table 1).

Over the years the region of Lahore has also experienced changes in its weather and climatic conditions (World Weather Online, 2020). Figure 2 demonstrates the change in temperature during the years 2010-2020.

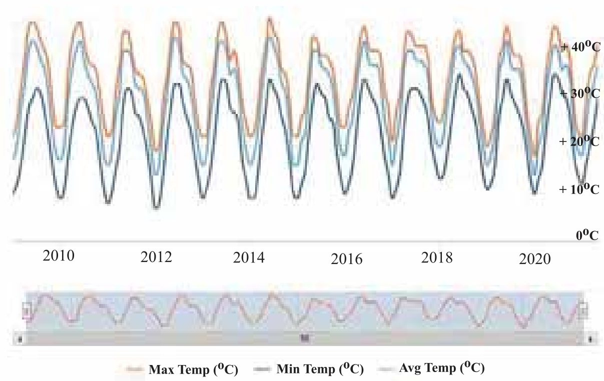


Figure-2: Temperature Graph for the Lahore City.
Source: Weather, 2021

Table-1: Climate data for Lahore (1961-1990), Extremes (1931-2018)
Source: NOAA, 2013

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	27.8 (82.0)	33.3 (91.9)	37.8 (100.0)	46.1 (115.0)	48.3 (118.9)	47.2 (117.0)	46.1 (115.0)	42.8 (109.0)	41.7 (107.1)	40.6 (105.1)	35.0 (95.0)	30.0 (86.0)	48.3 (118.9)
Average high °C (°F)	19.8 (67.6)	22.0 (71.6)	27.1 (80.8)	33.9 (93.0)	38.6 (101.5)	40.4 (104.7)	36.1 (97.0)	35.0 (95.0)	35.0 (95.0)	32.9 (91.2)	27.4 (81.3)	21.6 (70.9)	30.8 (87.4)
Daily mean °C (°F)	12.8 (55.5)	15.4 (59.7)	20.5 (68.9)	26.8 (80.2)	31.2 (88.2)	33.9 (93.0)	31.5 (88.7)	30.7 (87.3)	29.7 (85.5)	25.6 (78.1)	19.5 (67.1)	14.2 (57.6)	24.3 (75.8)
Average low °C (°F)	5.9 (42.6)	8.9 (48.0)	14.0 (57.2)	19.6 (67.3)	23.7 (74.7)	27.4 (81.3)	26.9 (80.4)	26.4 (79.5)	24.4 (75.9)	18.2 (64.8)	11.6 (52.9)	6.8 (44.2)	17.8 (64.0)
Record low °C (°F)	-2.2 (28.0)	0.0 (32.0)	2.8 (37.0)	10.0 (50.0)	14.0 (57.2)	18.0 (64.4)	20.0 (68.0)	19.0 (66.2)	16.7 (62.1)	8.3 (46.9)	1.7 (35.1)	-1.1 (30.0)	-2.2 (28.0)
Average rainfall mm (inches)	23.0 (0.91)	28.6 (1.13)	41.2 (1.62)	19.7 (0.78)	22.4 (0.88)	36.3 (1.43)	202.1 (7.96)	163.9 (6.45)	61.1 (2.41)	12.4 (0.49)	4.2 (0.17)	13.9 (0.55)	628.8 (24.78)
Mean monthly sunshine hours	218.8	215.0	245.8	276.6	308.3	269.0	227.5	234.9	265.6	290.0	259.6	222.9	3,034

Wah Gardens are located on the main GT Road, 50 kilometres to the northwest of Islamabad. Islamabad experiences four distinct seasons, including a lovely spring from March to April, from May to August is scorching summer, from September to October is autumn, and from November to February is winter. The hottest month is June, with average highs often topping 100.4 °F (38 °C). The wettest month is July, with a lot of rain and potential downpour-inducing night-time thunderstorms. With regional variations in temperature, January is the coldest month. Temperatures in Islamabad range from frigid to mild, frequently falling below zero. Snowfall on the hills is sparse. The temperature ranges are from 6.0 °C (21.2 °F) in January to 46.1 °C (115.0 °F) in June. June's average low and high temperatures are 2 °C (35.6 °F) and 38.1 °C (100.6 °F), respectively (NOAA, 2001) (Table 2).

The region of Wah has also experienced changes in its weather and climatic conditions (World Weather Online, 2020). Figure 3 demonstrates the change in temperature during the years 2010-2020.

SHALIMAR GARDENS

In 1641 AD, the Persian legislative leader of Punjab and canal engineer Ali Mardan Khan, conceived Lahore as a project and Shahjahan gave the go-ahead to create it. One of his initiatives was the construction of the Shalimar Garden, which was overseen by Khalilullah Khan, a prominent member of the court of the fifth Mughal emperor Shahjahan, in conjunction with Iranian architect Mulla Alaul Maulk Tuni and other notable individuals of the period. The Shalimar Gardens' location is around three miles higher east of the central Lahore city, next to Baghbanpura hamlet along the G.T road. The task was completed in a short span of one year, five months and four days by 1642. After the Taj Mahal, Shalimar Garden is recognised as one of Shahjahan's greatest achievements. It has served as a milestone through the development of Mughal garden design. According to several historians, Shalimar Garden is one of the most exquisite achievements of Mughal civilization (Nath, 1994).

Architecture Design and Layout of Shalimar Gardens

The Shalimar Gardens are a sprawling oval parallelogram surrounded by a high brick wall that is praised for its intricate fretwork. The design of this garden was inspired by *char-bagh* (four gardens). The gardens are around 16 hectares in area and stretch for 658 metres north to south and 258 metres east to west. Each terrace level is about 13 to 15 feet higher than the one before it. In accordance with the UNESCO Convention for the protection of the world's natural and cultural heritage sites in 1972, Shalimar Gardens and the Lahore Fort were combined as a UNESCO World Heritage Site in 1981 (Figure 4).

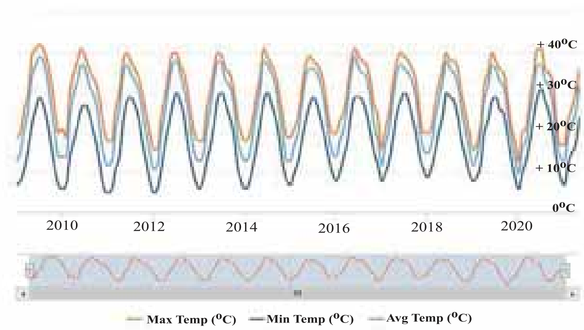


Figure-3: Temperature Graph for the Wah Area.
Source: Weather, 2021

Table-2: Climate data for Islamabad (1961-1990), Extremes (1931-2018)
Source: PMD, 2015

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	30.1 (86.2)	30.0 (86.0)	34.4 (93.9)	40.6 (105.1)	45.6 (114.1)	46.6 (115.9)	45.0 (113.0)	42.0 (107.6)	38.1 (100.6)	37.8 (100.0)	32.2 (90.0)	28.3 (82.9)	46.6 (115.9)
Average high °C (°F)	17.7 (63.9)	19.1 (66.4)	23.9 (75.0)	30.1 (86.2)	35.3 (95.5)	38.7 (101.7)	35.0 (95.0)	33.4 (92.1)	33.5 (92.3)	30.9 (87.6)	25.4 (77.7)	19.7 (67.5)	28.6 (83.5)
Daily mean °C (°F)	10.1 (50.2)	12.1 (53.8)	16.9 (62.4)	22.6 (72.7)	27.5 (81.5)	31.2 (88.2)	29.7 (85.5)	28.5 (83.3)	27.0 (80.6)	22.4 (72.3)	16.5 (61.7)	11.6 (52.9)	21.3 (70.3)
Average low °C (°F)	2.6 (36.7)	5.1 (41.2)	9.9 (49.8)	15.0 (59.0)	19.7 (67.5)	23.7 (74.7)	24.3 (75.7)	23.5 (74.3)	20.6 (69.1)	13.9 (57.0)	7.5 (45.5)	3.4 (38.1)	14.1 (57.4)
Record low °C (°F)	-6.1 (21.0)	-2.2 (28.0)	-0.3 (31.5)	5.1 (41.2)	10.5 (50.9)	15.0 (59.0)	17.8 (64.0)	17.0 (62.6)	13.3 (55.9)	5.7 (42.3)	-0.6 (30.9)	-4.1 (24.6)	-6.1 (21.0)
Average precipitation mm (inches)	56.1 (2.21)	73.5 (2.89)	89.8 (3.54)	61.8 (2.43)	39.2 (1.54)	62.2 (2.45)	368.0 (14.49)	334.5 (13.17)	122.2 (4.81)	29.3 (1.15)	17.8 (0.70)	37.3 (1.47)	1,291.1 (50.85)
Mean monthly sunshine hours	195.7	187.1	202.3	252.4	311.9	300.1	264.4	250.7	265.6	2275.5	247.9	195.6	2,945.8

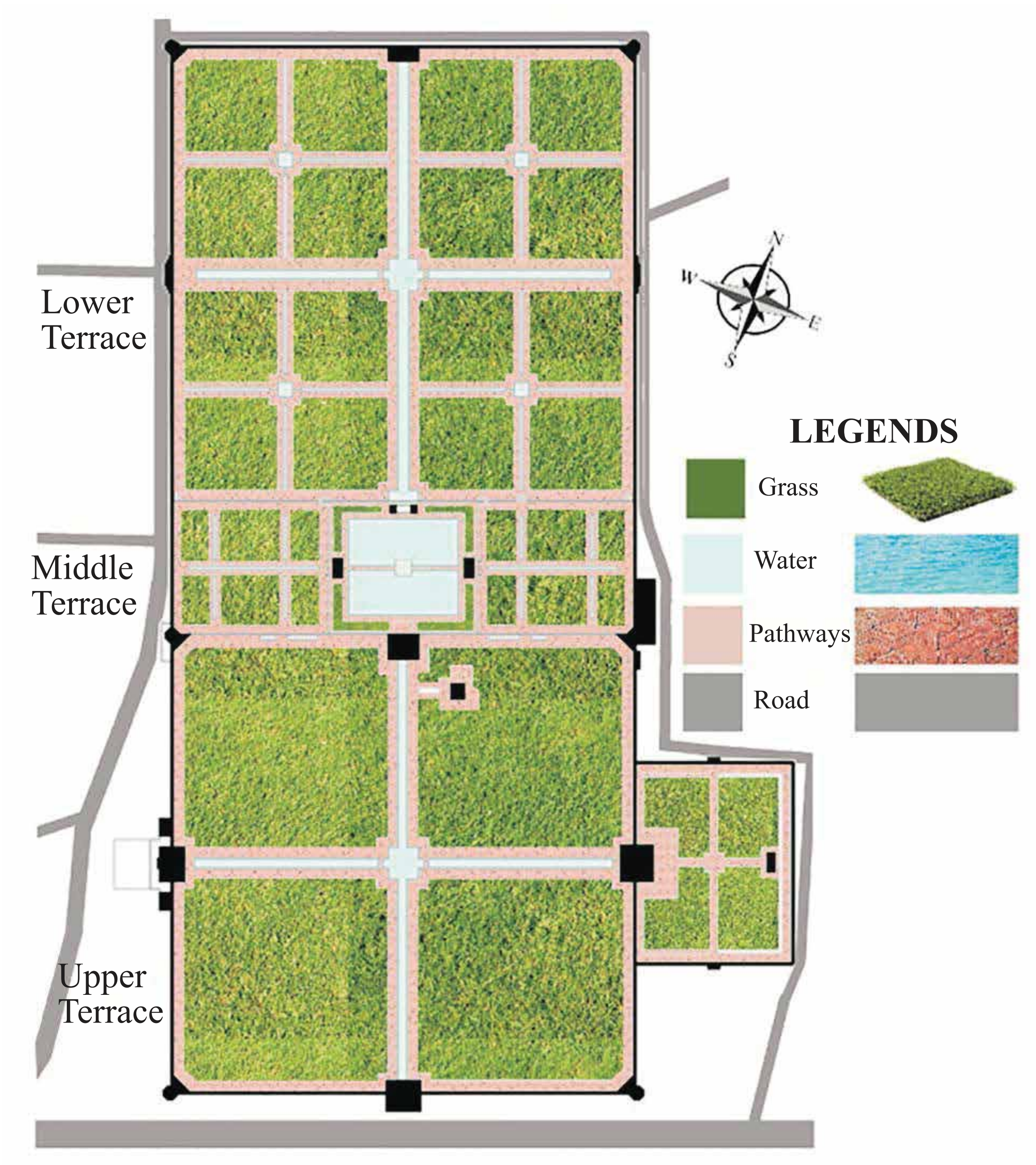


Figure-4: Master Plan of Shalimar Gardens, Lahore, Pakistan.
Source: Author

Three Terraces of Shalimar Garden

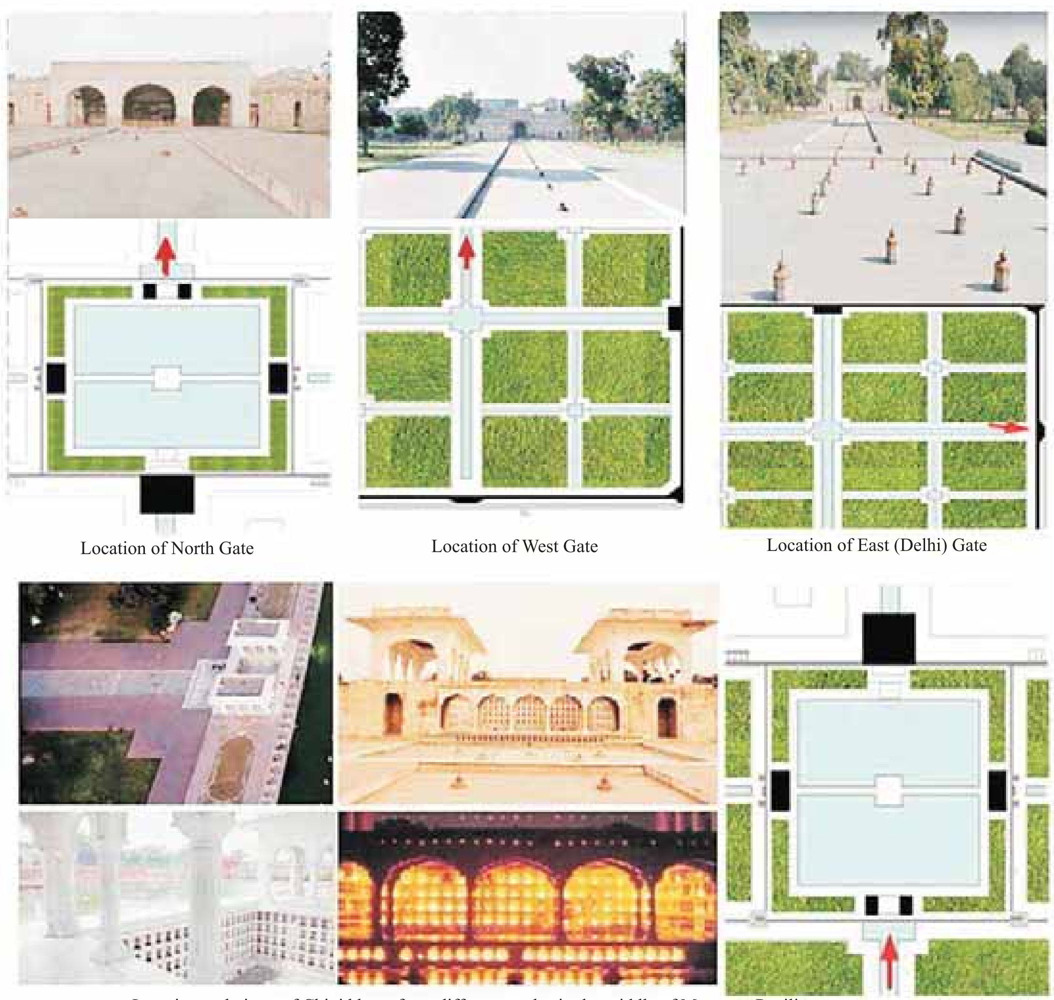
The Gardens are divided into three terraces that drop from south to north and are elevated by 4-5 metres from one another (Figure 5).

Detail of lower Terrace with the help of Plan view

There are four structures on lower terrace of Shalimar Garden (Figure 6).

Lower Terrace **Middle Terrace** **Upper Terrace**

Figure-5: Aerial View of Three Terraces of Shalimar Gardens, Lahore.



Location and views of Chini khana from different angles in the middle of Monsoon Pavilions

Figure-6: Perspective View of Buildings at Lower Terrace.

The various structures which are part of the overall composition of the garden are describe here.

1 Chini Khana: This is an elegant structure in the Shalimar Gardens, which was used by the emperors and the harem to enjoy the view from the monsoon pavilions. At nighttime it was lit in the traditional way. The position of Chini khana is in the middle of *Sawan Bhadon*, which has an entrance from the lower terrace.

Middle Terrace

2 Red stone Pavilions: Two red stone pavilions parallel to the *Mehtabi* (stage) were used by musicians at that time.

3 Throne: This was the royal marble throne of the emperor of that time, who used to sit and enjoy the dance performenes on the *mehtabi* (stage) infront of the throne.

4 Walkways: The square design-shaped terraces were both partitioned into four identical modest squares, using long fountains flanked by brick/walkways intended to raise the access and to give better views of the garden.

5 Cascade/Waterfall: This design element was cast on a marble path in what is called a *chadar* or "curtain" on the central terrace. The water gathered into a huge pool, known as a *haûz* in local language, over which a seating was designed red stone under a pavilion (Figure 7).

Upper Terrace

6 ***Aiwan**: Aiwan* is a private audience hall for meetings with special audience the emperor of that time.

7 ***Daulat Khana-i-Khas***: The place where emperor of that time used to meet with special audiences.

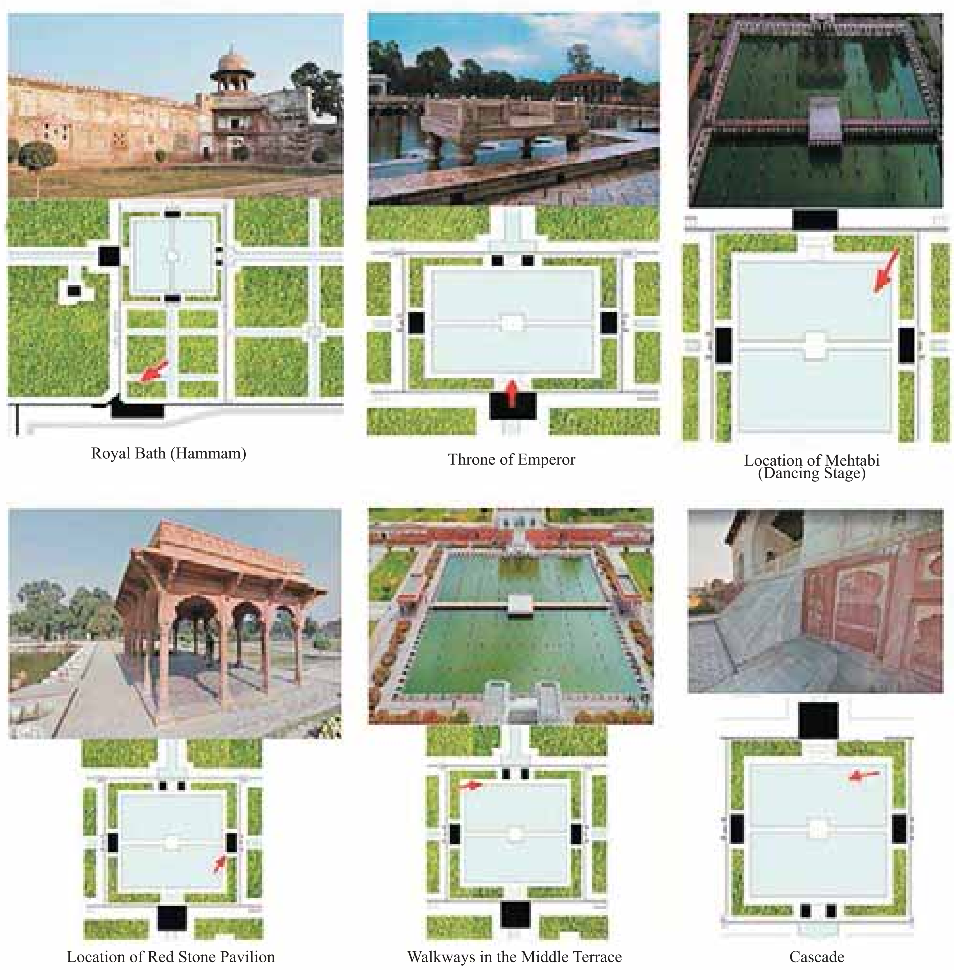


Figure-7: Perspective view of buildings at middle terrace.

8 **Moorcrof pavilion:** This pavilion also has underground residence. It was built by Ranjit Singh for the guest Moorcrof, he introduced himself as a medical doctor, but according to many historian she was spy (Figure 8).

IRRIGATION OF MUGHAL GARDENS

Irrigation of Shalimar Gardens

The water supply for the Shalimar Garden was designed by point architect engineer of the garden Ali Mardan Khan. He was the person who proposed to the emperor that water from Ravi river ought to be brought from Rajput (presently Madhpur in India) for the gardens. Within two years, a water canal named Shah Nahar (Royal Canal) stretching over 150 miles (242 km) was finished (Wahi, 2013) (Figure 9).

The middle terrace's enormous marble pool is where the canal, which cut through the gardens, was discharged. In addition, the hydraulic tank system was completed in 1644. The Shalimar Gardens in Lahore are specifically designed to serve as an example of how the Mughals constructed their buildings and gardens close to waterways or water sources and were subsequently prepared to draw both water and cooling benefits from an intentional hydraulic tank and irrigation system. This system, incorporated the use of

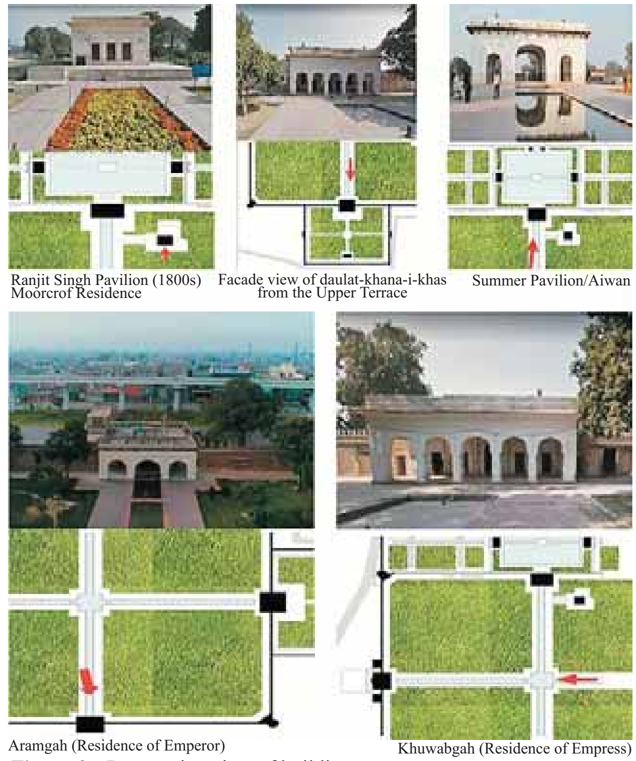


Figure-8: Perspective view of buildings at upper terrace.

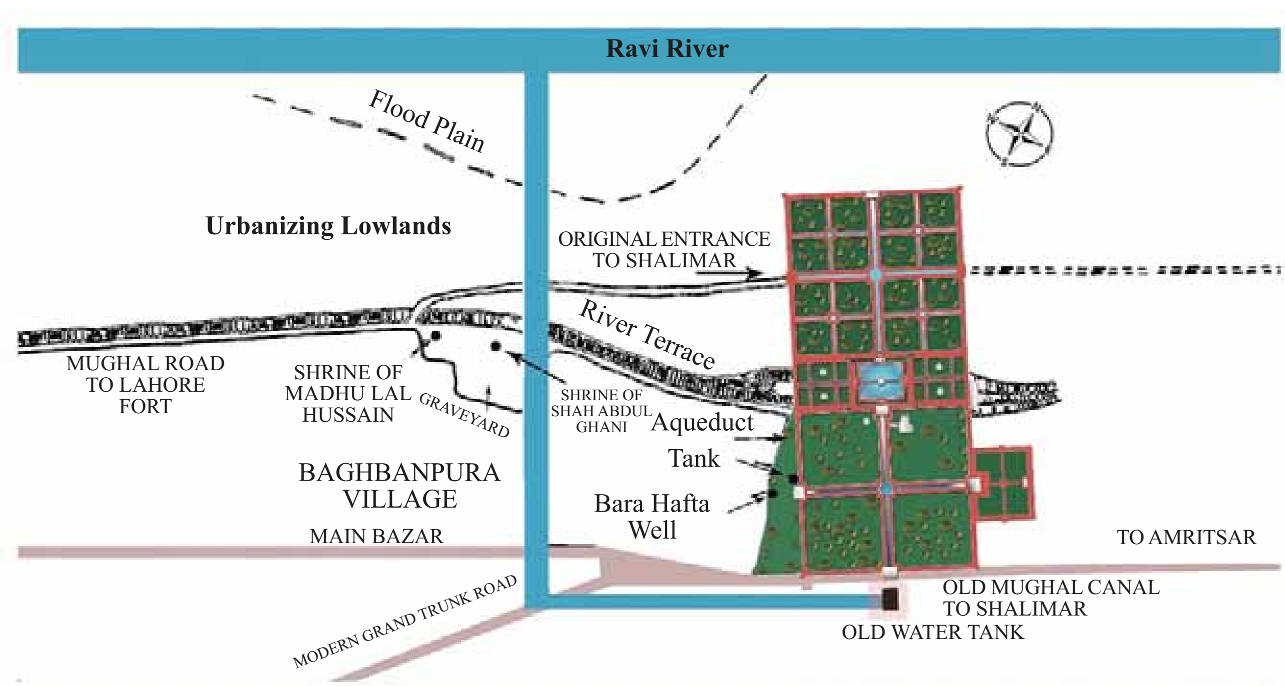


Figure-9: Water Canal from River Ravi for Irrigate to Shalimar Garden.

gravity and lifted the water through numerous dispersion mechanisms (Figure 10).

This system provided for the water arrangements in step-wells and reservoir conduits. For instance, at the Shalimar Gardens in Lahore, where the *baoli* (stepwell) is located, which is at the bottom of the park, it works as the primary supply of water. The water level was raised from one level to multiple additional levels or tiers. According to Fraenkel (1986), the mechanism for raising water is based on the development of the water wheel, also known as the Persian rehant system (Fraenkel 1986). Wheels with shafts that were propelled by either people or camels were found inside the *baolis*. Thus, up until the next stage of the waterworks, these wheels pivot the poles that drive a belt of clay pots that are filled with water (Fraenkel, 1986) (Figure 11).

The Mughals adopted the Persian wheel mechanism for lifting water from the well which had a source connected with river Ravi. Later on, the British made revit reservoir tank and after 1947 when Pakistan came on the map of world, concrete tanks were built at the same place. None of these exist today. They were existing till 2010. These time periods are mentioned in figure 12.

For agricultural and water-based cultural and economy, the Mughal gardens water supply systems have been referred to as the "aesthetic distillate" of the ancient Mughal civilization (Petruccioli, 1998: 351). These have evolved into several kinds of octagonal pools and gardens within squares and patios of urban buildings.

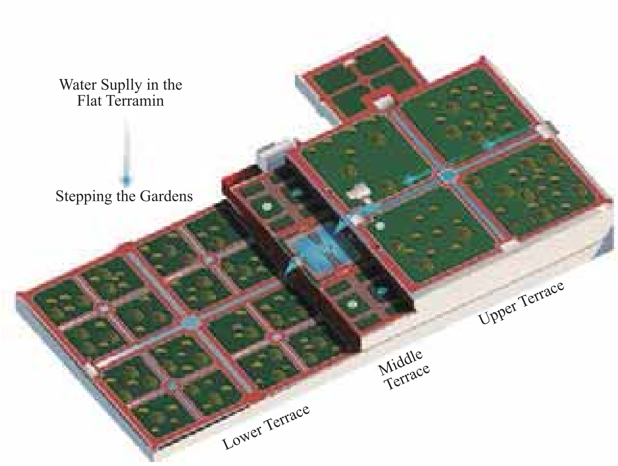


Figure-10: Stepping of Water in Shalimar Gardens Via Hydraulic Tank.

Figure-11: Aqueducts and Water System Raising Mechanism at Shalimar Gardens Lahore.

Figure-12: Irrigation System of Shalimar Gardens During Three Periods.

The original Persian *charbagh* is where such water frameworks originated. Figure 13 depicts the urban water to ground components of several Mughal gardens inside a defined limit. Its water to ground ratio is calculated, while expressing the amount of exposed water and ground zone that are located inside a specific boundary. Although the spatial morphology can be open or enclosed, its ratio is theoretically related to the solace level attained, which was dependent on the size of its water pools. This was placed within an enclosed boundary with less exposure to solar radiation facing high wind speed, especially during the summer. According to the investigation, the water-to-ground ratio in the courtyard of Shish Mahal is believed to be around 1:6, but it is predicted to be around 1:4 in the patio of Shalimar Gardens.

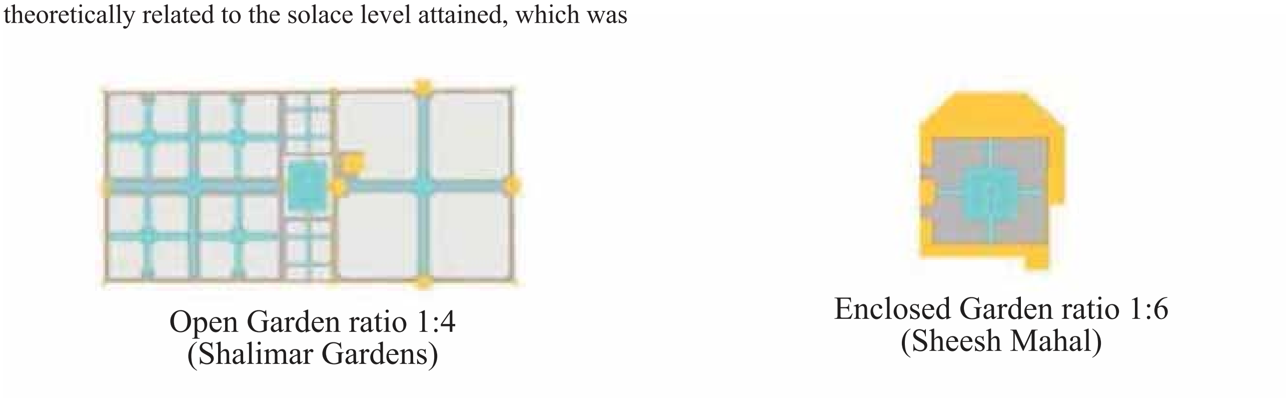


Figure-13: Morphology Configurations Charbagh (Gardens) and its Water to Ground Ratio.

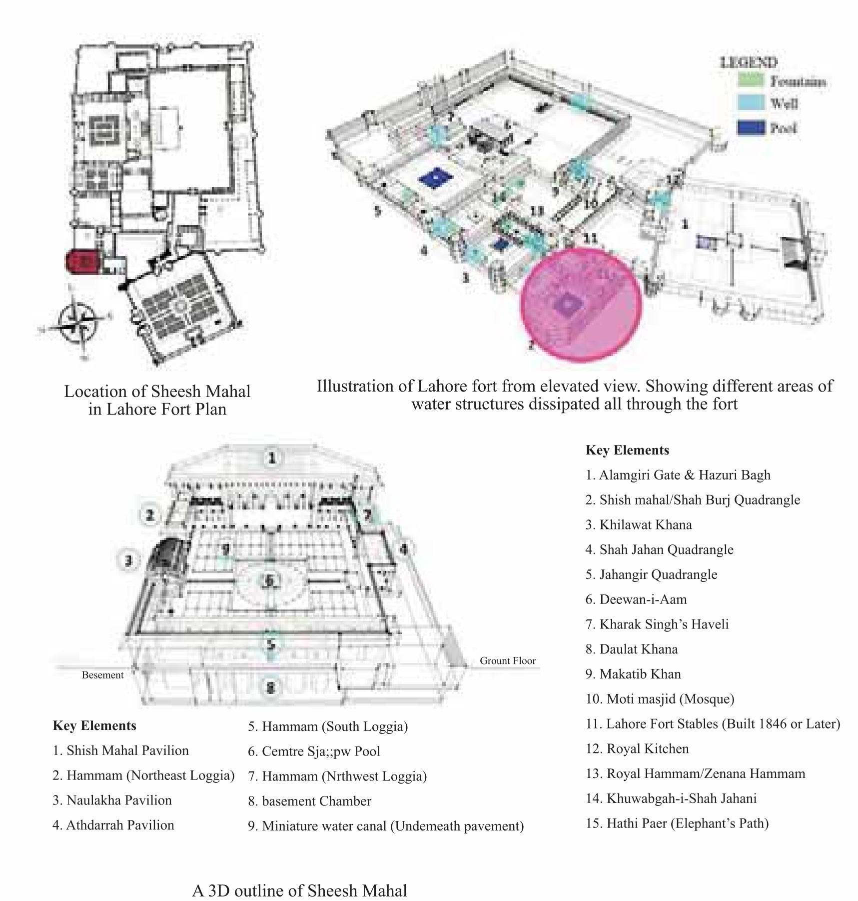


Figure-14: Water Flow Representation in Lahore Fort.

Sheesh Mahal, Lahore Fort-Pakistan

Variant Names

The Sheesh Mahal, commonly known as the "Mirror Palace," within the Lahore Fort was officially approved by Emperor Shah Jahan in 1631 and completed in 1632 under the direction of Asif Khan (Kamran, 2016).

Like all quadrangle designs, so frequently planned with a central pool at the centre, the shallow round pool of the Sheesh Mahal courtyard stands in contrast to others. The pool has a depth of 15cm and a width of 16m by 16m with a central decorated platform (called *mehtabi*) in the middle. It is decorated with pietra-dura using semi-precious stones, such as jade, agate, lapis lazuli, carnelian and chalcedony. Pietra dura or Pietre Dure is known as *parchin kari* in the Indian subcontinent. is a term for the inlay technique of using fitted, highly polished colored stones to create images. It is an ornamental art. The patio is developed into four quadrants of four narrow water channels where the southern channel is used as the sole inventory of water for the central shallow pool. The living rooms are cooled by means of *chadar* (water wall).

Structures at the Lahore Fort are arranged around an open forecourt that is covered by a variety of marble types. The courtyard previously boasted a sophisticated drainage system with water channels on each of its four sides and fountains that fed into a small circular pool of water in the middle. The marble *mehtabi* (stage), located on the middle terrace, is in the center of the swimming pool. A circular area in the middle of the patio is filled with water from a cascade (*chadar/abshar*) carved into the south wall. A sizable subterranean area beneath the quadrangle functioned as the Empress's summer residence (Figure 14 and 15).

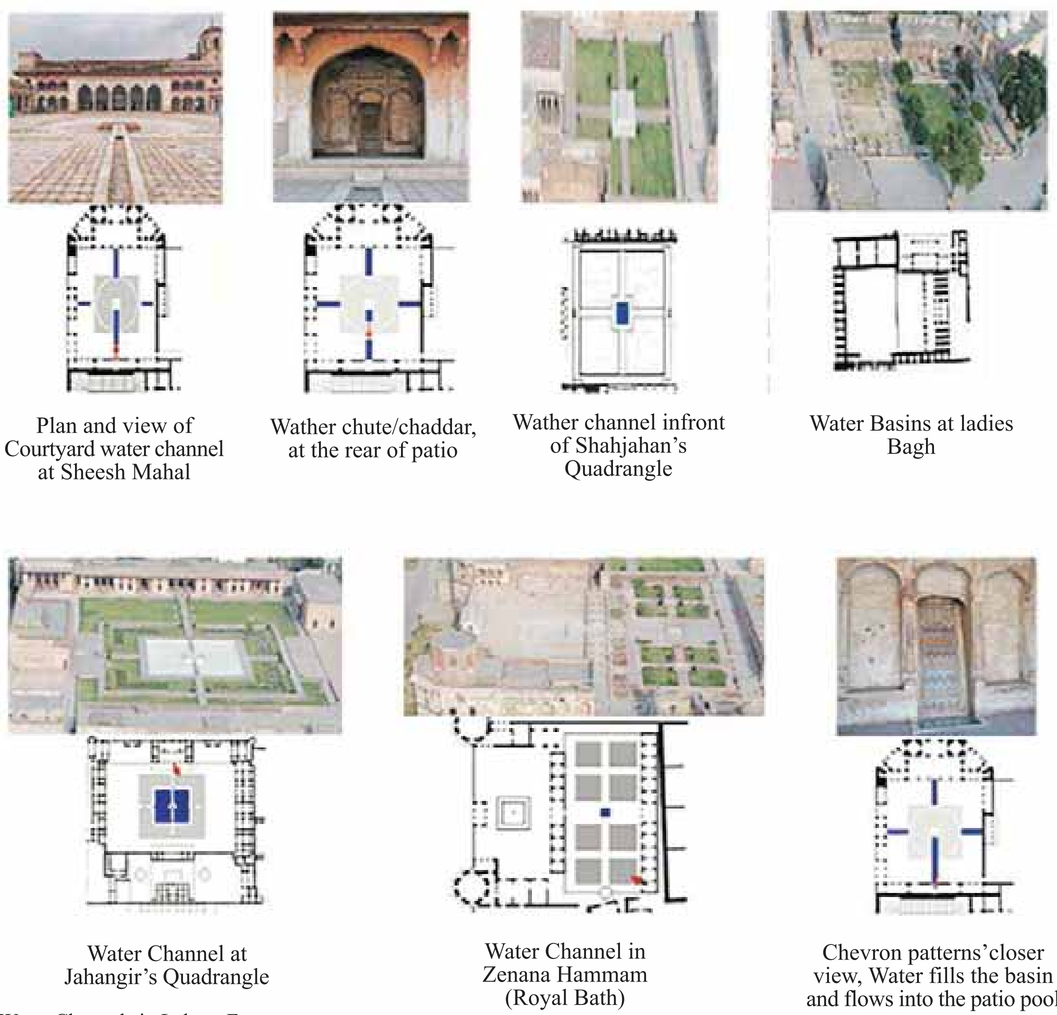
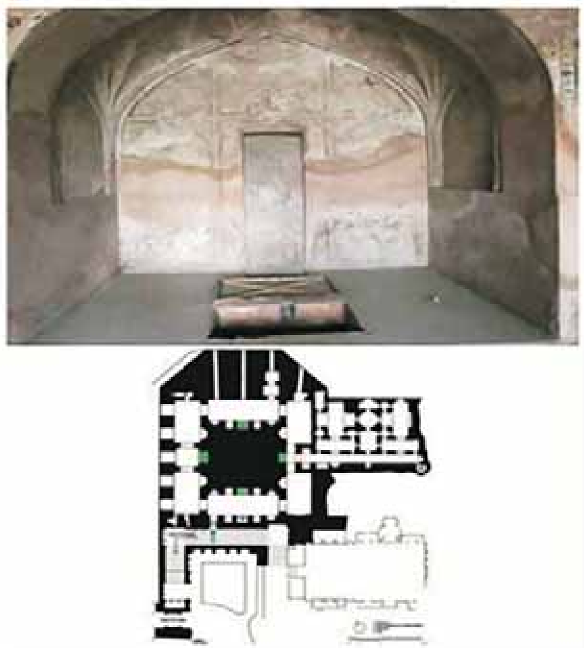
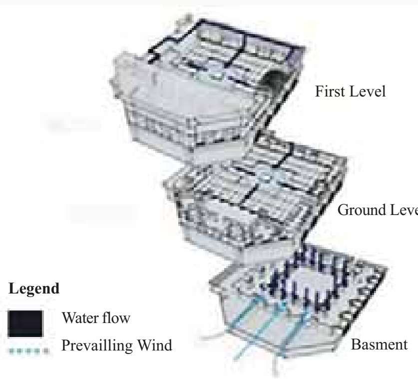


Figure-15: Water Channels in Lahore Fort.

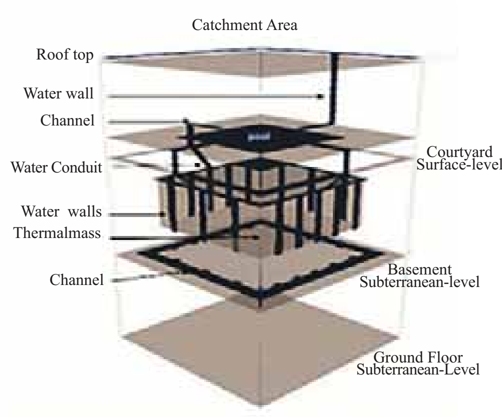
The *salsabils* of the summer palace (the basement of the Sheesh Mahal) are fed water through the fountain that is located on the patio above, in contrast to the traditional *chadars* or water chute or *salsabils* (a water distribution kiosk), where the pressure of the water is created by the marble slab and fed into a central fountain. A salsabil (or salasabil, also known as a shadirwan, is a type of funtain that maximizes the surface area of the water. It is used for evaporative cooling of buildings, cooling and aeration of drinking water and ornament (it has also been used to prevent eavesdropping. The water may flow in a thin sheet or thin streams, oftern over a wavy surface with many little waterfalls. Its use extends from southern Spain through North Africa and the Middle East to Northern India. The salsabil was connected to the fountain of the patio of Sheesh Mahal through a water spout that opened up in a nook of the summer palace and allowed the water to stream over the marble slab. The fountain of the Patio of the Shish Mahal kept the rooftop cool. By making the dry air come through the *mashrabiyas* more humid, water from the *salsabils* cooled the interior of the summer palace (Figure 16).



Location of Salsabil in the basement of Sheesh Mahal



Location of narrow wind tunnels at the basement and conceptual water flow illustration at three-floor levels



The water channel system of Sheesh Mahal connected with the upper fountain tank at the courtyard

Figure-16: Water Channel in Sheesh Mahal Building.

Wah Gardens

As one continues on the GT Road west of Lahore, past Islamabad one arrives at another Mughal garden close to the town of Hasan Abdal, at "Wah," which can be translated as “Wow/Amazing.” After observing the crystal-clear rivers and picturesque surroundings, the third emperor of the Mughal empire is thought to have given the name "Wah" to this place. Even though Hasan Abdal's springs and sites of devotion have a considerably longer history, the location and its gardens are primarily documented in detail by the fourth Mughal emperor, Jahangir. Aurangzeb, the sixth king, ruled the region for more than a year.

Clear, chilly springs that collect water in a sizable square tank on its upper terrace take care of the Wah gardens. The water initially flowed down a sloping cascade/chaddar that was decorated with a typical Mughal dark-and-yellow marble chevron pattern, past two flanking pavilion constructions, one of which housed elaborate shower rooms (*hammam*). The water moved through a pivot in the garden that was lined with cypress trees, a middle water tank and stage, and finally reached the main entrance of the garden. Part of the garden was discovered and rebuilt by the Department of Archaeology, and analysts have described its experiences, spatial layout, and highlights (Rajput, 1996). Due to its location on a major route and its similar spring-fed, terraced architecture, Kausar (1990) suggests it may be an example of modern Mughal garden design in Kashmir (Indian Occupied Jammu and Kashmir) (Figure 17).

Figure-17: Water Representation of Wah Gardens, Hasan Abdal , Pakistan.

Conclusion

Human life depends on water in many ways. It serves as a skeleton that is important in many communities and schools of thought. Water occupies a special place in architectural engineering from both a logical and expert standpoint. According to the exploration's findings of this research, water features like fountains and water channels were included in the case studies to maintain a comfortable interior temperature. Water absorbs the warm radiation as air flows over the water bodies. Along with its greatness, water also possesses a mysterious ability to reveal itself through sight and sound. It has a good impact on human audio and visual characteristics in addition to psychology and aesthetic sense. As a result, the Mughals exploited water not just to improve the area's beauty but also to deal with its climate. Therefore, the Mughals' use of water in their gardens is still a striking example of their unwavering architectural ability in maintaining and regulating the temperature as well as beautifying the area through lakes, fountains, canal water channels and pools.

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