

Report on the State of Water structures in Narnaul and its Survey methodology

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Abstract - The purpose of this research paper is to present architecture features and present state of water structure in Narnaul through the field survey that has been conducted in Narnaul, India. Moreover, this paper shares the methodology of the field survey of water structures for specific area/district which has never been focused.

An assessment of the inventory forms helped to identify 5 sub-categories within Water Structures in Narnaul: 1) Johads; 2) Talabs/Sagars; 3) Kunds; 4) Wells; 5) Baolis / Stepwells. The typology of water structures was essentially based on the purpose for which the water was used, the method of collecting and accessing water as well as their physical form and architectural character. Through documented water structures which are scattered in Narnaul, the feature and present state of a variety of water structures can be recognized.

Key Words: Water Structure, Narnaul, Stepwell, Documentation, Historical Heritage, Conservation

1. INTRODUCTION

Among the world's most important resources, water plays an important role in all livelihoods, development, and environmental protection [1]. In Indian context water holds sacred values and defines purity [2]. It narrates the story of lives, rituals and myths of its people. As the result of water capturing practices in the months of monsoon these magnificent stone structures came into shape which we call as Stepwells (Indian name- Baoli) [3].

While these underground water monuments comprise one of India's major building traditions, they are perhaps the most neglected of the world's great bodies of architecture [4]. This paper tells the feature and its uniqueness of water structures of Narnaul, semi-arid zone, one that shares in India's culture, especially its art, architecture and engineering.

Narnaul is a city handed down from over 5000 years ago. It is famous as a religious city and also as a city where Mughal culture once took root [5]. Narnaul, located just in the middle between Delhi and Jaipur, is the town having Hot and Arid, desert-like climate (see Fig.1). It is said that there were more than 300 water structures in Narnaul in



Fig -1: Location of Narnaul. (Source: Author)

the past. Fortunately, still, over 100 are suitable for research that existed.

1.1 Purpose and methodology of this paper

This research paper states the architecture features and tells about the present state of water structure in Narnaul through the field survey that has been conducted in Narnaul, India from 12th February 2018 to 18th February 2018. In addition to this, the paper shares the methodology of the field survey of water structures for specific area/district which has been highly overlooked.

All the research materials (drawings and sketches) used in this paper were obtained through on-site survey. Historical facts on individual water structures that we heard in the field survey are handled as unconfirmed information to the last, unless confirmation can be obtained with other materials.

Methodology of this paper is as follows; First of all, after reviewing the precedent research, Narnaul was identified as the research area because of the rich heritage which still remains as mentioned through the magnificent structures. Next, practiced methodology of the field survey has been

followed in detail while discussing each process and its self-assessments in order to justify the process of the field survey and share the experience. Finally, the features and present state of the water structures which were documented in Narnaul were analyzed.



Fig -2: Nagpuria Ki Baoli (Source: Author)



Fig -3: Talab around Doshi hill (Source: Author)



Fig -4: Kund in middle of the Doshi hill (Source: Author)

1.2 About precedent research

At first it was analyzed what has already been done in the area of water structures. Many researchers have already been involved in the study of water structures. Many of them are 'Patan's Rani ki vav' registered as a World Heritage Site [6] and 'Chand Baori' [7], which is the oldest stepwell, and limited to major cities such as Delhi and Ahmedabad.

The following works are listed as recently published exertions.

For an instance the books 'The Vanishing Stepwells of India' by Victoria Lautman [8] and 'Steps to water; the Ancient Stepwells of India' by Morna Livingston [9], both these books contain the pictorial documentation of existing water structures right from 4th century to late 1990's. So we looked what further can be done in this area. And, we observed that all these researches do not narrate about the water structures in depth.

Originality of this paper is to understand not only limited unknown water structures located in Narnaul as a specific water structure but also architecture features and its diversity of the water structures scattered throughout the town/district comprehensively.

There is no precedence research of Narnaul focused as a case example of this paper. Regarding with Narnaul, there is a booklet compiled by INTACH. Although it is reliable content, it is only introducing some existing historic buildings present in Narnaul.

1.3 Technical terms of water structure

The water structures to be treated in this research are divided into five main parts. These technical terms were based on the term called by local people in Narnaul, so in case of other area it may be different.

- 1) Stepwell- Stepwells, also called Baolis, are wells in which the water level is reached by descending a wide set of steps, often going down several stories. Built by the nobility for civic and strategic reasons, Stepwells were secular structures from which everyone could draw water [10]. (See Fig.2)
- 2) Talab and Sagar- Talabs and Sagar are large reservoirs used to collect water during heavy rains, and to prevent excessive flooding in surrounding areas. Such structures are lined with masonry and often have other architectural embellishments such as pavilions [11]. (See Fig.3)

- 3) Kund- A Kund is also a water catchment tool. Its main purpose is to harvest rainwater for drinking and other purposes. Many kunds are accompanied with temples and ascribed with sacred values [12]. (See Fig.4)
- 4) Well- Wells are vertical structures dug in ground for the purpose of bringing ground water to the earth's surface [13]. (See Fig.5)



Fig -5: Well in the town of Narnaul (Source: Author)



Fig -6: Johad outside of the town of Narnaul (Source: Author)

- 5) Johad- A Johad is a naturally formed pond that captures and conserves rainwater. It is one of the oldest systems used to conserve and recharge ground water. Johads are community owned, usually found in rural settings [14]. (See Fig.6)

2. About Narnaul

2.1 Climatic Context

Narnaul is a municipal corporation in the Indian state of Haryana. It is the headquarters of the Mahendragarh District. A place with a rich and varied legacy, Narnaul has created a deep impact on India's historical, social and economic order and, has contributed significantly to its cultural and architectural heritage. Narnaul lies at the border of Haryana and Rajasthan, at 135km from Delhi and around 160 km from Jaipur, on the historically significant Delhi-Agra-Ajmer axis. The location on this major highway has been a significant factor in shaping the history, economy and social structure of the town.

The proximity of Narnaul to Rajasthan also means that the town shares its climatic characteristics. The town has a Hot and Arid, desert-like climate. In summers, the highest temperature soars up to 55°C, while the winter temperatures can lower down to -10°C. The land is dry and suffers from a scarcity of water. These harsh conditions were the major triggers for devising a variety of innovative structures for water harvesting and management [15].

The low-lying, barren hills of Aravalli range form the backdrop of the town, with the Dhosi Hill located at 12 Km from the city, becoming an important landmark and sacred node for its people (see Fig. 1&7).

2-2. Historical background

The development of Narnaul, from a forest region in the 17th century to a thriving urban nucleus, has also been aided by abundance of mineral and botanical resources in the region.

In a country with history vaster than its diversity, and the opulence of its world-renowned archaeological marvels, the value of this small town has been largely overlooked. The history of Narnaul goes back to a period extending as far back as around 5,000 years ago. According to a legend, the town dates back to the Mahabharata as 'Nar Rashtra', from where it ended up in the hands of the Afghan ruler Sher Shah Suri, who was born on this land. The famed Mughal king Akbar, while he ruled, had established a mint here, churning out coins for the masses.

2-3. Historical resources in Narnaul

Despite being largely ignored in the pages of Indian history, Narnaul has maintained its historical and cultural relevance through its rich and diverse built heritage, ranging from havelis to kunds to talabs and baolis to temples and mosques. All of these had a crucial impact on the social and physical structuring of the town. In addition to substantial numbers of havelis and water bodies, the city of Narnaul also contains numerous gardens, tombs and

places of worship ranging from temples to mosques (see Fig.7).

3. Research methodology in Narnaul

Research methodology which was adopted is as:

Step1: Identification of Action Area (within historical boundaries of Narnaul)

As already mentioned above, when conducting the survey, we set the historic district (about 2 km square) written in the city planning drawing of Narnaul as the area



Fig -7: Diverse built heritages in the historic district of Narnaul (Source: Author)

to be investigated (Action Area). The limited area is as shown in the following figure 8.

Step2: Identification of the resources holding the historical heritage

For the survey, we divided the action area into 24 blocks, and picked up buildings, etc. that had been inside for more than 100 years. As a group of 5 people, we made records- (mapping in the map, writing down the coordinate on the page and identifying exact location on google map, writing information to the inventory form, recording in the photographs, measurement of the sizes, brief history, period of construction and Description of architectural attribute). The reason for subdividing the action area was to record in detail the range that can be walked around. Even in mapping to a map, there is an advantage that errors are reduced.

In this investigation, in cooperation with GoogleMap, the latest technology of mapping the building was used but it turned out that there are some errors due to radio waves and mobile phone capabilities. Even a small error on Web atlas will be very large in real city. Especially in the water structure most structures are located in the basement it becomes a big problem if the position shifts. In that sense as well, the location to be surveyed was limited to a narrow area so that the location could be determined. Another major problem was that several investigation teams conducted this survey, but to supervise them and to maintain the precision was little challenging at certain level. In this project, eight supervisors managed investigations one after another and were in charge of certain blocks. This further reduced the chances of discrepancies.

Step 3: Mapping of the Historical resources

In this step every identified structure was marked on the map using separate Color-codes for each use of the building (see Fig 7). Mapping was done in reference to coordination of GoogleMap and handwritten map written on the page and Inventory form.

As already mentioned, it is important to be aware that errors will occur in Google map's coordinate. By mapping together not only the original water structure but also other historical sources, it will lead to grasping the meaning from the urban, positional relationship of each water structure.

Again, it is also to reduce the discrepancy of the positional relationship in the mapping.

Step 4: Mapping of the Additional Historical resources

As the action area was investigated, some water structures were also identified outside the action area. Only for this, supplementary investigation was conducted

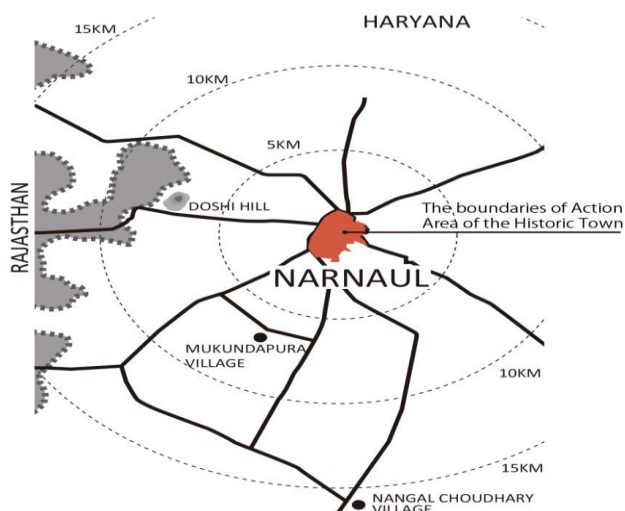


Fig -8: Action area of the historic town and surroundings of Narnaul (Source: Author)

in addition to the mapping created in Step 3, rather than a planned survey, it was a spot-like survey. Historical resources were thoroughly looked on the way to the target stepwell but historical resources cannot be covered outside the action area (see Fig.7). The stepwell found outside the action area is about 15 km away from Narnaul. In general, the stepwells are often located in places where villages once existed, and even in places up to 15 km apart, historical resources such as agricultural land and water structure (Narnaul city to existing village) are less likely to be located. However, it was found that there are several Water structures including wells etc. in the existing settlements. A total of five categories of water structures were identified from the inventory forms for detailed study and documentation (see Fig. 1-5).

Step 5: Documentation of the water structures

Plans of water structures were measured with the help of triangulation method and the depths of the water bodies were noted using various local techniques using thread and stone. An observation made resulted to a conclusion that the structures were not only restricted to the ground level but also extended to the underground levels from where the water bodies were easily accessible. The heights of the structures were measured using the measuring tapes and laser beams. Some of the water structures were present in condition of ruins and were documented with utmost care.

4. Water structures in Narnaul

4-1. Investigation result of water structures

As a result of the survey conducted by the above methodology, it was found that in Narnaul water structures is 1) Johads; 2) Talabs/Sagars; 3) Kunds; 4) Wells; 5) Baolis / Stepwells. The breakdown is as follows: As per the data collected while listing, the survey area in this research contains 01 Johad, 07 Talabs/Sagars, 04 Kunds, 83 Wells, and 07 Baolis. Out of these, all the 6 Baolis were taken up for detailed research. Incidentally, the undocumented stepwell, Polytechnic Baoli, could not be accessed due to bad state (see Fig. 9).



Fig -9: Polytechnic Baoli (Source: Author)

To explain these features easily, Johads and Kunds, being large storage tanks, were situated outside Narnaul's historical urban boundaries, whereas the Wells, Talabs/Sagars and Baolis, supplying water for daily household needs were mainly located within it. The documented stepwells are discussed in next section further.

4-2. Detail of the documented stepwells

Figure 10 shows drawings of six stepwells documented in Narnaul and Figure 7 shows the location of documented stepwells. Table 1 summarizes the outline of the documented water structures (see Table1).

Focusing on stepwell, these are found in several forms/styles. For stepwell, it can be divided into three types. 1) stepwell, 2) stepwell + additional structure, 3) complex: stepwell + other structures (see Fig. 11).

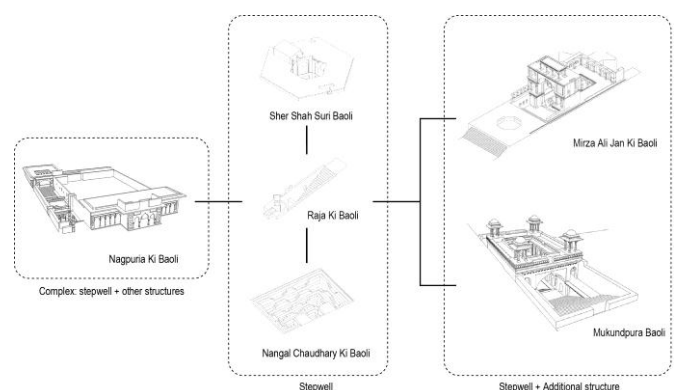


Fig -11: Stepwells categorized into three types

(Source: Author)

Among Type one there is Raja Ki Baoli, Nangal Chaudhary Ki Baoli, Sher Shah Suri Baoli. They are comparatively small in size and used on a community-base. Raji ki Baoli, which is rectangular with steps reaching well from only one side in order to draw water, is the simplest one. Nangal Chaudhary Ki Baoli is also rectangular, but has steps on three sides. These two are located on the outskirts of Narnaul. Sher Shah Suri Baoli is Hexagonal and its steps to access the well is narrow. Location of Sher Shah Suri Baoli is located on the garden within the historic area, but it has no relation with surroundings. Since the inside has two layers of galleries, this stepwell is not only people who use gardens and to draw water but also a place for taking rest.

In Type two there is Mirza Ali Jan Ki Baoli, Mukundpura Baoli which not only have steps leading to the basement but also have additional structure showing off the presence. It is believed that it is because kings used to come and take rest in the additional structure such as a flat-roofed pillared pavilion which is henceforth called 'takht'. So, it is comparatively larger with wide steps. In particular, Mirza Ali Jan Ki Baoli located in the center of the city, has a symbolic appearance and is the largest. Even though Mukundpura Baoli is located at the outskirts of the city, in the survey it was recognized that it was used by the ruler and was used as a gate of the village.

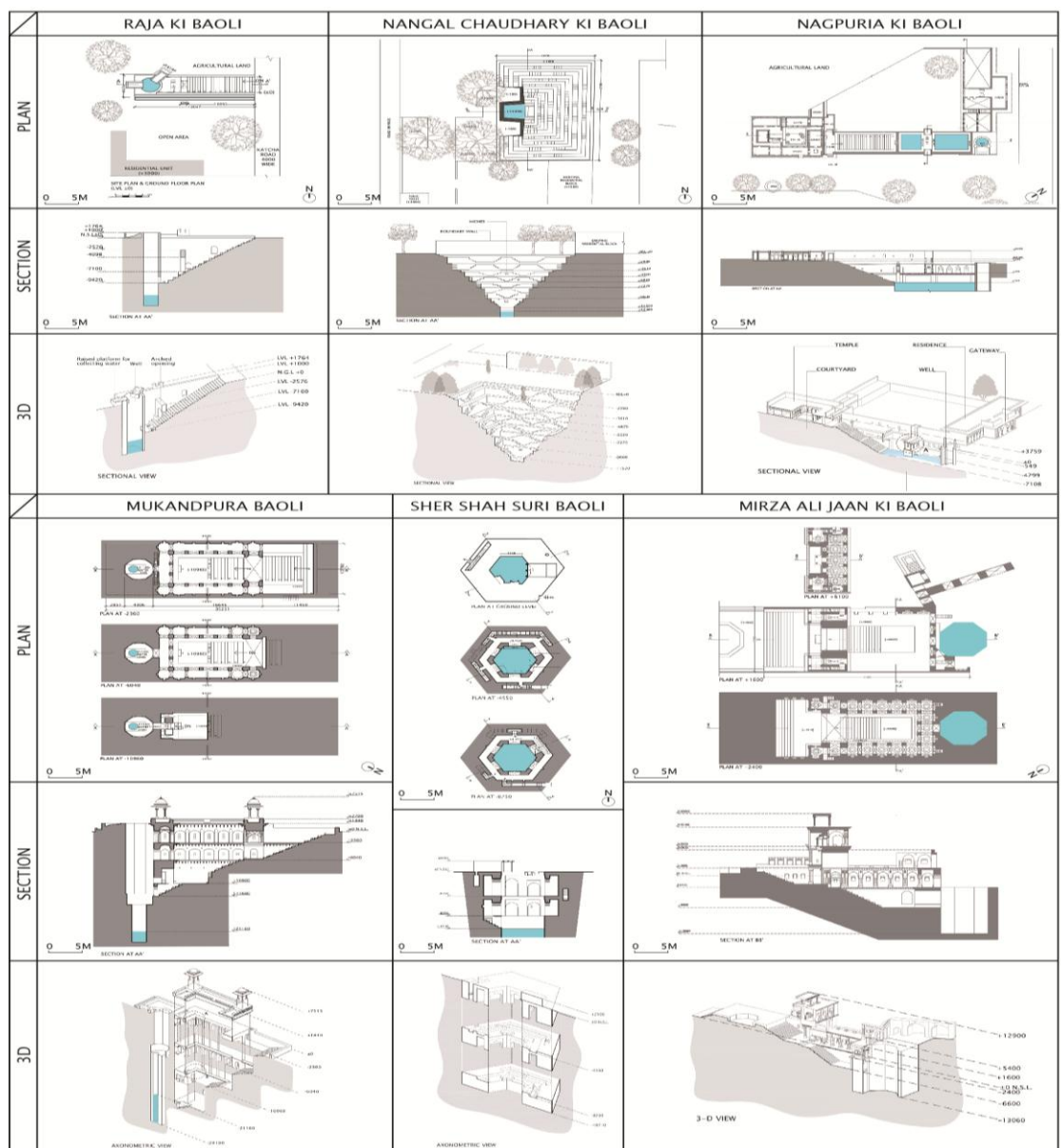


Fig -10: Drawings documented stepwells in Narnaul (Source: Author)

Table -1: Information documented stepwells in Narnaul (Source: Author)

S.N	TYOPOLOGY	NAME	LOCATION	SHAPE	LENGTH X WIDTH	ARCHITECTURAL FEATURE
1	Stepwell	Nangal Chaudhary Ki Baoli	20km from the Centre of Narnaul	Rectangular	21 X 15m	1. Repetitive series of steps 2. 29 landing platforms
2	Stepwell	Mukundpura Baoli	7 km from the Centre of Narnaul	'U' Shaped Structure	37 X 13 m	Four chhatris forming visual landscape
3	Stepwell	Mirza Ali Jan Ki Baoli	1.49 kms from the Centre of Narnaul	Rectangular	1775 Sq.m area	1. Arched entrance imposing gateway crowned by a flat-roofed pillared pavilion called takht 2. Red sand stone finish to the structure
4	Stepwell	Nagpuria Ki Baoli	1.1 km from the Centre of Narnaul	Rectangular	7 X 30m	1. Baoli divided into three parts by a pavilion and cusped arch in middle 2. The two side walls of the baoli having pointed arched niches at intermediate intervals. 3. Blind cusped arches and niches on north, east and west wall
5	Stepwell	Sher Shah Suri Baoli	17km from the Centre of Narnaul	Hexagonal	-	1. Exhibiting unusual hexagonal form with a corridor running along all the 6 sides, looking inward through the arcaded opening 2. Three staircases following the hexagonal frame of the baoli.
6	Stepwell	Raja Ki Baoli	Khanpur Village 12 Km from the Centre of Narnaul	Rectangular	20 X 4.6m	1. Pulley system 2. Exposed stone masonry laid in courses

Table -2: Current state and architectural features stepwells in Narnaul (Source: Author)

S. N	TYOPOLOGY	NAME	STRUCTURAL STABILITY	MATERIAL	ARCHITECTURAL FEATURES	MAINTENANCE	USAGE
1	Stepwell	Nangal Chaudhary kiBaoli	Excellent	All the stone work is in good condition and does not require any maintenance or replacement.	The main architectural feature of this baoli is its steps which are in good condition	It strictly requires maintenance and as due to heavy rains the well of the baoli has become inaccessible for groundwater recharge.	Abandoned
2	Stepwell	Mukundpura Baoli	Good	Plaster on the exterior façade is worn-off.	It is not blemished except for the few details like brackets on the first level, carvings over the niches have been depleted over time.	Strict maintenance required	Abandoned
3	Stepwell	Mirza Ali Jan kiBaoli	Good	All the stone work is in good condition and does not require any maintenance or replacement.	Details of the arches are weathered	The well has dried-up so it requires cleaning and strict supervision and repair	Abandoned
4	Stepwell	NagpuriakiB aoli	Good	All the stone work is in good condition and does not require any maintenance or replacement.	The main architectural feature of this baoli is its steps which are in good condition	A layer of algae has formed over the water, and slowly it has become a dumping area for garbage by so it requires maintenance and cleaning.	Abandoned
5	Stepwell	Sher Shah Suri Baoli	Good	Plaster has chipped off at most places.	The remains also have two pulley systems for drawing water, one each on adjacent sides. these are now in a dilapidated condition. the well exhibits very less ornamentation, with very few niches in some walls.	The well is dry and overrun by vegetation. the stairs are covered by thick and uneven layers of soil. maintenance and cleaning is required.	Abandoned
6	Stepwell	Raja kiBaoli	Poor	Plaster has chipped off at most places and Stone is majorly broken.	Steps are broken, It is not safe to access the well	Strict maintenance required	Abandoned

Note: Structural stability has been categorized into 3 categories.
 Excellent- When the structure is intact and there is no risk accessing it.
 Good- When the structure is not in dilapidated condition but requires maintenance and repair.
 Poor- When the structure is in ruins.

Then in Type three there is Nagpuria Ki Baoli which composed not only stepwell but also temple and school (now residence) as a complex. This complex exists and serves the purpose for the neighboring community than for the kings, so the stepwell was used for the daily life for neighbors. As described above, there are differences in how to use the stepwells, which shows that it appears as a difference of the shape.

4-3. Current status of the stepwells

Despite their historical importance, only a handful of stepwells are still relatively decently preserved by the early 21st century, particularly those in tourist-friendly areas. However, a number of factors contributed to the deplorable condition of most structures. For instance, stepwells were considered unhygienic breeding grounds for disease and parasites by the British Raj, and consequently were barricaded, filled in, or otherwise destroyed. As well as eliminating the physical need for stepwells, "modern" substitutes like village taps, plumbing, and water tanks also eliminated their spiritual significance. With time, stepwells became outdated, were abandoned, turned into garbage dumps and latrines, or were repurposed as storage areas, mined for their stone, or were just left to decay.

The current state of documented stepwells is concretely exemplified as below in Table 2 (see Table 2). As seen in table 2, the current state summarized from the view point of structural stability, material, architectural features, maintenance and usage.

Every structure including the polytechnic stepwell is abandoned and requires maintenance. Both Polytechnic stepwell and Raja ki Baoli have poor structure stability, and require restoration due to some deterioration. Though every structure would be stable for longer time since historic water structures are constructed by stone. The common cause of damage in both of two is vegetation growth and garbage.

With respect to the other 6 structures excepting the above two structures, even though maintenance would be partially required, main structure has maintained good state of structure stability. Although it is not the same as the above two, the deterioration of the structure is surely proceeding due to abandonment. Since stepwell are no longer necessary for daily life for getting water, the will to remain within the community is crucial point. It is indeed true that Nangal Chaudhary ki Baoli, that possess excellent structure stability was used until recently and remains close relation to the community. Looking back to Polytechnic Baoli and Raja ki Baoli, Polytechnic stepwell is located in the urban area but within the campus of the college, so that closed toward the community. In case of Raja ki Baoli, it has no relationship with a community from the beginning.

Documented stepwells all demonstrate structural stability but they need restoration. Restoration needs to be done using traditional materials with skilled craftsmen, architects and structural engineers.

5. Conclusion

This study focused on water structures of Narnaul which fortunately still remain even after tremendous historic recourses due to historical and climatic influence.

Over 100 water structures could be recognized throughout Narnaul, out of which 6 stepwells were documented through appropriate methodology of the survey and comparative analysis was brought out through drawings and photograph of documented structures. Thereby, this paper could share the feature of water structures, especially stepwells, in Narnaul and its present state. Obviously, methodology of the survey conducted in Narnaul would be useful for future survey.

Regarding with methodology of the survey, it seems to be very effective. Inventory form were filled in detail at a certain quality under supervisor, supporting with advanced tools such as Google Map in combination in order to get coordinate of the structure. Using the web atlas was very worthwhile way to analyze not only the individual case but also distributed structure in the whole area in order to understand the interrelationship with not only water structures but also other historical resources.

Through this survey in Narnaul, it was recognized that a variety of water structures still remained. Moreover, seven stepwells (including polytechnic Baoli) have different shape. Focusing the shape of the Stepwell, these shapes correspond to how they are used, and it can be seen their life when the water structures was used.

In discussion of the present state, historic water structures constructed by stone maintain in good condition having structural stability. The difference is related with the location. It is thus, the water structures would be in a state that the plant grows little by little, the step collapses, and it became inaccessible in case of a closed place from community or a place away from community.

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DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

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