

Historical Water Infrastructures of Hanuman Dhoka Durbar Square

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Abstract

The country of Nepal was united and divided in its several phases. When divided, the country had many small principalities along with their respective palaces as well. Accordingly, the valley of Kathmandu was also divided into three kingdoms. Hanuman Dhoka Durbar Square was the palace of Kantipur and the unified country of Nepal as well and is now accorded a UNESCO world heritage status due to its art, architecture, intangible culture and so on. Despite the prevalence of many research on several aspects of the palatial complex, none accounts the historical water infrastructures of the palace complex. In this context, an exploratory research to identify historical water infrastructures and to understand their use cases explores the palace in new way through this research. Data is collected basically through observation and photography of each are provided as solid evidence. The use cases of each infrastructures are collected through interview and observation as well. From this research, it is identified that there are in total four stone spouts, of which two are copper plated; six Jahruhiti, two ponds, seven wells, five toilet basins and not a single historical kitchen could be located from the palatial complex. Majority of the land-use inside the palace is rendered impermeable due to stone pavement joined with modern concrete expect for four courtyards that possess brick pavements and two zones are fully permeable. In three instances rainwater harvesting is performed. The use cases of Jahruhiti in modern time is obsolete but in history acted as water tanks for public which was filled manually. Among four stone spouts, two were sources for the pond and other two was used for ritual and worship purposes. Some wells served ritual worship to their respective temples while others were used for general purpose.

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Introduction

In early years Nepal was one and the seat of power in the form of government was in Kathmandu valley. Several dynasties such as Gopal, Mahishpal, Kirat and Lichhavi built their palaces here. The palatial complexes of the Gopal, Mahishpal and Kirata are not yet been located and neither have they left any literary evidence of their existence. Although the palaces of Lichhavi period are not in existence now, the whereabouts of Managriha, Kailashkut and Bhadradiwas have been surmised by several early scholars and tried to conclude by others on the basis of faint indirect evidences from inscriptions of Lichhavi period (Bajracharya, 1996).

After the downfall of Lichhavi dynasty, the center in Kathmandu valley began to loose its political clout and thus resulted in formation of Khasa Kingdom and Simraungarh with their own respective palaces (Nepal, 2005). Yet, the palace in Bhaktapur was the seat of power of Nepal till its division in the second half of the medieval period. More than 50 small states and their respective palaces was the new normal. Similarly, the valley was also divided and saw three major power centers in Kantipur, Bhaktapur and Lalitpur.

Ratna Malla, the son of Yaksha Malla, guided by his intentions to become king severed ties with his elder brother in Bhaktapur along with the kingdom and started anew in Kantipur. The existence of his palace is somewhere north of the present day Hanuman Dhoka Palace in Hiti Chowk (Slusser, 1998, as cited in Tiwari, 2012). One of the early structure has been laid by King Mahendra Malla to build the temple of Taleju (Tiwari, 2012). However, major contribution to the formation of present structures in Hanuman Dhoka palace square should be provided to King Pratap Malla and kings later to him. The name Hanuman Dhoka palace was also coined after the placement of Hanuman statue at the western entrance gate of the palace by King Pratap Malla. The latest addition in galore of the complex is Gaddi Baithak built by Chandra Shamsheer during the reign of King Prithvi Bir Bikram Shah (Vajracharya, 1976).

Hanuman Dhoka Palace or Kathmandu Durbar Square is an amalgam of several ideals of material and non material cultural heritages. Baskota (2025), Shrestha (2025) states in unison, the development of this palatial complex was an ongoing process from Lichhavi period to Shah period in terms of both physical constructions and intangible elements such as festivals, rituals and ceremonies of several kinds with complex interconnections. Vajracharya (1976) provides the detailed list of festivals and ceremonies that are centered around the complex or is an important part. They are: *Rajyarohan*, *Rajyabhishek*, *Dumaju Jatra*, *Nuwakot Bhagwati Jatra*, *Kumar Khat Jatra*, *Gaijatra*, *Changunarayan Jatra*, *Indradhojotsav*, *Indrajatra* and *Kumari Jatra*, *Pachali Bhairab Jatra*, *Dashain*, *Guhesworiko*

Jatra, Basantashrawan and Fagu. Khatiwada (2024) states, as any palaces, Hanuman Dhoka palace is constructed as a fort to ensure the security of the King and the royals which gradually accumulated several courtyards and other elements from Lichhavi till Shah period.

All beings need water to survive. However, humans not only use water for drinking but also for several purposes such as cooking, cleaning, cleansing, purification, worship, displays and so on. The historical settlements of Kathmandu valley created a system of water infrastructures for collecting, distributing, delivering and drainage to quench their need of water. Pond or a catchment area is used as collection zone, canals distributed water, wells and stone spouts delivered water inside the settlement and the drained water is either recollected or channelized to the nearby river (Joshi, 2022). In historical period, each well and stone spout was designated according to the social hierarchy and the use by people not belonging to the hierarchy was prohibited and punished. King and the royal family being at the top of the hierarchy had their own private water related infrastructures built for them inside the palace. Similar to palaces of Bhaktapur and Lalitpur, Hanuman Dhoka palace also had its own water infrastructures inside the palace premises.

In this regards, this paper aims to enlist and explain the water infrastructures inside the palace of Hanuman Dhoka along with their uses. The paper identifies geographical setting of the location of the palace in comparison to the historical settlement, followed by the land-use pattern in the palace, inventory of all the stone spouts, wells, Jahruhiti, historical toilets, sewage system, chamber of worship, water harvesting mechanism and also the architectural synecry to address the precipitation. the use cases of all the water infrastructures are also elaborated. The results are further analyzed in the section of discussions and finally a conclusion is presented.

Research Objectives

Major objectives of this research are:

- To identify and explain water infrastructures of Hanuman Dhoka Durbar Square
- To analyze the uses of those water infrastructures

Research Methodology

For the purpose of this research, the reality is identified as the existence of water infrastructures that are necessary for living and performing ritual activities inside the palace. This reality is material and objective but probablistically apprehendable. Historical water infrastructures include well, ponds, stone and copper spouts and Jahru hiti. Architecture or the buildings and land use pattern also guide the rainwater in its own way. So, even though indirectly, these also falls under the subject of the study of water infrastructures of Hanuman Dhoka Durbar Square.

This research is first of its kind performed in the Hanuman Dhoka Palace. So, it will espouse exploratory research design in which various elements of the historical water infrastructures are explored, enlisted and analyzed. The method of data collection is through interviews with the staff members of Hanuman Dhoka Durbar square and through observation.

Geographical setting

Hanuman Dhoka Durbar Square is the world heritage site that posses various intricate designs of stone, wood, terracotta and metal artifacts and several wall paintings as well. It also possess the temples, *Pati* (resthouse), *Dabali* (raised platform), palatial complex constructed in Nepali style of architecture, Gumbaj (Dome) style, *Shikhara* style, Vihar style and Neo-classical style of architectures. These are the elements that awe-inspire majority of the scholars, visitors, enthusiasts and general public. Therefore, the study of these elements become the content of public discourse and scholarly articles but one of the important part of the human settlement i.e. water infrastructures of Hanuman Dhoka Palace is yet be explored.

This section of the article enlists all the water related infrastructures of the inner sections of Hanuman Dhoka Durbar Square. In order to do so, firstly the geographical or physical location of the Durbar itself is ascertained followed by the land-use pattern of the inner sections of Durbar square. After this, the enlisting of all the stone spouts, wells, Jahruhiti, historical toilets, sewage system, water harvesting mechanism, elements or places that require water in order to operate such as: kitchen, areas of worship are also explored in this section. And lastly, the architectural syncretism to address precipitation is also explored.

The floor of Kathmandu valley is composed of several bluffs created by the riverine erosion over several millennia. Top of these bluffs were settled by many of the major historical cities and towns of the valley such as: Kantipur, Bhaktapur, Hadigaon to name some (Slusser, 1998). The bluff that extends from Bansbari to Panipokhari and continues declining ever slightly till it reaches the Bagmati river which forms its southern boundary. At the southern edge of this bluff segment lies the historical township of Kantipur. Of this medieval Kantipur city, at the southernmost section which is located at an elevation from the confluence of Vishnumati and Bagmati lied Lichhavi township of Dakshinkoli grama which was also called Yangala (Bajracharya, 1996). Yangala used to be the southern section whereas Yambu was the northern section which extended from Indrachowk to Ason and Chhetrapati. The Durbar square of Kathmandu was strategically located in between these two historical townships of Yambu and Yangala. Through these two historical townships traversed a route that led to Tibet which is evident till date.

The location of Durbar square of Kathmandu is in relatively flatter ground if not slightly slanting towards the north-east from the south-west. The totality of the the bluff

declines from Panipokhari or Lazimpat (north-east) through Lainchaur towards Jamal, where water naturally collects and Pratap Malla did decide to construct a pond called Ranipokhari. In Lainchaur as well, some scholars suggests of existence of a pond in olden days but has been lost in modern day. Another ponds is located towards the north of Durbar square near Chhetrapati called Ikha Pokhari, which is currently dry but renovation and replenishing works are in progress. To the west, the terrain declines from Maru and in this slope is situated a stone spout called Maru Hiti. Further to the south-west from the palatial complex towards Bhimsen sthan temple is another *Gaa: Hiti*.

At present, the palatial complex is surrounded by densely populated zones with newly constructed modern buildings in the east called New-road, Makhan to the north, Hanuman Dhoka police station along with Dwarika Chhen hotel in outer palatial square and Yatkha road to the west and Jhochhen to the south.

Land-use Pattern - Structure and Chowks or Bahals of Hanuman Dhoka

The land-use pattern of the palatial complex is divided into outer and inner zones. Since, the scope of this article is only to address the inner complex, the land-use pattern of inner zone will only be explored here. Several courtyards and sections of the Hanuman Dhoka palace (Fig 1) from north to south is stated as follows:

Trishul Chowk

This courtyard lies to the south of Taleju Temple and gets its name from the trident placed to the left of an approach steps towards Taleju Temple and to the right of a tree growing out of the extended Taleju plinth. To the west of the courtyard lies the courtyards of - from the north, Sundari chowk and Mohankali chowk. To the south lies Mulchowk and to the east lies open area with stable for horses. This courtyard is spacious and large with some pillars with the idol of king Mahendra Malla facing the temple. The floor is paved by stone blocks and are impermeable apart from few nooks and crannies between stones blocks. Water-logging was not witnessed and was not stated in an interview with Mr. Sunil Dangol (personal communication, September, 24, 2025). The floor slants slightly to the sides towards the shallow gutters at the corners. These gutters channels water to the underground canal. Rainwater from the slanted roofs of western and southern courtyards and from Taleju temple falls to this courtyard. A small well is centrally located in this courtyard. The floor of the plinth around this courtyard is constructed with brick connected with traditional mortar thus rendering them impermeable as well.

Horse-Stable, Barrack zone and Vegetative area

East of Trishul chowk seperated by a wall lies horse stable with open unpaved permeable front. Further east to this is the Barrack zone. The path leading upto the barrack through the side of stable is paved with stone and mortar. Barrack zone has a single storied

long house in sheet metal roofing on the right with stone paved front open space facing a semi-permeable tiny garden with trees and columns of flowering plants. The other side is another building used by the battalion of army. The area between the stable and Naag Pokhari is a vegetative zone. This zone is generally prohibited from visiting and the researcher as well did not approach but did interview the staffs about its condition. A temple is also under construction at the southern part of this zone.

Jalasakan Vishnu Pond

Further east of Barrack zone lies a large image of Vishnu reclining atop the coils of Vashuki Naga. The whole image seats above a platform located at the bottom of four flights of plinths diminishing from the ground level towards the platform (Fig 6). Subterranean water level separates the bottom plinth from the double layered concentric platform that holds reclining or Jalasakan Vishnu. Only three images of reclining Vishnu of large stature is present in Kathmandu valley, among which the two being in Budhanilkantha and another of comparatively smaller in size located in Balaju Baisdhara. The floor of the plinths and platforms are paved in brick with traditional mortar except for the addition of stone blocks on the edges of the plinth and platform; and the pathway leading upto the platform. Hence, the area is semi permeable. The diminishing plinths also possess two stone spouts each in northern and eastern side. Both the spouts are dry even in the period immediately after the monsoon. Their sources could not be identified neither through observation nor with an interview. However, bubbling of water from north eastern corner of the plinth during renovation after the 2015 earthquake was mentioned and noted. The same was not seen ever since.

Sundari Chowk

Sundari chowk is a small courtyard located to the west of Trishul chowk and north of Mohankali chowk (Fig 4). It has one well, one copper plated stone spout and two Jahruhiti. Well exists at the ground floor of the northern building wing of the courtyard whereas the half floral petal shape attached to rectangular extension of spout basin exists in the center of the courtyard. The copper plated stone spout is located at the central petal niche flanked by two other petal niches with *Jahruhiti* constructed in its base wall. The magnificent image of *Kaliyadamana* lying at the other corner faces the spout in-front. Curiously, the spout basin has only one flight of plinth and the spout is less than a foot below the ground level. By design, it does not seem the spout utilizes ground water but may have been sourced from a canal, the location of which is unknown. The floor of the basin is paved with stone and that of the courtyard is paved with bricks similar to Mohankali Chowk. This courtyard, as others, also has shallow gutters that collects surface runoff and roof drizzles in rainy season guided

by the floor slanted towards the gutter. Approach steps towards the spout basin is located in center of the either side and sewage outlet is at the southern corner next to the steps.

Mohankali Chowk

To the south of Sundari chowk lies Mohankali chowk (Fig 5). It is the most intricate of the courtyards in Hanuman dhoka durbar square with its many wood carvings and a copper spout with many stone image of deities no less beautiful than the one in Sundari chowk of Patan Durbar Square. The spout basin similar to the one in Sundari chowk, just below one flight of plinth from the ground level. Located at the northern corner of the courtyard is approached from the south. The floor basin is paved in stone, whereas the floor of the courtyard is paved in bricks connected with traditional mortar that slants slightly to the side to guide the precipitation to the shallow gutter and eventually to the underground sewage. A conspicuous niche with designs as in the entrance is built below the plinth of courtyard building in an approach way towards Sundari chowk. The purpose of this niche could not be ascertained. Water to the copper spout is channelized from its left side and is collected to the chamber that sits just above the spout. Roofs of this courtyard are all made of tiles slanted in two sides of the building.

Mul Chowk

Mul Chowk is the main courtyard of the palace complex which houses the patron deity of the royals. This courtyard does not possess any well, spouts or Jahruhiti. The floor in this courtyard is paved in bricks only and is again slanted towards the corners towards the gutter. This is the courtyard that sees sacrificial practices of many animals during the festival of Dashain. The gutter that opens to northeast through a eye windowed cover transports not only the rain water but also the blood from the sacrifices to the Big well (*Thulo Inar*) located out of the courtyard. This has caused contamination of water in well which is clearly noticeable from the foul odor that spreads throughout the area after Dashain. All the roofs of the courtyard buildings are made of tiles slanting in and out of the courtyard.

Nasal Chowk

The largest long rectangular courtyard of Hanuman Dhoka Palace is Nasal chowk. This courtyard is important throughout the history for many royal ceremonial activities specially remembered for the coronation of the King. This courtyard does not have any well, spout or *Jahruniti*. The floor is paved in stones and gutters built on the sides. Rain water collected in Daakh chowk is channelized to this courtyard.

Daakh Chowk

A courtyard located between Nasal chowk and Masaan chowk is Daakh chowk. The basic land-use pattern of this courtyard is a bit different from other courtyards with its flower garden on a raised platform on the west. These two small gardens are the only permeable

surfaces. Otherwise the floor is paved in stones with shallow gutters in corners. Rain water from the buildings in all sides fall and are channelized to Nasal chowk.

Masaan Chowk

This is an asymmetrical quadrangular courtyard to the west of Daakh chowk. It is not open to the public and currently houses many construction materials used inside the palace complex. It has two wells and floor has patchy brick work and dirt rendering it permeable. Kandel Bhagwati is located roughly at the center. This courtyard also has a large tree and as usual rain water from half of the roof flows in this courtyard.

Nhu Chhen Chowk

Located at the south western section of the palace complex is Nhu Chhen chowk. This courtyard has paved stone floor without the mortar and gutters and posses a well. As the roofs are slanted, the rain water falls towards the courtyard.

Lamo Chowk

South of Nhu Chhen Chowk is Lamo Chowk. This courtyard has stone paved floor without gutters and no visible outlet for the rain water falling from the surrounding roofs. This courtyard does not have any well, spouts and *Jahruhiti* but an important specimen of historical toilets and bathroom lies in one of the buildings located in this courtyard.

Vayu Chowk

A narrow courtyard south west of Lamo chowk is Vayu chowk and has stone pavement.

Lho Chowk

Lho chowk is located to the east of Nasal chowk and south of Mul chowk. An old well has been unearthed few years back in this courtyard. Paved in stone, gutters to the corners and a centrally located large block of stone or *Lho* provides this courtyard its name.

Thulo Inar Chowk

This is not actually a courtyard but an open space with a large well or *Thulo Inar* (Fig 8). This well even has its own approach steps that leads to the bottom. It has the surface paved with stone and does not have gutter to channelize the surface runoff during the rain.

Water Infrastructures of Hanuman Dhoka Durbar and their Uses

Stone Spouts

Palace of any country is the most important place as it is a seat of the King. It is home to not only the king and his family but many royal as well reside there. In Nepal, in

addition to the residence of royal the palace also hold many important temples of the deities. These various arrangements require water, not the still ones fetched from the wells but the running water as it is considered pure and a king or royals could not just acquire it from stone spouts located between city quarters due reasons such as security, privacy and dignity. In this regards, as in other palaces inside the Kathmandu valley, Hanuman Dhoka palace complex also posses spouts (Fig 2) that provide uninterrupted supply of running water inside its premises.

There are in total four spouts inside the palace. Two of them are stone spouts (Fig 6) and another two are also stone spouts but are plated in copper (Fig 3 & 5). Two copper plated spouts are located each in Sundari chowk and in Mohankali chowk. Both of them are situated not more than one foot below the ground level and are currently dry. The other two are located protruding out from the plinths facing south and west of reclining Vishnu or Jalasayan Narayan. Both of these stone spouts are also currently dry, even in the monsoon. The source of either of the four spouts could only be identified after the thorough excavation or by other means of geophysical survey. Water may have been channelized from the close vicinity by identifying the underground aquifers but buildings three to five storey tall with their foundation construction may have blocked or disturbed those channels. Finding of neither of underground infiltration gallery (*Nabhimandal*), underground canal/ open flow channel (*Hiti Dun:*) or collection chamber (*Athal*) have been reported or recorded during the construction of the surrounding buildings. In case of the copper plated spouts in Mohankali chowk, Mr Sunil Dangol (personal communication, September 24, 2025) reported that a canal coming from its right side channels water to the chamber just above the spout.

Wells

Well is basically a cylindrical chamber carved vertically to collect groundwater at the bottom and could be fetched by a bucket from an opening at the top. This is an ancient method to access groundwater and are suitable everywhere, even the places which are basically dry at the surface. Wells are omnipresent throughout the valley even in places that are not viable for the construction of spouts. Inside Hanuman Dhoka Palace, there are in total seven wells.

Two wells are located in Massan chowk and each in Lho chowk, Nhu Chhen chowk, Thulo Inar chowk (Fig 8), Sundari chowk and Trishul chowk. Among the wells, the largest one is located in Thulo Inar chowk, which is an open space to the east of the Mul chowk. This well is unique in its way of accessing the water through the steps build from the surface to underground. Currently, the access point to the step is barred with a metal gate. The water from this well is used for ablution of deities in Mul chowk and other ritual purposes. Furthermore, during the reiki of the area vile smell was coming out of the well, the reason for which is already mentioned elsewhere.

There are two wells in Masaan chowk. Among the two, one is used for ritual purpose of Kandel Bhagwati located in the middle of the courtyard and the other is used for the same in Degu Taleju temple. The well inside Lho chowk is only recently uncovered and the hole is in the state of buried. The well of Nhu Chhen chowk is covered for protection with wooden slab pressed with a stone. Any special purpose of this well is unknown. Well of Sundari chowk is located at the bottom of northern wing of building and is also gated with a metal mesh. Its purpose, potentially for the ritual and general consumption when the spout is dry. Finally, Trishul chowk has a well at the center of the courtyard again covered by a metal gate. Uniquely this well has a piped source of rainwater collected inside the courtyard. Water from this well is used for ritual of Taleju. Some plastic wrappers of ready made foods have also seen floating inside the well and so the water seem dirty as well.

Jahru Hiti

Jahruhiti is a water tank made of carved out stone. It is generally placed at the crossroads, near a temple and sometimes in front of the houses of the patron who wishes to earn merit from providing water to thirsty passers by and travelers alike. Water has to be poured from above in this tank to be filled and a bosom shaped outlet is closed with a wooden cork which is opened to access water. In this day and age the use of this tank is phasing out due to availability of bottled water and thus is on the verge of extinction. Although, seen in historical quarters, this tank is not used nowadays. Inside the palace there are six installed and one is left unattended. Three of these water tanks are located outside Sundari chowk (Fig 9). Apart from the ones attached to outer wall of Sundari Chowk many are attached to the plinth of Jagannath temple (Fig 10). Two of them are located as flanks of the spout on either side of Sundari Chowk (Fig 11). Another one is located at an upper echelon of the plinth of Taleju temple and the one left unattended is located in Trishul chowk below the stable wall.

Ponds

Ponds are one of the major element of the historical settlements inside Kathmandu valley. They are the reservoirs that collect water during the rainy season and releases through percolation during the dry season ensuring uninterrupted supply of water to underground aquifers throughout the year. This helps to fill the wells and keep the spouts flowing perpetually. Inside the palace as well there are two small sized ponds. Both are located to the east of the palace. They are Naag Pokhari (Fig 7) with serpent statue in the middle and another is a pond made for reclining Vishnu or Jalasayan Narayan (Fig 6). At present, water level in these ponds sits three flights of plinths below the ground level in Jalasayan Narayan and four flights of plinths below in Naag Pokhari.

Sources of Jalasayan Narayan pond used to two spouts in the north and the east along with ground water bubbling out of the north eastern corner. But at present, all the sources are dry and the current water level seems to be the representation of general groundwater level

of the vicinity. Same is the case regarding the water level for Naag Pokhari. But rainwater from inside the palace is channelized in this pond. A channel that directs water from the gully of Lho chowk and Mul chowk is emptied in this pond.

Historical Toilets

Consumption of food is vital for the survival for any living being on this planet. Once the food is consumed, it is processed by the stomach and intestines in order to extract nutrients from them. The leftovers are then excreted out of the body. This is only natural to all people, including the kings and royals. No matter how much extravagant and large a palace is, it must also have a designated place to make excrement i.e. “ a toilet”. In total, four toilet chambers counted as a pair of two along with another two toilet basins in one spot and another toilet basin atop the building in a hall located in Mohankali chowk have been identified from the palace complex. Two pairs are located next to each other in one place and are approached from Lamo chowk above the steps in its north-western corner.

The toilet infrastructure in Lamo chowk comprises of two stories and four small chambers in addition to one large room on the upper floor approached through toilet itself used possibly as a changing or for bathing purposes. One toilet pair comprises of two chambers. The top chamber has the main toilet basin (Fig 14 & 16) where a person squats and lower floor chamber (Fig 17) where excrement directly falls from a hole (Fig 15) to the collection pit (Fig 17) that also has an elongated channel from which the liquids are channelized into another pit. The solid excrement are then scooped and scraped out to be thrown elsewhere in *KhiKha Muga*:: or a farm. No piped or canal connection to channel the sewage has been found.

Another toilet basin (Fig 18) has also been located from the upper storey of the building located in southern section of Mohankali Chowk. It is located in the middle of the hall which does not seem like a toilet structure but as any other long hall in the palace complex.

Architectural Sycrecy to Address Precipitation and Rainwater Harvesting

The valley of Kathmandu gets around 1400 mm of rainfall every year. And almost 80% of the rainfall occurs on the four months starting from mid June till September. Between these months rainfall is continuous and sometimes torrential. All kinds of constructions must address this issue. To address this and the problem of water-logging and seepage inside the buildings, our ancestors have found an ingenious way of slopping the roof that ensured ease in trickling the water down. All but few of the roofs are slanted tiles and even the ones that are flat topped are slightly sloping to guide the water out of it.

Even the paved courtyards are ever slanting towards the side gutters (Fig 13) which eventually guides the water to the sewage and eventually out into the river. Throughout the whole of palace, only in three instances it is found that the rainwater is being harvested. The

first is channelizing the rainwater collected from northern slope of the roof of Lho chowk and the southern slope of the roof of Mul chowk is directed to Naag Pokhari. In second instance the rainwater collected in the courtyard of Trishul chowk is transferred to a well located in the center of the same courtyard . Lastly, rainwater from the courtyard of Mul chowk is also transferred to Thulo Inar (Fig 12). In all other cases the rainwater is found to have been transferred to the sewage.

Discussion

The land-use, architecture, location of water infrastructures as explained above shows certain patterns in its existence and uses. The analysis of those patterns is discussed in this section of research. Basic patterns include: greater concentration of many water infrastructures on the northern flank of the palace complex; Mohankali chowk and Sundari chowk are the only two courtyards that possess ornate forms of stone spouts; the other two stone spouts are located in a pond of reclining Vishnu; all southern courtyards only possess wells; living quarters may have been in the southern section of the palace and the northern sections may have been used for religious, ritual purposes; each of the courtyard have at least one well except for the Mul chowk and Nasal chowk; the two stone spouts inside the courtyard are just a foot or so below the ground level; they are currently dry and their sources could not be located; Mohankali, Sundari, Mul and Masaan chowk have brick paved courtyard but all the other have stone paved courtyards at present; lack of water harvesting facility inside the palatial complex despite the potential; and finally, direct channelizing of blood from sacrifices in Dashain festival to Thulo Inar has resulted the contamination of water inside the well as notified by vile odor around the vicinity. Further discussions on these issues are cared for hereafter.

Hanuman Dhoka palatial complex comprises of eleven courtyards along with other opens spaces such as ponds, Thulo Inar chowk (also kept under the term courtyard above), army quarters, stable zone and vegetative zones. But the concentration of many water infrastructures are located on the northern flank of the palace complex. The northern flank which includes: Sundari chowk and Mohankali chowk has one stone spout each, whereas the exterior of Sundari chowk also possess three *Jahruhiti* attached to the building wall. The reclining Vishnu has another two stone spouts along with its very own pond. A tank basin of *Jahruhiti* is left without its purpose on the plinth of below the stable wall. The southern part of the palace conspicuously has no other water delivery mechanism other than wells.

The intricate arts carved on the walls of the courtyard, the plinth and the stone spout ensemble itself along with the lack of such intricacy in other courtyards other than Mulchowk, suggests Mohankali chowk, Sundari chowk and Mulchowk are three oldest and most important courtyards of the palace. However, Mohankali and Sundari chowk as well

have been renovated in later dates is also apparent by the neo-classical styled windows and white ochre styled paints on them.

Furthermore, the possession of stone spouts in only two courtyards and lack of it in all southern courtyards but wells only, definitely arouses the curiosity to find the reason behind it. Whether the southern courtyards did not possess any religious sanctums that would require a pure flowing water or the contemporary rulers did not find it necessary to indulge in such an expensive activity of building another stone spouts has not yet been ascertained.

The other reason could be that the living quarters may have been in the southern sections of the palace but northern quarter may have been used for worship. This palatial arrangement may have found the use of wells sufficient enough to have in them. However, each square have at least one water infrastructure except Nasal chowk and Mul chowk. Regarding this, experts and palace staffs are of opinion that Nasal chowk may possess well and could have been buried later. And Mul chowk uses *Thulo Inar* outside of its courtyard for ritual purposes.

The *Thulo Inar*, despite its importance in rituals and ablution for deities in Mul chowk was found emitting vile odor when the researcher performed his reiki just after the end of Dashain. Blood from the sacrifices was the major pollutant to the well and a kind of mechanism should be employed to prevent its flow through the channel located in north east corner during the festival.

Regarding the sources of two spouts of Mohankali and Sundari chowk which is currently dry, only vague surmise of the experts and staffs alike could be accounted. According to them, the sources may have been the ponds of Ranipokhari. If it is the case, a canal through the road linking Makhan through Indrachowk to Asan could have been in existence but was destroyed in many instances of road construction. However, the water level in Ranipokhari itself seems to be below the spout. A gradient analysis of the slope from Ranipokhari to the two spouts in later date may yield some substance to the issue. Other perspectives point the source either towards the western region where police station is located now which may have been an open space before it construction. A perspective on nearby location within the palatial complex itself or a close vicinity is also in existence. But it is highly unlikely. Because, the ground level in all the vicinity does not seem more than a foot above the spout itself and the water level is below.

Only two specimens of historical toilet infrastructures could be found from the palatial complex. One is located on the top of the courtyard building of Mohankali and another in the western wing of Lamo chowk. However, the toilet in Lamo Chowk has two toilet rooms and two extra basin. In total, there are only five basins which does not seem to be enough and well spread throughout the palace in the historical times to accommodate all the

people that called palace home including the royal family, helpers, servants and attendants. It could be the case that apart from royal family, no one could use the toilet infrastructure and others would require to use the fields or excreta pits (*Khi-Kha Muga:*) every morning located below the settlement to empty their bowels. Furthermore, not a single clue on existence of kitchen could be ascertained from the whole complex for which, the renovation and new coloration may have been the cause that hid even the smoke stains.

The palatial complex is basically built in the pattern of multiple conjoined courtyard structures. Almost all of the courtyard floors are rendered impervious with the use of stone pavement except for three. Mohankali chowk, Sundari chowk and Mul chowk has brick paved courtyard with a kind of traditional adhesive to join bricks. Masaan chowk has brick pavement with bare dirt interruptions and also possess various building materials at present. Impervious surfaces prevent the seepage of rainwater underground. But a well inside Trishul chowk sees channelization of rainwater to it. And Naag Pokhari also harvests rainwater collected in from the corridor located between Mul chowk and Lho chowk. The palatial complex has plenty of open spaces and also has immense potential for rainwater harvesting that would otherwise be transferred to sewage. This potential is yet to be realized.

In conclusion, there are in total eleven courtyards, two ponds, two open spaces as in barrack and vegetative zone and a stable inside the Hanuman Dhoka palatial complex. Among the courtyards, four has semi-permeable surfaces whereas all the others are rendered impervious by the use of stone paving. Regarding the water infrastructures, there are four stone spouts, six *Jahruhiti* (not counting the ones immediately outside) that are intact in their original position and one without the cover for the tank and lastly seven wells inside the palatial complex. There are five toilet basins and four toilet chambers in a pair of two are located inside the palace. Not a single evidence of kitchen could be located.

Appendix



Satellite Images



Fig. 1: Satellite images of all the courtyards inside Hanuman Dhoka Drubar Square.
Source: Google Earth



Fig. 2: Satellite image of location of all the water infrastructures in Hanuman Dhoka Durbar Square. Source: Google Earth Water Infrastructures

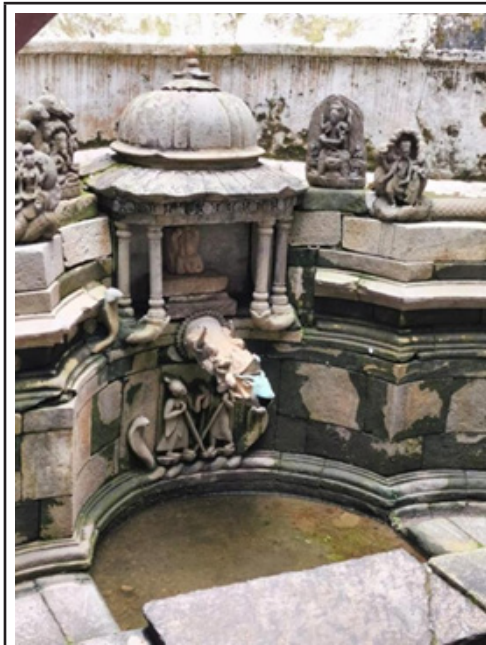


Fig. 3: Copper plated stone spout of Sundari chowk



Fig. 4: The stone spout complex covers majority of the courtyard of Sundari Chowk



Fig. 5: Copper plated stone spout and assembly of statues in Mohankali chowk



Fig. 6: Eastern (above) and Northern (left) stone spouts, Jalasayan Vishnu of Jalasayan Pond



Fig. 7: Naag Pokhari and under construction temple of Shiva



Fig. 8: Thulo Inar, and approach steps protected by an iron mesh cover



Fig. 9: Three *Jahruhiti* arranged side by side on the outside wall of Sundari chowk



Fig. 10: Collection of *Jahruhiti* in the plinth of Jagannath Temple and an example of stone pavement

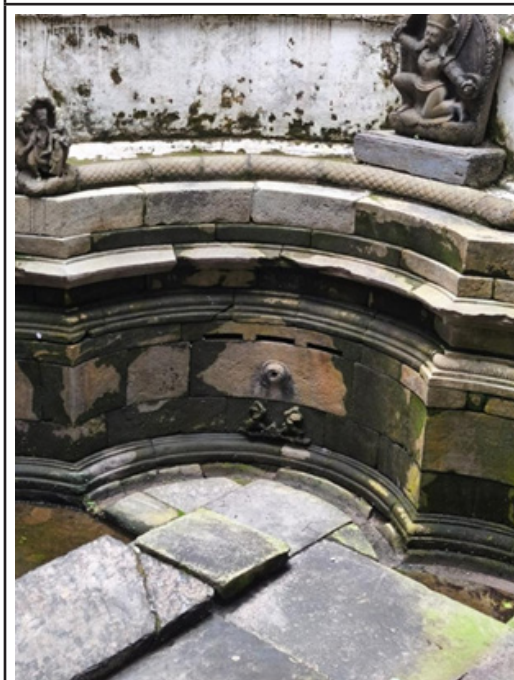


Fig. 11: *Jahruhiti* of left flank of spout in Sundari Chowk



Fig. 12: *Aankhijhyal* gutter cover and gutter located in north-eastern corner of Mul Chowk



Fig. 13: Artistic niche below the plinth (back) and sewage inlet (front)



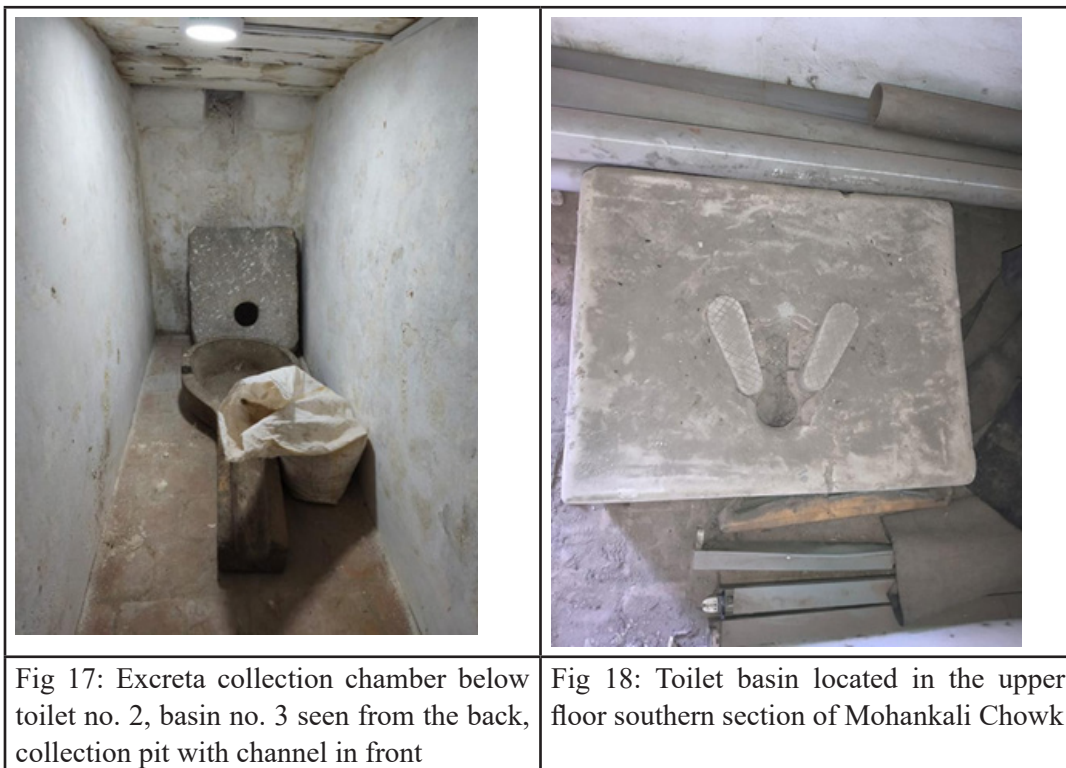
Fig. 14: Historical toilet basin no. 1



Fig. 15: Toilet basin hole of toilet no. 1 as pictured from the chamber below



Fig. 16: Historical toilet basin no. 2 and bathroom or changing room in background



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