System of Water Works and Tradition of Building Construction in India
A case study of Medieval Punjab (12th to 17th Century)

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Introduction

History as a discipline links the past- with the present which forms the basis of future. It is concerned with handling down of tradition and lessons of the past to the future. Therefore no age and country can do away from history.[1] India is a country with very deep historical roots and strong cultural traditions which are reflected in our social structures and institutions of community life. Despite social movements of diverse nature through the millennium, we have retained and connected the spirit and essence of these traditions. Some of our traditions, which were developed thousands of years ago by our ancesstors, have played an important role in various spheres of life. One significant among these is the tradition of collecting, storing and preserving water for various purposes.

"Water is both a natural and a social reality, which challenges traditional understandings in both the natural and social sciences. In nature and society water is not a single phenomenon but has many manifestations and meanings."[2] People's relation to water has been dependent upon many factors. There is a massive physique of traditional and primordial knowledge associated to water which has been orally transmitted over generations through the system of recitation and chanting.[3] Man has always preferred the area which is close to the water, however, sometimes due to circumstances he was forced to migrate to areas where water was deficient in amount, inferior in quality or erratic in behaviour. Thus he ardently erected hydraulic structures for survival. The old tanks, wells, aqueducts and reservoirs, some surviving and serviceable, are tokens of the dimensions for constructive thinking and co-operative endeavours which played a part in human progression.[4] Archaeological remains of canals, water channels, tanks, bunds, step-wells, wells etc. display the importance of water in history.

Water and traditions:

No life can be imagining without water and historically it has been used as a medium of power in many ways. During the course of history, water has effected the civilizations by its both powers: productive and destructive. In productive role it considered as life giving

which has been reflected in various forms such as purity, religious importance, pilgrimage, prosperity, power and luxury, fame and charity, architectural value and many more. In destructive manner it has been reflected in the form of flood and unwanted and untimely heavy rains.

Water has been an integral part of traditional and popular cultural ceremonies in India. It has been believed that the water comprises qualities and powers through which one can attain a high religious merit. As per the ancient Indian traditions, water is among the five *mahabhutas* which are eternal and exists in this universe.[5] It has been believed that the composition of the worlds is combination of these five elements.[6] Vedic literature is full of such references where the importance of water is defined and described. In the *Rig Veda*, Indra has been mentioned as the god of rain and responsible for causing the rainfall. God Varuna was responsible for personified water.[7] Many hymns in Rigveda and others have been attributed to Indra[8] and Varuna.[9]

Water has been considered as a symbol of purity and devotion in India which not only removes all physical defilements and provides strength to the human body but also purifies the soul of a human being and removes all sins. Physical purity can be achieved by normal bath but for attaining the inner purity, it was necessary to take bath in a river, tank which is divine. It was prayed that "may the waters be pleasant to our taste, be free from diseases, sin and sickness, be the remover of fear of death, be full of divine qualities and be the strength of eternal laws."[10] Foreign travellers had noted that the day of a Hindu family begins with washing and "the Hindus are more punctilious and much stricter than the Moslems in their ceremonies. No one, man or women, will omit to wash the body in the morning, however, cold it may be. The common people go to a river or running water, while the rich bathe at home; and they will not touch food till they have washed."[11] One will have to purify himself before performing prayers and worship. It means that before prayer and fidelity one has to be pure from all physical and mental stresses. In Indian traditions water of holy rivers, wells, and ponds has been considered an effective means of purification.

As water is a purifying agent in Hinduism, no *samskar* can be completed without water.[12] Water was used in religious and social ceremonies as it was believed that the divine and pure water convey the offerings of gods.[13] People regularly visited the rivers and tanks which they believed divine.[14]It was a common perception in the society that the water of these rivers, wells and tanks contained supernatural powers through which they can modify

their life. For many occasions water of these sources was used for gaining worldly desired as well as to improve next life. For attaining these desires, the most common practice has been the pilgrimage of various places. India has been the "land of water pilgrims par excellence not only in term of tradition but also in scale."[15]Foreign travelers who visited India during medieval period have left the detailed description on the Indian traditions and social customs which still followed by the contemporary society.[16]

"The ritual need for water is augmented by the belief that gods dwell and pass their time near water, particularly along river banks, and that therefore it is more likely that gods will permanently inhabit temples located close to water."[17] To the Indian craftsman the construction of a well, *baoli*(step-well), tank has been as much a religious work as the building of a religious shrine.[18]Al-Biruni has mentioned the *kunds* of Multan and Kurukshetra (Thanesar) where people worshiped by bathing themselves.[19] He elaborately described the architecture and system of using these ponds by the people. According to him, the Hindus think that on the occasion of eclipse, the pond at Kurukshetra receives water from all other ponds therefore if a person take bath here, he had washed in all holy ponds.[20] Description of father Monserrate on the temple of Mathura is also evident where he mentioned that "Huge crowds of pilgrims come from all over India to this temple, which is situated on the high bank of the *Jomanis* (Yamuna)…they must dip themselves several times into the river, that the water may wash away their sins: for the *Brachmanae (Brahmans)* promise forgiveness of all sins to those who have bathed in this water."[21]

Like Hinduism, special attention towards water has also been paid in Islam **"**The similarity in the attitude and the approach to water supply over a period of one and half thousands years, expressed in 'Hindu' as well as 'Islamic statements' is remarkable indeed. If the 'Hindu epigraphs' claims spiritual merit though digging of wells and construction of tanks and if Hindu religious works promise '*Sivaloka'* and permanent emancipation *(moksa)*, the 'Islamic writing' not only promise attainment of 'paradise' through such acts but go further and claim the presence of the divine, of Kauthar, in their handiwork".[22] In Arabic the word *ma'* is used for water which occurs sixty three times in the holly book Quran.[23] It is believed that "the water is sent by *Allah*, and the Prophet is frequently compared to blessed rain or a river flowing into the divine ocean of life".[24]Water is considered as the most valuable creation of God after human being,[25]from which "God created every living creature"[26]In imaginary Paradise, along with others, a river of pure and fresh water wold be expected.[27]It is worthy mentioned in the Holly *Quran* that "God sends down water from the

sky. With it we produce vegetation of all kinds, from which We bring greenery, from which We produce grains in clusters."[28]Water is source of life in Islam which "is absorbed by the plants of the earth, from which the people and animal eat."[29] For a follower of Islam, water not only signifies the material economy and spiritual force but also is an 'image of the soul'. Offering water to the pilgrims is as equal and fruitful as believing in the God.[30]

Water is reflected as source of life in Islam and is believed to refresh both body and spirit.[31]It has also been regarded as a "vehicle of purification and enjoys an almost sacramental status."[32] Islamic worship necessitated customary ablution (*wudu*) as an essential preliminary. Before praying *namaz* he must be in a state of ritual purity *(wudu and ghusl)* by washing hand, face and feet. *Ghusl* (washing of the whole body) should be made in a place of total privacy and one should not face towards *kiblah* while doing this. In this process it is instructed that only use sufficient water not to be skimped or wasted. "Intermediate between external and internal features is the ablution fountain, generally located in the centre of the courtyard to emphasize the initiatic function of water in Islam".[33]Water, which is provided by God, is not a private property but everyone, whether rich or poor, have its equal share.[34]It has been mentioned that water should not be wasted as God does not like those who wasted it.[35] The priorities have also fixed in Islam regarding the use of water.[36]

Water and Water Structures:

Water is necessary for the prosperity and economic stability of any state as it has the power to convert the deserted area into productive land. Man has always given preference the land which is proximity of good water. Agriculture has been the main occupation of the majority of people of India and the major source of state revenue since ancient period. A good and sufficient supply of water was always necessary for the growth of state revenue. It was considered more important than the land.[37] Water was received in two ways; natural and unnatural or man-made. The source of natural water has been rivers, springs, lakes whereas the unnatural sources include artificial lakes, canals, wells and tanks.[38] Most of the rain water falling from sky was carried to the oceans by numerous rivers therefore it becomes necessary to store this rain water for further use during the time it required more i.e. in summer.

Mauryan were aware about the importance of water and hence they took keen interest in making various irrigational schemes. It is suggested in *Arthashstra* that a king should construct various *setu* (reservoir) and fill them by other water sources.[39] He should also make daily inspection of these reservoirs.[40] State provided irrigational facilities and regulated water

supply for the benefits of cultivators. As per the description left by Megasthenis, the state officials measured the land and inspect the major channels through which water was released into smaller channels.[41] Ring wells were constructed for the first time in Gangetic plains which gradually spread beyond the boundaries of Patliputra. Water of these wells was utilized for domestic purposes which also served as "soak pits in congested settlements."[42]

Tax or revenue concessions were provided to those who either constructed new water structures or repaired the old ones.[43] Water was very precious so the provisions of punishment were made to those who try to destroy the water structure or affected their flow.[44] At the distance of every two to three kilometres, emperor Ashoka erected wells for human beings as well as cattle.[45] He also established *apanani* or drinking water stations and provided water in pots for both human beings and cattle.[46]Ashoka provided sluices or outlets in the Sudarshanlake to release water for irrigation.[47]During Gupta period, *Nadimmatrka* was used for the land which got irrigation from the river.Apart from wells and embankments, two sets of channels have also been mentioned: *Bandhya*, dug for apply water in the field and *Kheya*, to drain out excess water of the field.[48]

Keeping in view the significance of water in various purposes, medieval rulers paid special attention towards erecting step wells, wells, tanks, canals, water chutes and waterfalls etc. Due to the availability of good quality water, a particular area was developed into a specific industry.[49] If production was not sufficient, farmers used to run away and left the land uncultivated.***[50]*** It affected the income and strength of state economy. On many occasions due to heavy rains, a huge amount of cultivation used to get damaged. Both these causes stimulated rulers to make provisions for rain water harvesting. The state undertook the erection of canals and tanks/reservoirs and the responsibilities were put under the care of local officers such as *darpogah*.[51] The village community was also responsible for these works.[52]

Water has been the most focal factor in the history of urbanization in India. As water and water architecture has pivotal position in life of the people, it has been given an important and central position in the layout of towns and settlements. "Water flowed through medieval cities and in enclosed gardens, forming a backbone of urban patterns: a historical study of urban morphology would need to examine not only residential typologies and monuments, but also the location and distribution of water."[53] Most of the ancient and medieval Indian towns were developed on the banks of rivers, lakes, artificial tanks and reservoirs. Water structures and religious shrines have maintained close association. Either any temple was constructed on the bank of river or any water structure found constructed

near any temple. Due to the heavy crowd, many people started selling goods and laid out their stalls near these structures.[54] These places gradually developed into places of public gathering. People of surrounding areas gathered here and celebrate rituals and functions.

Very fewer references are survived of water structures which erected during early Turks and Khiljis. In order to reduce the prices of grains Sultan Alaudin Khilji directed Malik Kabool to build the large magazines upon the rivers Ganga and Yamuna and also other relevant places which would be convenient for water carriage.[55] But those were Tughlaqs who showed keen interest in making various types of water structures such as tanks, step-wells, channels, dams and bridges which could visualised in the forts of Tughlaqabad and Firoz Shah Kotla and surroundings as well. They developed their forts for residential, administrative and military purposes in which water structures have occupied special places. At each end of the dam was a tower with an octagonal chamber, probably designed for the dam's maintenance crew and for guards protecting the walls.[56] He also provides advanced loan to the farmers to dig well in order to increase the cultivated area during the great famine of his reign.[57]

Contribution of Firoz Shah Tughlaq, particularly, is considerable as he showed special interest in providing water facilities for irrigation. Central focus of Firoz Shah remained different from earlier *sultans* of Delhi and he spent money on urban and agricultural engineering projects rather than on defence.[58]He constructed 50 Dams, 30 reservoirs, 100 public baths, 150 bridges and 10 public wells.[59]He not only constructed new water structures but also repaired the old structures. He used to say that it is his duty to repair every public structure of utility which were constructed by his predecessors, including wells, reservoirs of water, aqueducts and canals.[60] Bringing new lands into cultivation was also a source of income for the sultan. The dry lands around the new city of Hissar required extensive irrigation, and the sultan's own funds not only paid for much of the city but also for two canals, flowing from the Jumna and the Sutlej, which doubled the area's agricultural capacity.[61]For rainy season Firoz Shah appointed officers “to examine the banks of all water courses, and report how far the inundations extended. The author’s father was several times appointed on this duty. The Sultan was greatly pleased when he heard of the spread of the waters. If any village in his estate went to ruin, he dismissed the officers in disgrace, and so during his reign the country was thriving and prosperous.”[62]

Water management became an essential feature of Mughal building construction. During this period water was started using in many ways in buildings. In 16th century, while visiting the area surrounding Delhi and Agra, Babur noticed the lack of water structures in the countryside as well as in the palaces. Babur observed that "The greater part of the Hindustan country is situated on level land. Many though its towns and cultivated lands are, it nowhere has running waters. Rivers and, in some places, standing-waters are its 'running-waters'. Even where, as for some towns, it is practicable to convey water by digging channels this is not done."[63] However further he also mentioned "that towns and countries subsist on the water of wells or on such as collects in tanks during the rains."[64]Babur introduced a tradition where water was used for luxury. He, however, did not concentrate on the huge project of civil works but he was more focused on the gardens specially its wells, pools and channels.[65] He has left a detail description where he shows interest in constructing water structures particularly, step-wells and gardens. Sher Shah continued the tradition as he constructed *serai* on the highways and adorned them with the wells.[66]

Emperor Akbar built a new city Fatehpur Sikri with fulls of hydraulic works such as step-wells, H*ammams*, artificial lakes, water channels etc.[67]During his reign canals of Sultan Firoz Shah were renovated and repaired, first by Shihabuddin Khan and later Nuruddin Muhammad Tarkhan.[68] In his 22nd year of reign when Akbar was returning from Ajmer, he noticed the bad conditions of water reservoirs. He, then, visited neighborhood and reservoirs cleaned up immediately.[69]Akbar constituted Water Department and appointed Khwaja Hasan as his head who was responsible for arrangements of the *sharbatkhana*, *sucikhana* (the wine cellar) and canals.[70]AbulFazl has mentioned some workman, with wages, who were engaged in various water related professions:

i. *Chah-kan*or (well-diggers): first class workman gets 2 *dams* per yards; second class workman gets 1.5 *dams* per yard and third class gets 1.50 *dam*.[71]

ii. *Ghota-khur*or (divers): this class of workmen clean wells and their wages depends on the season. In the cols season they gets "4 *dams per diem*; in the hot season, 3 *d*. by the job, 2 *R* for cleaning a depth of 1 *gaz*."[72]

iii. *Abkash*or (water carriers): first class workman gets 3 *dam* while second class workman gets 2 *dam per diem*. These were "used for furnishing house-builders with water for mortar and quicklime, get 2 *d* per diem."[73]

Jahangir was well aware about the significance of water. On water and water structures he issued some conduct (*dasturu-l-'amal*) to the nobles and common masses of the empire.[74]Reign of Shahjahan is considered the finest period in terms of construction of canals, wells and other water monuments. The previous water works were repaired and modified and tried to make available for better purposes. He also constructed *Nahr-i-Faiz, Shah Nahar* and *Ravi Nahar* to fulfill the requirements of the empire. During the reign of Aurangjeb the preference was given to digging wells. In one of his *firmans* (ruler's orders) he ordered to his *croris*(sub-collectors) to repair the old wells and sink new ones.[75]

Due to the efforts of rulers, a considerable understanding and awareness, in terms of water, was developed during medieval period. The important thing happened during this period was the wealthy contribution of nobility and prosperous people in building the wells, step wells, pond, canals and other water works. The houses of great and wealthy people (which they called *mahals*) were adorned with tanks and gardens inside.[76] Due to the immense utilization of water Karl Wittfogel has described medieval Indian society, especially Mughal, as 'hydraulic'.[77]

Water drawing mechanism and supply through channels and pipelines:

Rain, no doubt, was the main source of water but due to its limitation and irregularities[78] human effort was required to supply the water of rivers, lakes, ponds and other natural and artificial sources to the fields, gardens and other areas.[79] Attempts were made for regulating and utilizing the rain water during medieval India. Circulation of water in different parts required efficient system of canals, channels and conduits. Two principle methods have been adopted in India for irrigation; by lifting irrigation and by gravity flow of water.[80] Water in Tanks and wells required water lifting devices so that water can be drawn and distributed on high places also. Where water was not possible to be lifted mechanically, arrangements were made for people to approach water through flights of steps. But in both conditions a highly developed mechanical knowledge and expertise was required.[81]

There has been a great tradition in India of drawing water from various water resources. The most primitive and uncomplicated method was to collect the water in a vessel and carry it on head. But this method was only operational where the water was easily approachable such as rivers, lakes and ponds.[82] People of Indus civilization used to tie the earthen pots to the lengthy rope with other device to draw water from the wells. During Vedic

period many terms were used for lifting water such as *asmachakra, drone* and *ghatyantra.*[83] Mahatma Buddh permitted monks for using three water lifting devices: *tulam* (resembling the balance of merchant, it was the pulley for lifting water), *Karakataka* (device for drawing water with the help of long rope or strap, either manually or by using bull) and Cakkavttakam, (*arahattaghatiyantra*).[84] While describing the irrigational charges, Kautilya has mentioned some categories of cultivators who received water through different methods*: hastapravartimam* (who cultivate irrigating by manual labour)*, skandhapravartimam* (who cultivate by carrying water on shoulders)*, srotoyantrapravartimam* (who cultivate by water lifts) and *nadisarastatakakupodhatam* (who cultivate by raising water from river, lakes, tanks and wells).[85]In *Astadhayayi* of Panini a term, *Yugavarata*, has been mention which means the yoke and the rope or strap through which bullocks were driven for drawing water.[86]

In medieval India the various ancient systems of drawing water were continued. Some of them were modified and some other mechanisms were invented. There were verities of devices across the region which created to lift water from wells, rivers, canals, tanks or other low places to high places. In rural areas these were required especially for irrigation whereas in urban areas were the only means through which water was carried to the forts. Without these water lifting devices it was impossible to run fountains in gardens or other pleasing places. With the help of sources, especially contemporary paintings, historians are able to explain the functioning of various water lifting devices prevailed during medieval India.

Chadas or *charas*[87] was the most common method in India for drawing water from the well. It, as has been mentioned above, was among those methods which were allowed by Buddha to his monks. *Chadas* or *charas* was a huge leather bag or bucket which, in a round, could draw enormous water from the well. In 16th century when Babur came to India he noticed this method and described in his account: "In Agra, Chandwar, Biana and those parts, again, people water with a bucket; this is a laborious and filthy way. At the well-edge they set up a fork of wood, having a roller adjusted between the forks, tie a rope to a large bucket, put the rope over the roller, and tie its other end to the bullock. One person must drive the bullock, another empty the bucket."[88] But, according to him, this was a very dirty method as "every time the bullock turns after having drawn the bucket out of the well, that rope lies on the bullock-track, in pollution of urine and dung, before it descends again into the well."[89] This system was operated in both manners i.e. by using animal power or without it. Animal power was used where the need of water was excessive but where the water was required in less quantity, it was used without animal power, as he further mentioned that "to some crops

needing water, men and women carry it by repeated efforts in pitchers."[90] The description of Babur shows that the Pulley with animal power was used for agriculture whereas for drinking, washing and less watering into fields, it was enough to utilised man power only.

Dhenkli or *dhenkuli*[91] wasanother significant method prevailed in India was called *Dhenkli* or *dhenkuli.* In this system "a long rope is lashed to the fork of an upright beam or trunk of a tree (especially meant for this purpose) to put it in a swinging position. The bucket is fastened to a rope whose other end was tied to the one end of the swinging pole hovering over the well. The pole's other end carries a 'counterweight', a little heavier than the bucket when filled with water."[92] Stone or lower part of any tree could have been utilised for the counterweight. It was the simplest method of drawing water which "requires only a little effort on the part of the person operating it: he has only to give a light upward thrust when the bucket is drawn up full of water; the counterweight at the other end of the pole does the rest of the work. Slightly more effort, however, should have to be mustered by the operator when he forces the empty bucket downwards."[93] In his account John Fryer mentioned that through this system water is drawn "by a thwart Post poised with a sufficient weight at the extremity.[94] Based on the lever principle, it has been applicable to the areas where water level is not deep but found close to the surface level.[95] Historians believe that this device was very similar to *srotoyantra* which have been mentioned in Arthshastra.[96]

Noria[97] is the other devise which has been used in India since ancient times. "The *noria* consists of a large wheel having a series of containers fastened inside of the rim. In the less developed forms these containers are rigid. They are partially filled with water as they pass through the stream and they begin to discharge before they have reached the top, so that the water cannot be raised to the full height of the diameter of the wheel."[98] Reference of this water lifting device could be traced in old Indian texts such as Mrichkatika. During a conversation with Vasantasena and Sharvilaka, the leading hero of the play, Charudatta compare their destiny with a garland of pots, attached to a well, whose some pots are in the water, some have been filled with water and rest are waiting their number:

"Fate plays with us like buckets at the well,
Where one is filled, and one an empty shell,
Where one is rising, while another falls;
And shows how life is change-now heaven, now hell."[99]

A similar type of reference can be traced in Harcharita also, where handling a rosary has been symbolising "like a 'Persian wheel' containing the buckets for raising water from the well."[100] It was then known as *arghatt, arghattak, ghatiyantra* etc.[101] later on it was commonly pronounced as *rahat*or*arahat*.[102]*Noria* has limitation in terms of utilisation, as it would lift water only from the level which could not be beyond from the core of the wheel than its range.[103] It was, therefore, suitable for rivers, lakes, ponds; not wells. But, as we have the reference of *Harshacharita* above, it, from 4th century onwards, was started using in wells also.[104]

Another similar type of water lifting mechanism, *saqiya* was also in used in India during medieval period.[105] This was the developed version of *noria*. "When water was to be raised to even greater heights, or when relatively deep wells were involved, the principle of the *noria* was modified by attaching the buckets to a belt which passed over drums at the top and bottom of the lift."[106] But still there is an uncertainty of utilising gearing in India. Firoz Shah Tughlaq provided a well-wheel, with attached pot-garland, over a well built on the bank of a tank at Delhi but it is not clear whether it was run with using gearing or animal power.[107]

When Babur came to India in early 16th century, he saw the unique form of water lifting. "In Lahor, Dibalpur and those parts, people water by means of a wheel. They make two circles of ropes long enough to suit the depth of the well, fix strips of wood between them, and on these fasten pitchers. The ropes with the wood and attached pitchers are put over the well-wheel. At one end of the wheel axle a second wheel is fixed, and close to it another on an upright axle. This last wheel the bullock turns; its teeth catch in the teeth of the second, and thus the wheel with the pitchers is turned. A trough is set where the water empties from the pitchers and from this the water is conveyed everywhere."[108] This description of Babur removes curtains from many issues. This was the first statement of the use of this device in India which is known as geared *saqiya* or Persian wheel**.[109]** As per the description there were three wheels; one containing the pot garland and connected with the other wheel on the same axle; the cogs of this second wheel engaged with the third horizontal wheel. This last wheel is again connected with the ox and rotates with the movement of ox. As soon as the wheel moves, the second wheel also moves due to the engaged cogs and ultimately the wheel, containing pot-garland, run. From a contemporary painting of Sanwla, Irfan Habib have drawn the information that "the gears were formed by wooden pegs joining two horizontal circular boards, the pegs being so spaced as to mesh with pegs jutting out from the rim of a vertical wheel placed on the same axle as the main well-wheel, which carried the chain of pots. The kind of gearing is known technically as 'pin drum' or 'lantern' gearing.

"[110] Due to the non-existence of this device in writings of Sultanate period, historians considered its origin out of India which came from Mediterranean and Iraq during the beginning of the fifteenth century. When Babur came to India it was already in use in Sindh where it was operated by camels.[111]

Apart from the aforementioned water lifting devices, Abul Fazl attributed to Akbar some more inventions which has been cited by Irfan Habib; "His Majesty made such water-wheels *(daulab'ha)*, and such (gear-) wheels *(gardunha)* that [I] water may be lifted from distant low-lying places. [II] Two oxen may also turn four wheels *(charkh)* simultaneously; and [III] also with one ox, turning two-wheels, water is brought up from two wells, and a water-mill is turned."[112] In invention (I), which is illustrated in Nizami's *Khamsa*, "while the ox remains on the ground, rotating a high vertical axle by going round and round with a drawbar, the axle caries at or near its top (in one illustration, it seems to be attached to another post for stability; in the other it stands clear) a pin drum, with whose pins mesh pegs of a vertical wheel. The latter wheel in turn rotates the chain-of-pots wheel, placed on the same axle, and thus water is lifted up to the level of the pin-drum."[113] Effect of this effort could be visualized in the great water works of Fatehpur Sikri where water was lifted and utilised at a substantial heights. Invention (II) and (III) were basically the outcome of the development made in the gearing system.[114] Peter Mundy has described this function in his account but he use the word *Noria* for this device.[115] Till the beginning of the last quarter of the nineteenth century, wood had been used as material for the Persian wheel which later replaced by the metallic wheel and bucket chain. The awkward lantern gearing was also replaced by the toothed wheels.[116]

With the help of Persian wheel medieval rulers of India were able to supply sufficient water for irrigation work. It was "highly important for the relatively dry Indus basin because it could give constant flow, both when the ground water was close to the surface and when it was present only at great depth, where, though, a more distant spacing of pots on the chain might be required to reduce the weight."[117] Where in the first quarter of the 16th century Babur complaint about the less water in India, the scenario had been changed with in hundred years when in the first half of 17th century (1616-19) Edward Terry mentioned "besides their rivers, they have store of wells, fed with springs, upon which in many places they bestow great cost in stone-worke (work). To these they have many ponds, which they call tankes (tanks); some of them more than a mile or two in compasse (compass), made round of square, girt about with fairc (fair) stone walls, within which steps of well-squared stone which

encompasse (encompass) the water, for men every way to goedowne (go down) and take it. These tanks are filled when that abundance of raine (rain) falls, and keepe (keep) water to relieve the inhabitants that dwell farre (far) from springs or rivers, till that wet season come againe (again)."[118]It is true that in pre- modernvillages of north India almost all wells were made of *kachcha* material and were dug not for permanent use but people used to prefer digging every year a new well.[119] People usually digging wells during December and January when they sow wheat, *sarson*, barley, *chana, masur, matar* and other various pulses.[120] But unfortunately these *kachcha* materials were not permanent and disappear with the passage of time.

Water structures in Medieval South-East Punjab (now Haryana):

Geographically, Medieval South-East Punjab now Haryana state is bounded on the northwest by Punjab, on the north and northeast by Himachal Pradesh, on the east by Uttar Pradesh and the Union territory of Delhi and on the south and southwest by Rajasthan. Most of Haryana lies on the Indo-Gangetic Plain, but in the northeast, there is an extension of the low, Sub-Himalayan Siwalik Hills. The state on the whole is flat and the average height ranging from 700 to 900 feet above sea level. It is drained by one perennial river, the Yamuna, which does not flow in the state but forms its eastern border with Uttar Pradesh. There are numerous seasonal streams, the most important being the Ghaggar, which flows out of the Siwalik hills and forms its north-western border with Punjab. Rainfall is scanty in most areas. Although the state has a system of canal irrigation, there are chronic drought prone areas and occasional floods from the tributaries of the Yamuna and the Ghaggar. The climate is hot in summer and markedly cold in winter. The maximum temperature in summer (May-June) goes up to 46° C. the minimum temperature -2° C occurs in January. The soils are deep and fertile except in the eroded lands of the southeast and southwest where, bordering the *Thar* Desert in Rajasthan, they are sandy. During medieval times various types of structures were built by the rulers and their officials in modern Haryana region. Under this present project an attempt is being made to examine the following structures in the context of water management:

1. Stepwell or Baoli (Five Stepwells)
2. *Takht* of Mirza Ali Zan at Narnaul
3. *Jal Mahal* at Narnaul
4. *Madrasa* and garden inside the tomb of *Seikh* Chehli.

5. Mughal garden at Pinjore
6. Palace of Firoz Shah at Hissar

1. Stepwell or Baoli

Availability of good ground water, its effective preservation and erection of water monuments were some basic challenges which were felt throughout medieval India. In many parts, specially western and north-western India, this problem was resolved by constructing *baolis* or stepwells.[121] *Baoli* is basically a well that can be accessed with the help of descending stairway. In India, these structures are mainly found in the arid north-western region due to the scarcity of water. This is a monument of which the major portion is under the level of ground and comprisessome specific features of building construction. The key features which a *baoli* consistsare; a circular or octagonal well (*kupa, kua, kuo*) with water drawing mechanism; the stepped corridor, running from the entrance to the water level of the well; various intermediate tower (*kuta*) like pavilions built as open halls (*mandapa*) in the stepped corridor.[122]These are basically structure of great utility specially where the water level is found very low. However, architecturally these are specimen of great technological skill of a particular period or area. It also reflects the level of understanding of those people who used natural resources to overcome their necessities.

The location and construction style of a *baoli* reflected its utilization. *Baolis* were often constructed close to the tombs, mosques and temples where people washed and bathed before prayers. Water of these *baolis* was considered sacred by using which one would get rid of their sins.The stepped corridor in a *baoli* is the symbol of transition from this physical world to spiritual world.[123] When a stepwell was erected within or at the edge of a village, it was mainly used for utilitarian purposes and as a place for social gatherings.Various ceremonies were performed at the *baolis* by local women, who prayed and made their offerings. Such stepwells were also used as covered spaces for social interaction where discussions were held on various issues.[124] The *baolis* which were erected on trade roots were very useful for the various trading communities (*carvans*) as they used to reside around these *baoli*s while their journey and stay.They were often frequented as resting places.[125]

Stepwells which were constructed away from any major river but situated near the seasonal streams or low places, were used as source of drinking water throughout the year. The purpose of construction here, apart from drinking, was its use as a resting place where travellers also used to spend their cold nights especially during local travels. The *baolis* were also used as a cooling chamber during the hot seasons. The stepwell's corridor was always open to the sky. The galleries and chambers surrounding these wells were often carved profusely and provided aesthetic experience to the visitors.[126] It became cool, quiet retreats during summers. The temperature of a step well in summer was cooler than the earth above it.[127]

Description of existence of several stepwells in modern Haryana region is available in various pre-modern and modern texts and reports. Based on the information, a detailed field work of five stepwells was undertaken during the present work. List of these five *baolis* is as follows which are described further as per chronological order of their construction:

i. *Baoli* of Luhari, Jhajjar, Haryana
ii. *Baoli*adjacentto the Hanuman temple, Thanesar, Haryana
iii. *Baoli* of Mukundpur (near Narnaul), Haryana
iv. *Baoli* of Saidu Kalal, Meham, Haryana
v. *Baoli* of Kaithal, Haryana

i. *Baoli* of Luhari, Jhajjar, Haryana

In modern Haryana region, an old *baoli,* which I was able to explore, is situated in Luhari village.[128] Luhari is situated on Pataudi to Jhajjar road and the *baoli* lies about 100 metre on west of main road. It is known as *Mughalia baoli* or *Mughlon ki baoli*.[129] However, the architectural style suggests that it was built during Lodhi period.[130]During my visit, the villagers informed that there was an inscription engraved on a stone slab which is not available now.

The *baoli* lies north to south where the entrance is on the north side. It is rectangular in shape that runs, internally, 30'9" from east to west and 63'4" from north to south. The whole structure is made of dressed stones and rubbles. A series ofstairs[131]descend towards the well. Upper portion of the *baoli* has been adorned with 6 small blind niches on both eastern and western wall of the *baoli*. A remains of an archway is still available in the *baoli*, however, due to the invisibleness, the size and level of this archway is not clear. At the end of

the stepped corridor, a circular well is available which in recent times has been covered.Between the well and stepped corridor, remains of a rectangular tanks are still available. Through the stairways people could access the water of this tank from the inner sides.

The side walls running parallel to the stepped corridor are adorned with six deep niches on each side. On different levels of the stepped corridor, pathways have been erected to access the chambers and well. The height of these pathways suggests that these levels were largely utilised as per the water level in the *baoli* that fluctuated according to the weather. It can be more explained in the way that water level, especially in rainy seasons, was usually remained high. But as soon as the water level used to fell down, it was not easy to access water without constructing these pathwaysspecially for those who could not able to walk down such as physical handicapped, women and aged persons. The widths of the side pathways are different at each level. The width of upper two pathways is about 2' whereas the lower two level has width of 1'7". Narrow stairways[132] have been built on either side to easy access the pathways and uppermost portion of the *baoli* which also, unfortunately, not survived today.Chambers, comprising two archways, have been erected on both sides of the well which could be accessed with the help of side pathways. Two enclosed chamber on either sides of entrance are still available. Earlier it was single storey chamber but later on another floor was added. Height of side walls of stepped corridor and well were also raised at that time.[133]

Remaining well shafts[134] show that water used to be hauled up from the well with the application of water lifting devices. Unfortunately remains of water channels have been buried and destroyed in recent times, so, the extant of management and distribution of water is not clear. Also, non-existence of any major structure in the proximity suggests that this *baoli* was not used for any pleasant place. In general, it was a small structure which seems to be used to fulfil the local need of water and by which travellers also benefitted.

No historical information is available about this *baoli.* It is not a protected monument.It is in bad condition and, due to the negligence, it has turned into garbage dumping where people used to throwing their waste material. Immediate preservation can only save this great and traditional method of water conservation and preservation.

ii. *Baoli* adjacent to the Hanuman temple, Thanesar, Haryana

A small *baoli*[135]exist outside the city of Thanesar which is commonly known as the *mandirwali baoli*or *baoli* of Sarsawati-Hanuman temple. It is in the close proximity of the tomb of *Saikh* Chehli and a *serai* of seventeenth century on old Shershah Suri road. Made in *lakhori* bricks, this *baoli* runs north to south and its dimension is very less. It runs 40' from north to south and 8'9" from east to west. An archway survived inside the *baoli* and at the end of stairways a circular well is still visible.[136] One can access the well through a stepped corridor, comprising 12' wide steps, which descend and lead to the well.[137] On both sides of stepped corridor, pathways of 4' each have also been constructed through which one can reach to the upper portion of the well.[138] There is a small archway erected in the wall of the well which connects it to the stepped corridor.[139] Remains of having more sub-structures over and around it are not available.

It is not evident that the water of this *baoli* was considered holy or used exclusively for performing religious rituals. The architecture style of the temple suggests that it was not the part of original construction but added later. Also, we do not find any description of organizing any huge religious ceremony here from which it is known that the water of this *baoli* was used in religious rituals. Keeping in mind the location and size of the *baoli*, it can be easily envisaged that this *baoli* was also not used for irrigation purposes. The primary use of this *baoli* was for drinking and bathing purposes. Like many other isolated *baolis*, no contemporary historical information has been traced out about the builder and its construction. However, it has been mentioned that this *baoli*was constructed in 1480 A.D[140] which I believe is not reflecting from its construction style. As mentioned earlier, this *baoli*is in the proximity of a large medieval *serai*andtomb and *madarsa* of *Shaikh* Chehliof seventeenth centuries.Remains are not available of having any major water body near this *serai* so it is quite possible that the water of this *baoli* was utilized by the travellers and residents of the *serai* and tomb.As water was needed in huge amount, the well might have been once adorned with the water shafts through which water was drawn by using Persian wheel.Outwardly the well, in this context, must have been adorned with any water tank and water channels on southern side through which water was carried to the *serai*. However, due to the heavy decay of the structure and rapid urbanization, all have been converted into ruin and not survived today.

This *baoli* is not a protected site and its maximum part has either collapsed or occupied by the residents from the neighbourhood. It needs preservation with immediate effect to save it from complete ruination.

iii. *Baoli* of Mukundpura, (near Narnaul), Haryana

At the bottom of Aravali hills and on the eastern side of the Maukundpura village a small but magnificent *baoli*[141] is situated. Mukundpura is a small village situated around 7-8 km from Narnaul Bus stand in Mahendragarh district of Haryana state. As name suggests, this village must have been related to Rai Mukund Das who was a noble of Shahjahan and was appointed as *Divan-i-Bayutat* (Superintendent of buildings etc.).[142] Narnaul was his native place and residence where he erected many buildings.[143] Since he was responsible for various building activities, we can relate the construction of *baoli* to him.

No contemporary historical information is available on the construction work of this *baoli* and we depend on the archaeological evidences for the fundamental information.The *baoli* is in good condition whose principal portions is still survived and could be visualized properly. Flanked with a huge arch, it is a four storey structure that is very similar to the *baoli* of Mirza Ali Zan's *Takht* in Narnaul in construction style.[144]The *baoli* runs west to east where the entrance is on the west. The structure is made of undressed rubble masonry with association of limemortar. Black stone slabs have been used on roof and for constructing pathways on each level. Stones are full of glittering elements due to which these stone slabs shines not only in day time but also in moon light during night. In this way, these pathways are very useful in locating ways during nights. As per measurement taken from the inner side of the *baoli,* it runs 87'4" east to west whereas north to south it is 34'10". The measurement does not include the thickness of the outer walls and well. Like other *baolis* of the region, it also opens with a series of descending steps[145] and ends with a well. A three-tier enclosed chamber, comprising three arches on each tier, have been erected between the well and stepped corridor.[146] Upper tiers are adorned with arcade pavilions on both sides comprising five arches on each side. Since this structure lies in a dry and sandy area,[147] it was good to enclose it to avoid sandy hot winds and extreme heat. These portions were erected for using it as shelter from rain and extreme hot weather of summer. Enclosed chambers also served as an ideal place for spending cold nights of winter. Internally these parallel side chambers are adorned with small niches. At the end of the upper level stairways, containing 13 steps on each side, have been erected to access the roof. These stairways are very narrow having the

width of 1'9" and maintaining the height of 1' between every step. The roof is flanked with four *chhatris* on each corner where each *chhatri* stands on four pillars and having small dome on top due to which this *baoli* could be seen from the long distance.[148]

The *baoli* is embellished with four sets of stairways at different levels to excess its various levels. As we go inside the *baoli*, it gets narrower. As soon as we enter the *baoli*, 20 steps run down towards the next level. After 7 steps, a passageway has been erected to access of upper storey of the *baoli*. Like *baoli* of Mirza Ali Zan at Narnaul, it is also flanked with a massive arch covering the whole entrance of the arcade pavilions of all tiers.[149]Under second set of staircase, 9 steps descend towards water tank, which is constructed between the stepped corridor and octagonal well. There is another set of stairs which is the only way to enter into the tank. Tank[150] is rectangular in size having width 18'10" and depth of 17'8". It is remarkable that where the rest of staircases descend west to east, alongside the walls of chambers, this third level staircase descends from north and south sides of the tank. A set of four stairs, is available on all side of the tank. Last level of staircase with seven steps links tank to well. There is an archway, constructed between the tank and well, through which one could access the water of the well from the inner side of the *baoli*.[151]Well is multi-shaped whose lower portion is round whereas the upper portion is octagonal.[152]

Shafts have been constructed over the well for hauling up water. A huge amount of water might have been carried out from the well as a massive stone slab, measuring 11'5" x 8', is still available on the east of the well.[153]A small cistern measuring 3' x 2'10" is also erected here. With the help of small holes on all sides except west, water used to release in three sides. Minor structure, which was erected on south, has been demolished. However, a *khel* (small cistern) on east side and a water tank on north side still survive.[154]I was able to take some photographs of the *khel* and was not able to take measurement as it is occupied by the neighbouring resident. A small tank measuring 4'6" x 3'6" is still available on north sides of the *baoli*.[155] This tank is connected to the stone slab through underground channels. There was also a tank on the south of the well but today only remains are available.[156]There are three holes on east, north and south sides of the slab through which water was released to these abovementioned *khel* and tanks.

The stone slab which has been mentioned, is severely bend on the lower side. The size of well and stone slab and their underground links shows that a huge amount of water used to be hauled from the well. It was successfully achieved with the application of Persian wheel.

Efforts were made here for utilizing maximum water through constructing water channels and small tanks. The well is very deep which is well reflecting the topography and ecosystem of this area. During rainy seasons enormous water from the surrounding hills used to collect here so the level of ground water was maintained. The structure is still in good condition.

iv. *Baoli* of Saidu Kalal in Meham, Haryana

The *baoli* of SaiduKalal in Meham (Lat. 28°54' N; Long. 77°18' E)[157] is considered the finest and well-preserved stepwell of Haryana.[158] According to a Persian inscription[159], engraved on a marble tablet affixed to the eastern wall of the shaft on the well, SaiduKalal, who was in the service of Mughal *Padshah* Shah Jahan as mace bearer (*chobedar*), was responsible for its erection in A.H. 1096 (A.D. 1658-59)[160]. The translation of the inscription is as follows:

"In the reign of the king of kings, conqueror of the world, this spring of paradise was dug by Saidu. When I searched for its date from the sage, he replied 'The water of charity floweth ever'. 1096 *Hijri*."[161]

A detailed description of this *baoli*has been provided by Captain Mundy who considered this "a monument of public utility worthy the munificence of a Roman Emperor."[162] Situated on the south-east of the town this *baoli*lays north- south axes where the entry is from north side. This is basically a three storeys structure and as per the description of C.J. Rodgers, who visited this *baoli* in nineteenth century, and reports of Archaeological Survey of India, it comprises 101 steps leading from entry to the water level.[163]This building descends in three stages and each marked by a platform. The walls are adorned withblind niches[164] and pathways leading to the big screen. Two sets of stairways[165] have been erected on first and second level arcade to easy access the upper portion and vice-versa. The stepped corridor ends with an octagonal tank[166] which further connected with a circular well[167] at the end of the stepped corridor.The octagonal tank comprises deep nicheson all side. It is connected with the well through making a way in one of the deep niches. The excess water of the well as well as the rain water used to collect in this tank. Through the stairways people could easily reach to the water of this tank.

Externally, the well is surrounded by a raised platform on the east, west and south sides.[168] To the east and west sides of the well, two small water tanks have been built on this raised platform where water could be accessed with the help of stairs on all sides.[169]It is

possible that these water tanks were used for religious or social rituals by the local residents as well as travellers. In addition, these tanks might have been beneficial for the disable peoples who could not enter into the *baoli* and were not able to reach to the water level of the tank.

This high platform is surrounded by water channel.The surplus water of the well and abovementioned two tanks were directed to fall into the channel through small water ways[170]where women wash clothes and clean utensils, camels and cows drink from troughs and men sharpen knives on the stone. Surplus water was used either by the artisans of different occupations or in irrigation of plants. Water shafts are still available over the well[171]through which water was carried outwith the application of water lifting devices.The location of this *baoli*suggests that its water was not used for major irrigation purposes,however,we have informed that during later period in nineteenth century it was primarily used for irrigation purposes.[172]

The *baoli*at Maham is builtoutside the locality in a plain terrain which is almost under the level of ground and nothing is visible on the surface except the upper portion of well and raised platform. This *baoli* is lying from north to south and due to the safety from dust and sunrays it is ecologically ideal hydraulic structure. In the construction of *baoli* both trabeate and arcuate styles[173] have been utilized and brick, *kankar* block and lime mortar is used as chief building material. As the location of structure suggests, the *baoli* at Meham was not limited to the royal class but was open for the common masses. The main object of the *baoli*was the fulfilment of the need of the people of the place which also served travellers, voyager and troops, in the medieval period.[174]

The *baoli* is a protected monument under the administrative control of Archaeological Survey of India, vide Notification No: PN, 4891, dated 12.02.1923[175] who has taken some necessary steps regarding his conservation and preservation over the years.The crushed and extricated buff stone flooring of the platform of well was dismantled and work of rearranging was carried out. Its walls were also restored by underpinning the tumbled parts.[176]With the continuation of this work, each damaged portion around the wall of the *baoli* was replaced restored as per the original appearance. The crushed and extricated work of *lakhauri* bricks was also carry out and completed.[177]Its buried portions and outer northern walls were uncovered whereas front portion of the Platform of the *baoli* was laid in lime cement.[178]Pathways, constructed along with the internal walls of the *baoli*, were concreted

and broken and disappeared bricks were replaced with the new ones.[179]Work of restoration of the steps was started and completed along-with the replacement of *lakhauri* brick on walls of *baoli*.[180] The *baoli* of Meham was suffered from a heavy flood, therefore, the restoration work along with the reconstruction of side walls of the *baoli* was continued.[181]Further, the collapsed western walls was restored to become stable the dangling portion of the side wall.[182] When I visited this *baoli* for the first time, I found it full of rain water and during my second visit the renovation was going on by Archaeological Survey of India.

v. *Baoli* of Kaithal, Haryana

A massive *baoli*[183] is situated adjoining the western wall of the old Civil Hospital at Kaithal. No contemporary information is available which could provide about its actual date of construction. As per the description of C.J. Rodgers, it was popularly known as the *baoli* of Sandhas, who was responsible for its construction. It has been mentioned that in its construction about 50,000 rupees were spend.[184] In previous reports of Archaeological Survey of India, a *baoli*in the name of Chhajju Mal has been mentioned at Kaithal[185] but there is no information about the connection of both individuals i.e. Sandhas and Chhajju Mal. For detailed information we largely depend on the monument itself which is still in condition that we can draw some important archaeological information.

The structure runs south to north with having a total length of 277' and width of 36'10", including 8' width of both outer walls (4+4) of *baoli*.One can access the water level with the help of 100 stairs.[186] It is a three storey building[187] with four level stairways which gradually narrow down at each level while descending. Upper storey is open and airy with huge central arcade whereas middle storey is somewhat enclosed. Spaces around the archways have been filled with bricks and given a shape of enclosed chambers. Lower storey of the structure is again an open enclosure where there are steep stairs to reach the water level of the well.[188] Each level of the *baoli* is adorned with side pathways, running parallel to the walls of stepped corridor through which one can access the specific floor of the structure which is marked by a huge central archway.[189] No remains of having water tank between the well and stepped corridor is available. In fact small archway have been erected in the wall of well on all three stages.[190]A huge circular well with remains of shaftsis available at the end of the steeped corridor on north, marks the end of the *baoli*.[191]

The structure is adorned with two rows of arcade at irregular distance which are constructed in the similar style.[192] The upper portions of both rows are comparatively open

which might have been used for getting warm sunrays during the winter seasons. Middle level is enclosed which probably used from the protection of hot air of summers. One can sense coolness in this portion due to the propinquity of water and remoteness of the sun rays.

Sidewalls, running through the stepped corridor, of the upper portion are adorned with deep recess on both sides[193] where geometrical designs have also been engraved. Total width of the first storey structure, including 8' pathways constructed on both sides (4+4), is 28'10" whereas length measuring 16'8". Width of middle storey structure is 22', including 8' width of pathways on both sides (4+4). Lower portion is divided into two parts; one comprising width of 14'7" and the bottom level, whose stairs have almost destroyed, measuring width of 7', excluding 6' area of pathways (3+3). Remains shows that chambers on every storey were full of artistic expressions but due to the negligence, the plaster and paintings of the structure do not survive today.[194]

The entire construction is in bricks, however, stone slabs have been utilized in side pathways and stairways. Lime has been used for coating for the safety of water. In its construction both trabeate and arcuate styles have been utilized. The use of cusped profiles suggests its construction during 17th century.[195]This is not a protected monument,however, a caretaker has been appointed by the Deputy Commissioner of Kaithal. This *baoli* is in good condition but due to the negligence of authorities'lots of wild vegetation hascome up grown. So it requiresimmediate works of restoration and preservation.

Every region has its own geographical and ecological conditions which have a significant impact in the construction of a building. Therefore, apart from some of its special features, there are some more other features also in *baolis* located in this region. For example, an octagonal or circular tank is found available between the well and stepped corridor in almost each *baoli* of substantive size for easy access the water of well through inside. Although *baolis* were usually adorned with shafts which were used for hauling up water yet the steps provide direct access to people who descend the steps to reach the water of the tank specially to feel the coolness during summer. Secondly, there are plateaus in almost every *baoli* to easy access the water.In almost all *baolis*, the entrance is the most open and wide part, but as we go down the stairs to the water level, it becomes narrower. Except some early *baolis*, such as *Gandhak ki baoli,* all are embellished with arcade pavilions at gradual and sequential levels which could be accessed through these pathways.

Thirdly, all *baolis* are erected some above of ground level so that water can be saved from the dust. As the water keeps coming here and accumulating it from the surrounding areas, its level also remains high. Fourthly, *baolis* of Narnaul region, such as *baoli* of Mukundpura, are adorned with *chhatris* through which one can visualise these structure from the long distance. Fifthly, in comparison to the other *baolis* of the area, *baoli* of Mukundpura has been given the shape of a resting place by enclosing it from the inside to get rid from the extreme environment of this area.

Sixthly, direction of the maximum stepwells under the present study is from north to south or south to north. As per the present study, two scientific and practical sturdy reasons were responsible behind the selection of this particular direction: first, in summer seasons the direction of flow of wind remains east and west. During the months of May and June the wind is full of dirt and if the direction of structure is north to south, water could remain safe from the hasty flow of wind. Outer walls of the structure keep the dirt away from the water. Second, protection of water from the sun rays, especially during hot days of summer, was also a very fundamental concern. By choosing direction from north to south the builder had also solved this problem. Sunrays fall straight on the surface during summers and the contact period of water and sunrays is merely 1 to 2 hours which is very less. The huge side walls of *baoli* kept the sunlight away from the inner part and prevented it from the heat of sun.

2. *Takht* of Mirza Ali Zan, Narnaul

Situated in the south-west of Narnaul town,[196]the enclosure of Mirza Ali Jan's *takht* (the throne of Mirza Ali Jan)[197] is a very significant complex in terms of the utilization of water in scientific manner. The principle and earliest building of this complex is a *baoli*[198] that in later period was added with a garden on north[199] side and east[200] portions.

The structure was built by Ali Khan during the reign of Akbar.[201]The main entry to the whole enclosure was through the north side of the garden with small openings on either side.[202]The *takht* is available on the top of the structures. Made in multi-coloured stones, it is basically a pillared pavilion that is based on 8 pillars and having flat roof on top. Parapet is adorned with red sandstone with merlons designs. This *takht* is in trabeate style and adorning with carving in base-relief.[203]This *takht*looks like the *jharokha* of Mughals. This arcade is basically the entrance of the *baoli*. The *baoli*isbasically a four story structure, having *takht* on top (fourth floor), whichcovers the length of 121'. Stairways have been erected alongside the arcade to access the upper portion.[204] Like other *baolis* of the region, this also comprises a

stepped corridor[205] and a well.[206]The innermost portion of the stepped corridor has given the shape of a rectangular tank for accessing the water of the well from inner sides and also for storing extra water of it. It measures 35' north to south and 17'from east to west.[207] One can access and utilise the water of the well here through descending the stepped corridor. Due to the dust, I could reach down to 15 feet but the actual depth is beyond this. 13 steps leading to the water level of the reservoir were traced during the exploration. This reservoir is surrounded by a colonnade *dalan* where brackets and *chhajjas,* in Rajasthani style, have been profoundly used over the arches. The inner walls are adorned with niches.[208] The whole enclosure is made of local available undressed stones and rubbles with *chuna masala*. Black stone has been utilised in *chhajjas* and making pathways.

The common wall of reservoir and well comprises small archways at each level.[209] The well is not in good condition and converted into ruin. However, shafts and water slab are still visible on its western side.[210]In front of the central arcade, on a raised platform of 40' x 46', is a huge octagonal tank in which remains of a fountain still exist.[211] This octagonal tank is 24'2" in diameter whose present depth is 4'3". Location suggests that this octagonal tank was not erected with the *baoli*. It seems that the tank and garden were added later.[212]

Running towards north, once this raised platform ends, the garden area starts which covers the area of 118' x 46'. A pathway of 9'10" has been traced out in the middle which begins from the raised platform and runs through the middle of the garden towards the main entry.[213] Beyond the garden, towards north and between the walls of garden and main entry, an area comprises 38' length is available with remains of staircases on either side.[214] This is the last level of the enclosure and due to the main entry, on north, it looks like the first level through which one enters into the whole enclosure. The third portion of this complex is situated on the eastern side of *baoli*comprising some graves, water tanks and a series of broken arcade. [215] Like the northern garden area, this portion is also in ruin condition. It's all built portions has been collapsed except a series of arcade on western portion.

In this area, this is the only structure of medieval period where water was used so extensively as per principle of Boyle's law. The whole structure is wealthy in terms of hydraulics. With the help of Persian wheel and channels, it is a substantive example of distribution of water of a well in a large area. An effective system was adopted for the smooth functioning of the fountains here. We do not have any written document or inscribed evidence which could provide us more details about the functioning of the well. However,

keeping in mind the construction of the whole structure and available physical remains, it is quite possible that a huge amount of water used to drawn continuously from the well. Size of the well reflects that it was very huge. It also reflects through the fact that a huge stone slab measuring 10'6" x 10'6" is projected on the western side of the well.[216] This slab is further connected to a rectangular water cistern (*khel*) measuring 17'6" x 1'8".[217]Through this slab water was distributed to the whole area as the relics of two tier water channels are still visible in the enclosure. One set of channel runs through the garden[218]and other leads to the eastern area.[219]

The central raised tank was well connected to the well through water channel. Here the principle of siphoning seems to have been adopted for running fountain.The size and the depth of the water channel gradually narrowed down so that the pressure of water would be increased. After crossing the area of *baoli*, the channel suddenly goes down promptly on a slope and falls speedily at the bottom of the fountain. The slope increases the flow of water so that the water of the channel release promptly and the fountain runs effectively. Water channels, starting from the well, do not bound to the tank but proceed towards the end of the garden which could be traced through the remains.[220] The tank is connected to other 1' wide channel through which superfluous water of the fountain used to release into the garden.[221] Between the fountain tank and garden, water used to fall through a sloping ledge.[222] This projected ledge comprises shining elements and it would have been really splendid to visualize running water on the projected ledge in moon light. The two sloping waterfalls were interconnected to each other through small cisterns and waterways.[223] Remains of vegetation of that period do not survive in this garden, all that survives are two water-chutes, formed by receding layers of stone.

The eastern portion of the structure has two small cisterns[224] which were connected to the well through a water channel, constructed over the common wall of the well and stepped corridor.[225]The similar system of hydrology, which was adopted in the garden area, was adopted here. The water channel gradually narrows down, as per Boyle's law, and falls promptlythrough a projected sloping ledge into a cistern which comprises the area of 6'3" x 6'3" x 1'7".[226]This projected ledge is east facing and its stones are full of shining elements. During the first half of the day when the rays of sun fell on the running water of the ledge, the reflection must have been divine. Same expression could be visualized in moon light also. This cistern is further connected to other small cistern through an 8" wide and 5" deep peripheral water channel.[227] The outer walls and apartments of this portion have been fallen

down and it has completely converted into ruin. This eastern portion consist many graves in its courtyards which might have been related to the residents of this building. This eastern portion of the enclosure is very simple and seems to have been used for performing religious rituals. Remains of five huge archways[228] on west, along with *quibla* are still visible which seems to be used for prayer whereas the small cisterns were used for performing the *wuzuh*. This portion, which is surrounded by the water channels, again shows that paradisiacal imagery continues to be a trade mark of Mughal architecture.

A seasonal river, known as Challa Nadi, used to flow alongside the *baoli that* helped in maintaining its water table high around the year.[229] This was not a public utility structure and might have been used exclusively by the select sections of the society. Water channels with running fountains, associate this structure with the paradisiacal imagery traditions. Shining rubles provides this structure extra ordinary look. Based on a sandy piedmont of Dohan River, its fountains and water channels must have once looked impressive and splendid. It is a protected monument under Haryana Archaeology and Museum Departmentvide Notification No. 46-(GOI)-(2)Ed.II-68/3285 dated 15.2.1968[230] but due to the negligence of the administration the structure is turning into ruin speedily with the passage of time. The well and some parts of underground compartments have crumbled and the remaining parts need immediate restoration and preservation.

3. *Jal Mahal*, Narnaul

Situated on the south of Narnaul town there is a huge pool which is locally known as the *Jal Mahal*.[231] It was erected by Shah Quli Khan who was a noble of Akbar and erected many beautiful buildings and dug huge tanks in Narnaul.[232]According to a set of Persian inscription which is placed over the main entrance, it was erected in 1591 A.D. Following is the translation of the inscription:

i. "This pleasant building, which is the envy of *Iram*, its water and air are refreshing like Paradise.
ii. It was built in the reign of Akbar, the victorious, the king who has placed his foot on the heads of the kings of the world.
iii. As Shah Quli Khan has laid its foundation, O God! make it durable like the palace of the highest heaven.

iv. The far-sighted wisdom, for the date of its foundation, said, "This was built in the year 999A.H"- 1591 A.D."[233]

Amidst the pool is a water pavilion where one can reach through a causeway[234], measuring 291' in length and 23'6" width (including 4' width of wall on both sides) with a height of 13'8" (from ground to ceiling of the archways).There is a square platform,covering the area of 85'6" x 85'6", in the centre of the pool. Amidst this platform is a raised square pavilion whose central chamber measures 19'6" x 19'6" whereas the peripheral outer enclosed chamber measures 55'7" x 55'7". With the help of deep squinches[235] the upper portion of the wall of this inner central chamber has been given the octagonal shape. Four open niches have been made in all sides (one in each side) in squinches for allowing sun light in the chamber.[236] These open niches were also useful in throwing out hot air of inner chamber. Earlier these niches were adorned with coloured screens but during the course of time these all have disappeared. These squinches were full of multi-coloured geometrical designs whose remains can still be seen. The inner portion of the pavilion is an adaptation of *hast behisht* arrangement.[237] It is flanked with a huge circular dome over the squinches.[238] It is also flanked with huge central archways on each side and one can access the inner portion through doors, erected in these archways.[239] The inner portion of these archways is adorned with honeycomb style decoration[240] which is again incorporated by two tier small archways on each side. This pavilion is flanked with a series of *chajjas* which are spotted by brackets.[241]

On north and south sides of central pavilion, stairways have been erected to access the roof.[242] The flat roof is adorned with five cupolas (*chattris*); four in each corner and one in the centre.[243] Corner cupolas are standing on square platforms and are flanked with *chhajas*. With the help of vertical pillars and brackets these corner cupolas are made in trabeate style. Central cupola is octagonal in shape which stands on an octagonal platform and here eight pillars have been utilised in construction. This cupola is bigger than the others and except the shape, all features are similar in each cupola. During the medieval period cupolas, built over the roof, were quite common features which were profoundly adopted in the buildings of Fatehpur Sikri and other areas.[244]

On the east and west sides of the pavilion, there are staircases through which one can access the water.[245] Each staircase contains 18 stairs which become wider as soon as descends. (first 4 steps measures 3' each in width, middle 12 steps are of 4' and last 2 steps

are of 6' each). The whole structure is made of stone and rubbles which was easily available in the nearby hills. Lime mortar has been used as cementing agency as well as for coating. But the most interesting feature is the shining elements of the stones and rubbles[246]which have been used on the stairs and peripheral pathways of pavilion as well as pool**.** Due to these glittering elements, stonesused to shinein moonlight so one can easily access the water even during the nights. The bridge which is resting on sixteen arched spans shows its continuation as paradisiacal imagery in Mughal architecture.

The above mentioned water pavilion is surrounded by a very huge water pool[247] measuring 640' x 640' area with a peripheral pathway of 14'. As per another set of inscriptions, this was also built by Shah Quli Khan in 1593 A.D.:

1. "Jamshaid in dignity, Shah Quli Khan, the honour of the Country, he who has carried away the ball of valour from his rivals:
2. Generous like the ocean, grave like the mountain, of exalted rank; a second Rustam and the Hatim Tai of this time:
3. May the wine of joy be ever in his palate, may he be victorious in the day of battle and prosperous in the day of entertainment?
4. He has built a tank which is a second *Kausar*, and a palace like the garden of *Iram* in the middle of it.
5. The water of immortality gives an idea of its water, and the pleasant air of Paradise is a specimen of its air.
6. O God! Keep it safe from the vicissitudes of time, so that he may sit in joy and exultation in this house.
7. I enquired of Wisdom about the date of its completion; the reply, "the house of Grace," came to the ear of my soul. 1001 A.H. = 1593 A.D."[248]

Narnaul is situated on the bank of a seasonal river Chalab which might have been the main source of water for this tank during medieval time.[249] One more seasonal river which used to flown in the western parts of the Narnaul was known as Dohan River.[250] Also, this structure exists in the vicinity of Arawali hills[251], therefore, during rainy seasons a huge amount of water from surrounding areas received through various channels. The remains of water channels can easily be traced out on the west and south-west sides.[252]

The design of this Water Palace had inspired structures of subsequent period.[253]*Jal Mahal* must have been used by elite than the common people. Apart from storage of water

and using it as cool chamber, it appears that the structure was also used as '*shikargah*' due to the availability of tigers in neighbouring forest of Narnaul.[254] Due to the rapid urbanisation in recent times, most of the natural channels and water ways have either been blocked or diverted by the local inhabitants and administration. This structure is under the protection of Archaeological Survey of India, vide Notification no[255] SR & CA. NO. F.4-7/61C.1 dated 04.08.1961, but in the lack of regular water supply this structure is not reflecting its real legacy.

4. *Sheikh* Chehli's tomb enclosure and *Hammam*, Thanesar

Tomb of *Sheikh* Chehli[256] (Lat. 29°58' N; Long. 76°50 E')[257] comprises a huge complex that includesthe above tomb, *madrasa*, a well and *Pathriya masjid* (mosque of stone) of Firoz Shah Tughluq period. There is also a *serai* (resting place) of 17th century on the north of this complex. According to David Ross the tomb of *Sheikh* Chehli is the most magnificent building of north India after Taj Mahal at Agra.[258] The identity of *Sheikh* Chehli[259] is not confirmed. However, legends link him as the spiritual advisor of Prince DaraSikoh, elder son of Shahjahan.[260] On the south east corner, a mosque stands erected by *Sultan* Firoz Shah Tughlaq.[261]

There is no contemporary information available about the construction of the *madrasa* but the construction and maintenance of such a huge structure was not possible without the financial assistance of ruling class. Alexander Cunningham has identified this building as a seminary (*madrasa)* [262]which is followed by subsequent writers. This *madrasa* is erected on a raised platform and can be reached with the help of flight of stairs from the main road, linking city and the *serai*.[263] The whole structure is made of bricks whereas lime coating has been used for plaster and colouring as lime prevents seepage.[264] A small garden, covering the area of 97' X 97', has been laid out in the centre of *madrasa* which further surrounded by a pathway of 9'2".[265] Amidst the garden is a square water tank which measures 27'4" X 27'4". Inside the water tank remains of a fountain is still available.[266]

Outside the southern wall of the *madrasa* a deep circular well[267] is available. According to Alexander Cunningham, this *Otwala kua* is 12 feet broad and 54 feet deep.[268] The real function of the well is not known. However, as we have set of channels on the roof of *madrasa,* it seems that it was employed for irrigating the garden and running the fountain.[269] A rectangular sloppy cistern of 13'5' X 8' X 1'6", connect the well to the

madrasa.[270] Water used to discharge in the cistern and then release into the leading channel. With the employment of Persian wheel the builder got success in running fountain at the height of 40' above the ground level. The remains of water shafts over the well are still visible. The principle of Boyle's law is adopted for watering the garden. Cistern, where water used to release from the well, becomes sloppy which increases the flow of water. Through a small waterway water from here release in the leading channel.[271] The length and width of this main channel is 38'9" and 9" respectively while the depth is 1'. This channel used to fall into another channel which runs 169'6" towards left and 113'4" towards right. It gradually becomes sloppy for increasing the flow of water. Another system, to increase the flow of water, utilized hare is that at least four sharp bend at irregularly distance have been created in the channel.[272] The channel is connected to the fountain of the garden through underground channel. The channel which turns right to the main channel again turn right and fall into another small tank.[273] This tank has a sharp slope, with a vertical water way, on corner but due to the lack of information, the actual purpose of its construction is not known.

Keeping in mind the need of enormous water for successfully running the fountain, it can be easily fathomable if the high pressure water from the substantive height fall at the bottom of fountain, the water will release vehemently through the fountain and reflect efficiently. The basic purpose of these channels was the running fountain. However, excess of water, released from the fountain, was utilized for watering the garden. On the west of the *madrasa* there was another well measuring 9'1/2" x 66' which has been disappear with the passage of time. In recent times the whole complexis under the administrative control of Archaeological Survey of India vide Notification No. PN, 8516 dated 10.07.1918.[274]

The above complex is surrounded by a mound on south-west sides. It is generally known as *Raja Harsh ka Tila*. Archaeological Survey of India has undertaken the excavation work and some of its portions have been traced out of medieval period. Archaeologists have traced the remains of a set of *hamams*[275] just west to the abovementioned *serai* of 17th century. The portion runs north to south where the entry is from the flow of Saraswati River on north. It measures 254'3" from north to south and 61'6" east to west. There is a well in the centre which is 9'7" in diameter.[276] This well was connected to the *hamams* through channels.Now these channels are not visible however some description has been left by Sanjay Subodh. As per his description here "are two sets of *hamams*; one has a hole in it and measures 16 feet 1 inch x 16 feet 1 inch x 3 feet 6 inches. The diameter of the hole is 5 feet 8

inches. At the back and side of it are remains of other *hamams*. However, since they are not fully excavated their measurements could not be obtained. Adjacent to these are remains of another set of *hamams* which was probably used by the privileged. It has holes in its walls for the flow of warm water during the winter season its measurements are 33 feet 2 inches x 18 feet 7 inches x 1 inch. This whole set of *hamams* is connected through channels."[277] Archaeological Survey of India has imposed a peripheral railing and has done some modifications due to which the original lay out has been affected.

5. Mughal Garden, Pinjore

Utilization of water as means of power and luxuries could be better experienced in the Garden of Fidai Khan, popularly known as Mughal Garden at Pinjore on Chandigarh-Kalka highway. Foundation of this great specimen was laid down by Muzaffar Husain, entitled Fidai Khan Koka[278], in 17th century. Fidai Khan was the foster brother of Mughal Emperor Aurangzeb and among his few reliable whom the Emperorreally admired.[279] According to the traditions, there was an ancient garden at the spring of Panchpura. Panchpura is the old name of this location and according to the legends this was belong to five *Pandavas* of the great epic Mahabharata.[280] Earlier there was a garden which was destroyed by Timur and the site remained desolate until Fidai Khan selected this for his project.[281] Fidai Khan had got enough knowledge and experience of building construction in Lahore region, where, he constructed some buildings during his appointment. He extensively utilised that experience in constructing the garden. He did not live here for long time to enjoy the beauty of his creation. After some time, the garden passed into the hands of Raja of Bhiwanaand then to the Raja of Sirmaur. The Patiala State bought the garden along with a huge area from Sirmur for Rs. 60,000.[282] During British period, theViceroy used it as aresting place to enjoy the cool shade and running water on their relaxed progress to their summer capital in the hills.[283]

The garden of Pinjore, which is basically influenced from the Shalimar Garden of Lahore, was a halting place for the royal camp on their way to Kashmir. Laid out on a natural slope, the site is beautiful which looks through a luxuriant gorge rounded by hills. This garden is laid out in six terraces in rich tradition of other Mughal Gardens. Being a terrace garden, the natural gravitational force have been used in each terrace in providing water to the various parts of garden along-with the principle of Boyle's law. No information is available on the actual date of the construction of this terrace garden, however "its pavilions with cusped arches supported on baluster columns, reserved in Shah Jahan's reign solely for

buildings intended for the emperor and his immediate family, suggest that the garden was built in Aurangzeb's time".[284] This place was once surrounded by many water tanks. Fidai Khan dug a canal at the foot of the neighbouring hill and led it to the garden for numerous functions which enhanced the splendour of the place.[285]

The garden is set out on six terraces and is divided into two major portions; the upper or eastern portion includes *Sheesh Mahal* and *Rang Mahal* or *Rani Mahal;* whereas the lower or western portion comprises *Jal Mahal* as major structures. The garden is not a wealthy structure in terms of architectural characteristics and building techniques. However, it is full of water channels and appears that the main objective of the builder was to provide abundant supply of water to *Jal Mahal* as well as trees and flowers through the efficient management of water channels which have been distributed in the whole garden.

All sub-structures, constructed in the garden, have been modified and repaired many times and do not pose any significant construction techniques. The main entrance of the garden is on the east and the whole garden is surrounded by a raised wall containing octagonal towers in each corner and gateways at regular intervals.[286] With the help of pathways and water channels each terrace and portion has been designed in *chaharbagh* style. The first terrace ends with a rectangular structure having two small side openings towards *Rang Mahal* or *Rani Mahal*. This rectangular structure is full of small mirrors and thus known as *Sheesh Mahal.*[287] It is also mentioned as *baradari* in old references.[288] In recent times, however, this building has been modified and does not resemble a *baradari.*

The channel which is leading towards the *Sheesh Mahal* andwhich is 12'3" wide and 2' deep gradually narrows allowing Boyle's law. Here, the principal attraction lies in the running water which underneath the '*Sheesh Mahal'*[289] falls over a projecting ledge towards the *Rang Mahal*.[290] The wall comprises 90 small niches in 15 rows (up to down) where each row has 6 ledges. These small niches were used for placing earthen lamps for lighting during nights. There is sharp slope in the channel where water used to release beneath the *Sheesh Mahal* and from the eyes of an artist it is really amazing to see falling water at the height of 8'3" and "when the little earthen lams are lit, they twinkle through the shining falls of water like green glow worms: while the rosy warmth of lights within the white pavilion gives the illusion of some huge transparent shell, poised above the waterfall, its curving back showing dimly against the twilight sky and the darker blue of the mountains beyond."[291]

The second terrace is almost 14' lower than the first. At that time this portion was known as *pardah* garden.[292] There is a huge simple structure at the edge of this terrace with five huge archways on both sides, known as *Rang Mahal or Rani Mahal*.[293] The measurement of the channel, leading towards*Rang Mahal*, remains same as was in the first terrace. The walls of this building touch the outer walls of the garden proceeding towards the north and south which mark the end of first portion of the garden. Adjoining *Rang Mahal*, towards *Jal Mahal,* we have a rectangular pool measuring 45'9" from north to south and 29'1" from east to west with depth of 2'6".[294] A fountain has been erected in the centre of this pool. In this pool, water falls from the height of 13' and here also 117 small niches have been projected[295] for lighting and the same scene could be visualised here as noticed in *Sheesh Mahal*.Pool is surrounded by a water channel having width and depth of 9" to release the excess water. Adjoining the pool is a platform which measures 67' from north to south. Further, through linear spaces, water used torelease from the tank and fall into a channel from the height of 16' through a severe and artistically rich slope.[296]

With this third terrace the lower portion of the garden begins and as per Boyle's law, the width and depth of water channel gradually narrows down so that pressure and flow of water could be increased. There is no structure at this terrace except a sloping ledge[297] at the edge which looks like a waterfall with side stepped ways down towards the next terrace comprising *Jal Mahal.* Here, water falls from the height of 11'. A water channel comprising width of 12'2" and depth of 2' connects it with *Jal Mahal.*[298]

The most significant structure of the garden is *Jal Mahal*[299] which is situated at the fourth terrace. The beauty and significance of this lower complex of the garden lies in the fact that with which skill water has been delivered to the *Jal Mahal,* specially its fountains.This structure is connected to the water channels on all sides. Major source of water supply for this structure is a canal which enters from the north corner of the *Jal Mahal.*[300]With the help of channels[301], on all sides except west, it provides water to the *Jal Mahal.* In the middle of the *Jal Mahal,*on a raised platform, a small structure stands which do not possess any unique feature of erection.This central structure, along with pool, is adorned with water channel on all sides.

From *Jal Mahal,*water channel leads towards west and fallinto a channel through an artistically adorned hedgefrom the height of 6' into a channel which mark the beginning of fifth terrace.[302] In the beginningthe depth of the channel is 18" which gradually decreases and

become 2" at the end, while the width remains same. At the end of this terrace, this channel falls from the height of 13'6" through a sloping wall intoachannel.[303] Here, also, depth of water channel, like other parts, gradually increases from 22" to 30". This sixth and last level subsequently ends with the garden[304] and the flow of water diverted towards garden area for watering the trees and flowers.

In the whole garden, with the help of natural gravitational forces, the principle of Boyle's is adopted. Each terrace is lower than the earlier and the last level of the garden is almost 75' lower than the first terrace. Recently this garden has been modified with additional construction. This is also done with the closing of some structures. These modifications are like obstacles in terms of understanding these structures in real historical context.

6. Palace of Firoz Shah, Hissar

The idea of making and constructing forts emerged from the basic need of all human societies i.e. security. Right from the beginning of the civilization, human being had the feeling of security and protection from the natural disasters, wild animals and rival human groups, which initiated the feeling of shelters by adopting various means of protection such as raising fences and walls around their shelters.[305] During medieval period many parallel terms were used for fort such as *hisar, qilah,* and *garh*.[306]

The palace of Hissar was founded by *Sultan* Firoz Shah Tughlaq in 1356 AD. Sams-i-SirajAfif gives a detailed description on the foundation of the city.[307]Hissar is situated on the old Delhi-Multan route (Lat. 29°10' N, Long. 75°44' E)[308] and "as destined by God, was always short of water and when the travellers from Iraq and Khurasan reached there during the summer season, they paid four *jitals* for glass of water on account of such shortage."[309] During the foundation of the city *Sultan* Firoz Shah remarked, "I am hopeful of God's kindness and mercy as I am laying the foundation of a new city on this spot for the benefit of Muslims, God, the Merciful, would surely provide enough water for this land through His kindness and mercy."[310]At first, Firoz Shah tried to utilise rain water and dug huge tanks in the newly founded city.[311] He also brought water from Yamuna by erecting two canals named the *Raiabwah* and the *Ulughkhani*. First canal *Rajabwah* was named after his father Rajab (*wah* means canal). Second canal *Ulughkhani* named after his cousin and predecessor Ulugh Khan later known as Muhammad Tughlaq.[312]In digging, "advantage was taken of natural

depressions or drainage channels whose slope and direction were suitable. The channel thus took the form of a linked series of drainages and depressions rather than a canal as the word is understood today."[313]These canals provided huge supply of water to the newly built town and surroundings. It reflected in the fact that earlier, due to the lack of water, the cultivation of wheat was totally depended on rain but when a copious supply of water was brought to Hissar-i-Firoza via these two canals, the production of wheat and other spring harvest were easy to cultivate.[314] Also, water level of the land near canal so upraised that anyone could get water after digging only four yards pottery-lined well.[315] Due to the rapid urbanisation remains of the canal are not visible in the town today.

The fort of Firoz Shah was built in typical Tughlaq style. It was earlier surrounded by a deep ditch with full of water.[316] The hard stone of Harsai hills with rubbles, strong quick lime and burnt bricks were used as building material in construction.[317] The main entry of the fort is through the western wall of the palace. As soon as we enter the palace, there is a mosque in front which stands on a platform and which is known as *Lat ki Masjid.*[318]The residential area is situated in the north-western portion of the palace. Towards the south-east side of the *Lat ki Masjid,* there is a huge '┐' shaped tank[319]which runs 74'2" north to south and 92'4" east to west. It is 23'2" wide and 10' deep**.** It gives the impression that the basement of the mosque was full of channels through which water was distributed to the residential area of the palace but today the entry has been closed by the Archaeological Survey of India.On the south of the courtyard of the mosque another rectangular tank is available underneath the platform which comprises the area of 37'8" x 6' x 11'2"**.**[320]The size and location of this second small tank suggests that it was probably used for ablution (*wuzuh*) at the time of *namaz* (prayer).

Remains of the water channel can still visualize on the roof of northern portion of the palace. It is connected to a small square tank that comprises the area of 6'6" x 6'6" x 5'6".[321] Spots have been erected inside through which one can enter the tank. This square tank is connected with another rectangular tank of 16'8" x 7' size on north-south side.[322] The depth of the tank is not clear as the tank is full of dust. An archway is visible inside the tank, probably, through which water was carried to the other parts of the first and ground floor of the palace. The channel might have been used for carrying surplus water of the small square tank, erected on the roof.[323]On the north of the enclosure are the remains of a small garden that runs 79'6" from east to west and 41' from north to south.[324] The surplus water of tank

might have been used for watering the garden that is surrounded by 1' wide water channel and is connected to a small well situated on north-east of the garden. It seems that this well was primarily used for drinking. It is also possible that this well was erected later. On the south-eastern portion of the enclosure another compartment exists that comprises a central pool. Running from north to south it must have been constructed during later period than the hall.[325]

As is observed, the whole palace was full of hydraulic works. Water was lifted from the canal with the application of water lifting devices and then stored in the main tank erected beside the *Lat ki Masjid*. From this tank water was distributed to the palace area through channels beneath the masjid. It was not possible to supply water on the first and second floors without the help of any mechanism. Also it was not possible to lift huge water from the canal and then tank manually for further supply on high places and able to run fountains. Another thing is that the canal was flowing alongside the eastern wall of the palace and it is quite possible that some more tanks and channels must have been constructed inside the palace.[326] But today that portion has marginally survived and we are unable to present the entire picture of water management in the palace. The structure is under the administrative control of Archaeological Survey of India, vide notification no. PN, 11078 dated 09.04.1924.[327]

Water structures in South Asia: a Neglect Study

Study of water structures have been a neglected subject in whole South Asia. There have been certain problems due to which the study has been suffered and no serious effort has been made by the scholars and professionals to collect all water structures in an encyclopaedic manner. It is evident that some rulers of medieval India, such as Firoz Shah Tuglaq, Akbar and Shahjahan, have not merely patronized the work of new construction but also made efforts for renovation and conservation of old buildings. But many rulers did not patronize the old structure and within some years these structures converted into ruins. The description of Francisco Pelsaert, who visited India during the reign of *Padshah* Jahangir, is noticeable here: "Nothing is permanent, yea, even the noble buildings- gardens, tombs, or palaces, - which, in and near every city, one cannot contemplate without pity or distress because of their ruined state. For in this they are to be despised above all the laziest nations of the world, because they build them with so many hundreds of thousands, and yet keep them in repair only so as the owners live and have the means. Once the builder is dead, no one will carefor the buildings; the son will neglect his father's work, the mother her son's, brothers

and friends will take no care for each other's buildings; everyone tries, as far as possible, to erect a new building of his own, and establish his own reputation alongside that of his ancestors. Consequently, it may be said that if all these buildings and erections were attended to and repaired for a century, the lands of every city, and even village, would be adorned with monuments; but as a matter of fact the roads leading to the cities are strewn with fallen columns of stone."[328]

Various types of water structures such as tanks, wells, ponds, *talab*, and canals have lacking of pleasant artistic expressions so the significance of these water monuments in South Asia has been undervalued by the art historians. These structures usually connected to the temples and other holy shrines and while studying these 'religious structures', the art historians often do not discuss the closely associated water monuments.When these historian define 'secular structures' such as palaces, forts and pavilions, again they have often ignored the water monuments which are equally utilitarian. These have been often misinterpreted and underrated by the scholars in comparison of major structures. Even scholars who have acute interest in building construction and have comprehensive understanding of Indian architecture, only focused on technical and engineering aspects and underrate their artistic and religious importance. Almost hydraulic engineers of South Asia have mainly undertook the study on irrigation related structures such as dams, sluices, bridges and canals and others either neglected or slightly explained.

Another practical problem which has been faced by the scholars is that these water structures are constructed below the level of ground andin the lack of maintenance and preservation several have been concealed into earth. They are not visible from far-flung and hence usually reflect no indication of their grandeur and ornamental richness above the surface. Many of these water structures are not redundant. These are continuing used by peoples and the responsibility of its maintenance is in the custody of local bodies. This is also one reason why the lack of attention is paid by the administration, art historian and other government bodies.[329] In addition, in the lack of understanding and awareness, numerous water structures have been demolished by local inhabitants over the last few decades due to the rapid industrialisation and urbanization in South Asia. As per an estimates "Delhi has lost approximately half of its ancient Islamic monuments"[330] in the last fifty years. This estimate includes those gardens, wells, ponds and other water structures which were erected during the medieval period.

It has not been very easy for me to complete the field work as I have faced many problems during exploration of sites. Many water structures which are scattered in the towns and country sides have not been recorded in the lists of Archaeological Survey of India and other government agencies. So not as much of scholars are aware about the existence of these structures. There are a lot of water oriented monuments scattered in the whole region of Haryana but due to the lack of awareness among the inhabitants most of them have been neglected. This is more evident in the rural zones where minor structures are vulnerable to vandalism by local communities. Also, several structures have been modified even partially closed, as part of their work of renovation and cannot collaborate with the existing information. In addition to this, due to the insufficient information and bad conditions many structures have been misinterpreted by the modern historians and writers which I have already discussed. In many cases government agencies have failed to secure medieval monuments from natural and human factors. In these conditions a study of structures which have survived assumes considerable importance.

Relevance of the study in present time

Traditional knowledge is the technical, social, organizational and cultural collective memory of human responses to the complexities of life, and is a part of the great human experiment of survival and development. Many traditional knowledge systems are relevant to economic planning today, because they are eco-friendly, sustainable, labour-intensive, rather than capital intensive. Implementation of traditional technologies should be done in parallel with top down 'modern' scientific development. For example; water as a resource is a major concern in India and many other parts of the world.

In recent times, humanity faces a serious challenge of water shortage and the ominous prospect of global droughts and changes in weather conditions are prompting policy-makers to seek out political solutions, and water professionals to find managerial and technical solutions to water scarcity. In this context a study of water history becomes more than an idle intellectual pursuit. It may be argued that conditions today are so different from those in the past that a study of water history is irrelevant. But such an argument would be overlooking the important trans-cultural structures, continuities and principles that inform human actions. Even within today's technologically and scientifically dominated water management systems, a hydrologist operates within a socially constituted tradition, shaped by an overall scientific and engineering paradigm, and historically accumulated and legitimized canons and 'facts'.

Scientists estimate there were millions of man-made water lakes and ponds across India. These are now being rediscovered using satellite imagery. These enabled rain water to be harvested and used for irrigation, drinking, etc. till the following year's rainfall.With the introduction of new technologies the use of traditional system of water works declined gradually in India and replaced by modern means of hydraulics based on oil or electricity. These include the construction of reservoirs created by new dams along the seasonal rivers, which normally fill during the rainy season and are used for irrigation in the summer, when the dam is opened, and water enters the river. It is also possible to find modern hydraulic pumps for irrigation placed close to the old hydraulic works in order better to exploit the quantity of water available in the area. In numerous cases, the old watercourse channels are employed for carrying water, raised by the pumps, to the fields.

Even though the medieval water works of India such as step well, Persian wheel or *noria* provide substantial environmental and economic benefits, as well as safety, it is difficult to develop a basic method for renovating these hydraulic works, particularly in the area of my study. By evaluating the practicability of renovation of these means of hydraulic as a justifiable and sustainable system, along with an expression of historical and cultural heritage, it has been noted that re-employment for their original purpose would present considerable difficulties.When these water structures stopped working, they were subsequently abandoned for several years and most of them deteriorated considerably and some aqueducts collapsed.

Furthermore re-activating the *baolis*, Persian wheels, *norias* would not solve the increasing need for water, also if they would be supplemental irrigation systems. By contrast, a preliminary proposal that may be putted forward aimed to re-evaluate water-wheels in terms of historical heritage and ancient tradition, giving a great contribution to the knowledge and studies of water architecture in India and increasing the awareness of the historical and cultural value of the sites.Some of the larger reservoirs, such as the *Jal Mahal* at Narnaul are of ecological value and some have considerable potential for heritage tourism as part of a ‘Rural Tourism’ circuit. Living aside a few specialists, the common people do not know much about the historicity of a particular water structure or site. With these water structures are associated a large corpus of folklore and legends.

These water structures are great example of medieval Indian architecture which has not been explored and included by the historians till now. These monuments are the symbols of the composite culture of that period where both, trabeate and arcuate, styles have been

utilized in construction. These are considered as secular structures which unlike temples, tombs, mosques and *madrasa* were not associated with any particular religion. People belong to different religion background and caste visited these places frequently.Unfortunately, as the above study indicates, most of the water structures are not in satisfactory conditions and are destroying day by day.

Conclusion:

The roots of water safeguarding are as ancient as the Indian civilization and which has been witnessed by the numerous surviving structures of pre-British period in the whole country. Every structure has a distinctive purpose of construction which lies in its style, method, technique and usage but unfortunately a very few known have been studied by the scholars and professionals. Many ancient and medieval sites are still waiting for exploration and investigation in accurate context so that the development of indigenous technology and its impact on society could be understood. Role of Geographical and ecological data can be very significant in the study of variety of medieval hydraulic structures such as wells, step wells, tanks, canals, dams, etc. This is also because there was no major river that could provide water to the area sufficiently for whole year except *Yamuna* which was useful only for frontier areas toward the state of Uttar Pradesh.

The above study indicates that maximum structures have been reduced to ruins on account of neglect. The structures and traditions of these medieval sites, which are an integral part of our cultural heritage, are being destroyed under the pressure of rapid urbanization process. They are not merely structures of bricks and stones, but they have specific architectural characteristics and historical importance. If we want to preserve our cultural heritage these monuments should not be left in the hands of their custodians who, often, are ignorant of the structure's architectural significance and allow important parts to crumble, while subjecting the rest to over-restoration and modernization. If they are properly preserved, they can become treasure houses of the past and a mirror of the posterity. They can serve as centre of tourist interest for all those who wish to enquire into the past which is the best way for bringing history close to the common people.

This project is a sincere attempt to understand how the role of water played a significant part of our life. During my field work I came to know about the various methods of water management through building construction which were prevented in the region of

modern Haryana but still following in other part of the areas in the subcontinent. This project not only allows me to interrogate the core relation between human life and water and its serious implications but the empirical facts which i personally encountered which help me in my future endeavour in researching indigenous knowledge production.

It gives me immense pleasure to acknowledge my indebtedness and deep sense of gratitude to all those who have helped me in completing the valuable task. First of all I express my sincere thanks to SAARC Culture Centre, Colombo specially Director Shri G.L.W. Samarasinghe, who selected and gave me this opportunity to work on the project. I am also grateful to Prof. Lakshman Dissanayake, Prof. Kalinga Tudor Silva, Prof. Shantha Hennayake, Prof. Liyanage Amarakeerthi and Dr. Nalani Hennayake whose sincere comments and guidance helped me in constructing the frame work of the study. I would like to thanks to the staff of SAARC Culture Centre, Colombo specially Ms. Apsara who helped me in many waysduring the project.

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References

[1] Sanjay Subodh, 'Religion, Aurangzeb and Historiography: Some rethinking', in Kiran Pawar and Sanjay Subodh (ed.), *Studies in History*, New Delhi, 2002, p. 50

[2] T. Tvedt and T. Oestigaard (editor), *A History of Water, Vol. III ; The World of Water*, New Delhi, 2013, p. xiv

[3] Vijay Paranjpye, 'Water Management Concept in Classical Indian Literature', in Kalyan Kumar Chakravarty, Gyani Lal Badam and Vijay Paranjpye (ed.), *Traditional Water Management System of India*, Bhopal, 2006, p. *59*

[4] *Ibid,* p. *61*

[5] The other elements of his composition are heaven, wind fire and earth. See Al-Biruni, *The Kitabul Hind*, English translation by Edward C. Sachau, *Alberuni's India*, *Vol. I*, London, 1910, p. 20.

[6] *Ibid.*, p. 224

[7] R. S. Sharma, *India's Ancient Past*, New Delhi, 2005*,* p. 114

[8] "Forth from the middle of the flood the waters-their chief the Sea-flow cleaning, never sleeping. Indra, the Bull, the Thunderer, dug their channels: here let those Waters, Goddesses, protect me." See *Rigveda,* English translation *Rigveda: The Oldest Divine Book* by R.T.H. Griffith, Delhi, 2011, p. 27

[9] "Those amid whom goes Varuna the Sovran, he who discriminates men's truth and falsehood-Distilling meath, the bright, the purifying, here let those Waters, Goddesses, protect me."*Ibid*.

[10] Radha Krishnamurthy, 'Water in Ancient India', *Indian Journal of History of Science, 31 (4)*, 1996, p. 328

[11] Francisco Pelsaert, *Jahangir's India*, English translation by W.H. Moreland and P. Geyl, Cambridge,1925,p. 76

[12] For example we have informed that just after the born of a child, the father took bath in cold water whereas the child and mother bathed on the sixth day. Likewise, after the death of a person his body was washed and Ganga water was put into his mouth. His last ceremony (funeral) was also performed near any river, pond or other water resources. For more details see Abul Fazl, *The Ain-I Akbari, Vol. II-III,* English translation by Colonel H.S. Jarrett, LPP, New Delhi, 2001 (first pub. 1927), pp. 348-55; Bernier was also witnessed of these funeral rites specially on the bank of Ganga. See Francois Bernier, *op. cit.*, p. 315.

[13] Radha Krishnamurthy, *op. cit*., p. 327

[14] While describing the sacred places of pilgrimage of Hindus, Abul Fazl has mentioned twenty eight rivers which were termed *deva* or divine and were dedicated to Brahma, Vishnu and Mahadev. For more details see Abul Fazl, *Ain-I Akbari, Vol. II-III, op. cit*., pp. 332-33.

[15] T. Tvedt and T. Oestigaard (edited)*, op. cit.,* p. x

[16] In this regard, the following description of Ibn Battuta is significant: "The Indians have a similar practice of drowning themselves and many of them do so in the river Ganges, the river to which they go on pilgrimage, and into which the ashes of those who are burned are cast. They say that it is a river of Paradise. When one of them comes to drown himself he says to those present with him, 'Do not think that I drown myself for any worldly reason or through penury; my purpose is solely to seek approach to Kusay,' Kusay being the name of God in their language. He then drowns himself, and when he is dead they take him out and burn him and cast his ashes into the water." Ibn Battuta, *Rehla* English translation *Ibn Battuta, Travels in Asia and Africa 1325-1354* by H.A. Gibb, Routledge& Kegan Paul Ltd, London, 1953 (first pub.1929), p. *193*.

[17] Julia A.B. Hegewald, *Water Architecture in South Asia: A Study of Types, Development and Meanings*, BRILL, 2002*,* p. 23.

[18] In this regard, the following description of *MatsyaPuran*is significant: "A wise person who causes a well to be dug in a waterless (dry) land, (would) stay in heavens as many years as there are drops of water therein (154/511)."See, M.S. Mate, *A History of Water Management and Hydraulic Technology in India (1500 A.D. to 1800 B.C*.), Delhi, 1998, p. 29; A similar kind of verses is reflected in a 12th – 13th century text, *Aparajitprccha*, which states: "*Vapi, kupa, tadaga* (wells and tanks) are the resorts of water, (one) should celebrate the festival of *punya* by creating such resorts

for water. If a person creates (a resort) even as small as the impress of a cow's foot, he would enjoy *Sivloka* for sixty thousand years."M.S. Mate, *Ibid,* p. 30

19 "In every place to which some particular holiness is ascribed, the Hindus construct ponds intended for the ablutions. In this they have attained to a very high degree of art, so that our people (the Muslims), when they see them, wonder at them, and are unable to describe them, much less to construct anything like them."Al-Biruni, *op. cit*., p. 145

20 *Ibid*; Also cited by Francois Bernier who has mentioned an incident where water and water structure have been utilized for fulfilment the spiritual desires: "No sooner did these idolaters perceive that the obscuration of the sun was begun than they all raised a loud cry, and plunged the whole body under water several times in quick succession; after which they stood in the river, lifted their eyes and hands towards the sun, muttered and prayed with seeming devotion, filling their hands from time to time with water, which they threw in the direction of the sun, bowing their heads very low, and moving and turning their arms and hands, sometimes one way, sometimes another. The deluded people continue to plunge, mutter, pray and perform their silly tricks until the end of the eclipse."Francois Bernier,*Travels in Mogul Empire AD 1656-1668*, Eng. Trans. Archibald Constable, Delhi, 2011(first pub. 1934, London), p. 302

21 Father Monserrate, *The commentary of father Monserrate; On his Journey to the Court of Akbar*, Eng. Trans. J. S. Hoyland, London, 1922, p. 93

22 M.S. Mate, *op. cit.*, p. 33

23 Naser I. Faruqui, 'Islam and water management: Overview and principles' in NaserI.Faruqui, AsitK. Biswas and Murad J. Bino (ed),*Water management in Islam*, Tokyo, 2001, p. 1

24 Julia A.B. Hegewald, *op. cit.,* p. 27

25 Naser I. Faruqui, *op. cit*., p. 1

26 *The Quran*, translated into English by TalalItani, Dallas, 2009, p. 182

27 *Ibid, p. 267*

28 *Ibid*, p. 68

29 *Ibid*, p. 103

30 *Ibid*, p. 93

31 Y.C. Wong and V. Kallianpur, 'Water as a Symbol of Power: the Hydraulic System of Golkonda Fort, Hyderabad', in T. Tvedt and T. Oestigaard (ed.), *op. cit.*, p.106; "And He sent down upon you water from the sky, to cleanse you with it, and to rid you of Satan's pollution, and to fortify your hearts, and to strengthen your foothold."*The Quran,op. cit*., p. 87

32 James Dickie (YakubZaki), 'Allah and Eternity: Mosques, *Madrasa*s and Tombs' in *Architecture of the Islamic World: Its History and Social Meaning* edited by George Michell, Thames and Hudson, London, 1978, p. 35

33 *Ibid.*

34 Naser I. Faruqui,*op. cit*., p. 2

35 "O Children of Adam! Dress properly at every place of worship, and eat and drink. But do not be excessive. He does not love the excessive." *The Quran*, p. 75

36 The first priority of water is for drinking of human beings; the second is for cattle and household animals; and the third is for irrigation. Naser I. Faruqui,*op. cit*., p. 2

37 It is significant to be mentioned here the words of Charles Trevelyan who observed, "irrigation is everything in India. Water is more valuable than land, it increases its productiveness at least six fold and generally a great deal more and it renders great extents of land productive which otherwise would produce nothing ornext to nothing." See J.N.Sammedar, *Lectures on the Economic conditions in Ancient India*, Calcutta, 1922, p.17

38 T. M. Srinivasan, 'Irrigation and Irrigation Works', in A. K. Bag (ed.), *History of Technology in India, Vol. I*, New Delhi, 556

39 Kautilya, *Arthshastra*, English translation byR. Shamasastry, *Kautilya's Arthashastra* Government Press, Bangalore, 1915*,* p. 62

40 *Ibid*, p. 211

41 R. S. Sharma, *op. cit*., p. 180

42 *Ibid*. 184

[43] "In the case of construction of new works, such as tanks, lakes, etc., taxes (on the lands below such tanks) shall be remitted for five years (*panchavarshikahpariharah*). For repairing neglected or ruined works of similar nature, taxes shall be remitted for four years. For improving or extending water-works, taxes shall be remitted for three years. In the case of such acquiring such newly started works by mortgage or purchase, taxes on the land below such works shall be remitted for two years." Kautilya, *op. cit.,* p. 244

[44] "Persons, letting out the water of tanks, etc., at any other place than their sluice gate *(apare*), shall pay a fine of 6*panas*; and persons who recklessly obstruct the flow of water from the sluice-gate of tanks shall also pay the same fine." *Ibid*, p. 245; it is further mentioned that "when a person breaks the dam of a tank full of water, he shall be drowned in the very tank; of a tank without water, he shall be punished with the middle-most amercement"- *Ibid***,**p. 325

[45] Irfan Habib and VivekanandJha, *Mauryan India*, Aligarh, 2004, pp. 76-77

[46] *Ibid*, p. 77

[47] *Ibid*

[48] Raj Vir Singh, 'History of Irrigation in India', in A. K. Bag (ed.), *op. cit., p. 427*

[49] For example, in medieval period the indigo of Bayana was considered superior to the others due the availability of good quality of water in its surroundings. Francisco Pelsaert, *op. cit.,* p.13

[50] History of medieval India is full of references of *zamindari-i-zortalab.*This term was used for the areas where state used military force for collecting revenue. Irfan Habib, *Agrarian System of Mughal India 1556-1707,* New Delhi, 2008 (first pub. 1963)*,* p. 35; Bernier has mentioned that due to the bad manners of Governors, the poor people to "seek a more tolerable mode of existence, either in the town, or camps; as bearers of burdens, carriers of water, or servants to horsemen." Francois Bernier, *op. cit.,* p. 205.

[51] Ishtiaq Husain Qureshi, *The administration of the Mughul Empire*, New Delhi, 2010 (first pub. 1973), p. 175

[52] Father Monserrate gives the description of a town Sahar Gulam, near Ludhiana that "in order to prevent draught in summer they dug for themselves four tanks of remarkable size and depth, in which all the rain-water from the surrounding hills used to be collected." See, *Father Monserrate*, *op. cit*., p. 146. In a similar condition, Monserrate narrates about Sirhind in page no.102 where "the inhabitants have met the difficulty oflack of water by making of a deep artificial lake on the southern side of the city. Care is taken to fill this lake during the rainy season by means of irrigation channels. In the middle of the lake stands a tower, which is open to the public for their enjoyment. From this tower there is a pleasant prospect over the lake and the surrounding parks and gardens."

[53] Monica Juneja (ed.), *Architecture in Medieval India*, Delhi, 2001, p. 70

[54] In his account, Firoz Shah Tughlaq has left a similar kind of instance: "In the village of Maluh there is a tank which they call *kund* (tank). Here they had built idol-temples, and on certain days the Hindus were accustomed to proceed thither on horseback and wearing arms. Their women and children also went out in palankins and carts. There they assembled in thousands and performed idol worship. The abuse had been so overlooked that the bazar people took out their all sorts of provisions, and set up stalls and sold their goods. Some graceless Musulmans, thinking only of their own gratification, took part in these meetings." See Firoz Shah, *Futuhat-I Firoz Shahi*, English trans. by Sir H.M. Elliot and John Dowson, *The History of India as told by its own Historians, Vol. III*, Delhi, 2014(first published 1867-77), pp. 380-81

[55] Mahomed Kasim Ferishta, *Tarikh –i-Ferishta*, Eng**.** Trans. by John Briggs, *History of the rise of the Mahomedan power in India, Vol. 1*, Calcutta, 1908, p. 355

[56] Anthony Welch and Howard Crane, 'The Tughluqs: Master Builders of the Delhi Sultanate', *Muqarnas*, *Vol. 1*, BRILL, 1983, p. 154

[57] Sir Wolseley Haig (ed.), *The Cambridge History of India, Volume III, Turks and Afghans*, Delhi, 1965, p. 153

[58] Anthony Welch and Howard Crane,*op. cit*.,p.130

[59] Ferishta, *op. cit*., p.465

[60] *Ibid*, p. 464

[61] *Ibid*, pp. 152-154.

[62] Sams-i-Siraj Afif, *op. cit.*, p. 302

[63] Babaur, *Baburnama*, English translation by Annette Susannah Beveridge, Vol. II, London, 1922, p.486

[64] *Ibid*, p. 487

[65] James L. Wescoat Jr., 'Early Water systems in Mughal India', *Environmental Design*, *Journal of the Islamic Environmental Design Research Centre*, special issue on water in Islamic architecture and design, Vol. 2, 1985, p. 52-53

[66] Shaikh Rizkullah Mushtaki, *Wakiat-I Mushtaki*, English trans. H.M. Elliot and John Dowson, *the History ofIndia as told by its Historian, Vol. IV*, Delhi, 2014 (reprinted, first pub. London, 1867-77), p. 550

[67] Father Monserrate has left the following description of Fatehpur Sikri: "To supply the city with water a tank has been carefully and laboriously constructed two miles long and half a mile wide. The work was performed, by the King's directions, in the following manner. Across the end of a low-lying valley which was filled with water in the rains, (although the water afterwards drained away or dried up), a great dam wasslowly built. By this means not only was a copious supply of water assured, but the discomfort of the climate was mitigated."- Father Monserrate, *op. cit*., p. 31

[68] Irfan Habib, *Agrarian System of Mughal India,* pp. 33-34

[69] O.P. Jaggi, *History of Science & Technology in India, Vol. VII; Science and Technology in Medieval India*, Delhi, 1977, p. 215

[70] Abul Fazl, *The Akbarnama, Vol. 1&2 (bound in 1)*, New Delhi, 1998 (first pub. 1902-39), p. 647

[71] Abul Fazl, *Ain-i-Akbari*, *Vol. I*, p. 235

[72] *Ibid,* p. 236

[73] *Ibid*

[74] "On roads where thefts and robberies took place, which roads might be at a little distance from habitations, the *jadgirdars* of the neighbourhood should build *sarais*(public rest-houses), mosques, and dig wells, which might stimulate population, and people might settle down in those *sarais*. If these should be near a *khalisa* estate (under direct State management), the administrator (*mutasaddi*) of that place should execute the work" "In my dominions if anyone, whether unbeliever or *Musalman*, should die, his property and effects should be left for his heirs, and no one should interfere with them. If he should have no heir, they should appoint inspectors and separate guardians to guard the property, so that its value might be expended in lawfulexpenditure, such as the building of mosques and *sarais*, the repair of broken bridges, and the digging of tanks and wells."Jahangir, *Tuzuk-i-Jahangiri*, English translation by Henry Beveridge, London, 1909,pp. 7-8

[75] T.M. Srinivasan, 'Irrigation Works: Reservoirs, Canals and Wells', in Harbans Mukhia (ed.), *History of Technology in India, Vol. II*, New Delhi, 2012, p. 162.

[76] Francisco Pelsaert, *op. cit.*, p. 64.

[77] This is a society whose agriculture was dependent upon enormous waterworks for irrigation and floodcontrol. He believed that centralized control was established on the means of irrigation; government representatives monopolized political power and dominated the economy, resulting in an absolutist managerial state. In addition, there was a close identification of these officials with the dominant religion and an atrophy of other centres of power. The bureaucratic network directed the forced labour for irrigationprojects.For a detailed description on the issue please consult Karl Wittfogel, *Oriental Despotism: A Comparative study of Total Power*, London, 1957.

[78] Bernier has left the detailed description on the time and duration of the raining in Delhi-Agra region. According to his information, raining starts in the excessive heat month July and continued three successive months. But he made complaint about the uniformity as well as quantity of the rain. For more details please see Francois Bernier, *op. cit*., pp. 431-34

[79] Lallanji Gopal, 'Agriculture', in A.K. Bag (ed.), *History of Technology in India, Vol. I (from Antiquity to c.1200 A.D.),* New Delhi, 1997, p. 417

[80] R. P. Kulkarni, Irrigation Engineering in India', *Indian Journal of History of Science, Vol. 17, Part I*, p. 28

[81] M.S. Mate, *op. cit.,*p. 2

[82] *Ibid*, p. 81

[83] O.P. Gaggi, *Technology in Ancient India,* p. 169
[84] Lallanji Gopal, 'Agriculture', *op cit*., p. 427
[85] Kautilya, *op. cit.,* p. 165
[86] O.P. Gaggi, *Technology in Ancient India,* p. 169
[87] See figure 1
[88] Babur, *op. cit.,* pp. 487
[89] *Ibid*
[90] *Ibid*
[91] See figure 2
[92] A.J. Qaisar, 'Agricultural Technology Depicted in Mughal Paintings', *Itinerario, Vol. XVI*, Issue 02, July 1992, Leiden, 1992, p.
[93] *Ibid*, p.
[94] John Fryer, *A New account of East India and Persia being nine years' travels 1672-1681, Vol. II,* London, 1912, p. 94
[95] Irfan Habib, *Agrarian System of Mughal India.op. cit*., p. 28
[96] Irfan Habib, *Technology in Medieval India, op. cit*., p. 14
[97] See figure 3
[98] Abbott Payson Usher, *A History of Mechanical Inventions*, New York, 1929, p. 80
[99] Shudraka, *Mricchkatika*, English translation by Arthur William Ryder, *The Little Clay Cart Mrcchakatika; An attributed to king Shudraka*, published by Harvard University, 1905, p. 175
[100] Bana, *Harscharita*, English translation by E.B. Cowell and F.W. Thomas, *Harsa-Carita of Bana*, London, 1897, p. 264; Lallanji Gopal have mentioned these references in details in their accounts. For more details please see Lallanji Gopal, *History of Agriculture in Ancient India*, Varanasi, 1980, pp. 114-168; Lallanji Gopal, 'Agriculture', *op. cit*., pp. 426-429
[101] R. Nath, op. cit., pp. 94-95
[102] *Rahat* or *arahat* traces their origin from the Sanskrit word *araghatta*; Prakrit or Pali word *arahatta. Ara*means spoke and *ghatta/ghatti* means earthen pots. See Irfan Habib, 'Pre-Modern Modes of Productions and Transmission of Power', in Harbans Mukhia, *History of Technology in India, Vol. II, Medieval Period*, New Delhi, 2012, p. 257
[103] *Ibid*, p. 258
[104] *Ibid*
[105] See figure 4
[106] Abbott Payson Usher, *op. cit.*, pp. 81-82
[107] Irfan Habib, *Technology in Medieval India,* p. 11
[108] Babur, *op. cit.*, p. 486
[109] See figure 5
[110] Irfan Habib, *Technology in Medieval India,* p. 11
[111] *Ibid,* pp. 11-12
[112] Irfan Habib, 'Akbar and Technology', *Social Scientist, Vol. 20, No. 9-10* (Sep.-Oct., 1992), p. 8
[113] *Ibid*
[114] *Ibid,* p. 9
[115] "The water to water it is also to fill the Tancks (tanks) alofte (aloft), and for their use is drawne from the valley, first into one Tanck and then from that into another higher, and soe into 4 or 5 until it come alofte, by that which we in Spaine call Noraies" Peter Mundy, *The Travells of Peter Mundy, in Europe and Asia 1608-1667, Vol. II; Travels in Asia, 1628-1634*, London, MCMXIV, p. 228
[116] Irfan Habib, *Technology in Medieval India,* p. 13
[117] *Ibid*, pp. 12-13
[118] William Foster, *op. cit.,*pp. 299-300
[119] Irfan Habib, *Agrarian System of Mughal India*, pp. 28-29
[120] Francisco Pelsaert, *op. cit.*, p. 48
[121] Various terms in different areas are in use for the step well such as *vav* or *vawri* in Gujarat, *baoli, bauli, bein,*or*bain*in Delhi, Haryana and Rajasthan region. "To persons not familiar with the East such an architectural object as a *baoli*may seem a strange perversion of ingenuity, but the grateful

coolness of all subterranean apartments, especially when accompanied by water, and the quiet shade of these recesses, fully compensate, in the eyes of the Hindu, for the more attractive magnificence of the *ghats*. Consequently, the descending flights of which we are now speaking have often been made more elaborate and expensive pieces of architecture than any of the buildings above ground found in their vicinity." James Fergusson, *History of Indian and Eastern architecture, vol. 2,* London, 1910, p.183

122 Jutta, Jain-Neubauer, *The Stepwells of Gujarat in Art-Historical Perspective*, New Delhi, 1981, pp. 1-2.

123 Ralf Finch, a European traveller who visited India in the 16th century, have mentioned: "moreover, they have a great place made of stone like to a well, with steppes to go down; wherein the water stand very foul and stinketh, for the great quantity of flowers, which continually they throw into it, doe make it stink. There be always many people in it; for they say when they wash themselves in it; that their sinner be forgiven them, because God, as they say, did wash himself in that place." William Foster, *Early travels in India 1583-1619*, Oxford University Press, London, 1921, p. 21; J. Horton Ryley, *Ralph Fitch: England's pioneer to India and Burma; his companions and contemporaries with his remarkable narrative told in his own words*, London, 1899, pp. 104-105

124 "It was also a tradition in India that much of the village gossip and exchange of ideas, particularly among the womenfolk, is transacted at the village well." K.V. Soundara Rajan, *Islam Builds in India (Cultural study of Islamic Architecture),* Agam Kala Prakashan, Delhi, 1983, p. 155

125 "For caravans and individual travellers, a stepwell was the end and aim of a day's journey, where one could spend the night in cool, comfortable surroundings and also where there would be no need to search for water for men and animals. Stepwells were used as suitable and cool places not only for a night's halt, but also for resting during the uncomfortable and suffocating heat of summer day." Jutta, Jain-Neubauer, 'Characteristics of a Stepwell', p. 478

126 "Wherever a stepwell links brilliant Indian sun to a clear pool of water, two separate worlds are joined. In the well's stone corridors people moves between one realm and the other. The diminishing light descending thestairs conveys a sense of passage deep into the earth, moving further into darkness. Excavation is balanced with construction-one pair of opposites in a series that includes sky and water, solid and liquid, empty and full. The experience is mesmerizing." Morna Livingston, *Steps to Water: The ancient stepwells of India*, New York, 2002, p. 1

127 "Its deep vertical shape presents only a parapet to the direct sun, while its pavilions, like umbrellas, shade the stone and water below. The stepwell protects its visitors from sun and hot winds. The well profile maintains the deepest water near the temperature of the earth at 55°, even when the surface air reaches 120°. Slight temperature differences encourage air to rise slowly and move through the open pavilions with ease." Morna Livingston*, op. cit.,* p. 17

128 Plate 1A

129 Plate 1A

130 Leading with the stairs, we have found a uniform way of construction on both sides. If one side is adorned with stairs, the other side is also having a stairway. Also, on both sides, same size of substructures has been constructed.

131 During the exploration I found only 34 stairs which were visible. As the lowest portion of the steps was not visible, I was sure that some more stairs will be there which have been buried during the course of time. However, on another occasion these were counted 46 stairs. See JagdishParshad, *Medieval Monuments in India; A historical and architectural study in Haryana (1206 A.D. –1707 A.D.),* Agam Kala Prakshan, New Delhi, 2011, p. 141; Plate 1B

132 Plate 1C

133 Plate 1A

134 Plate 1D

135 Plate 2A

136 Plate 2B

137 Plate 2A

138 Plate 2C

139 Plates 2B, 2D

[140] Dalipsingh, '*Baolis*(Baoris) of Haryana', *Proceedings of Indian History Congress, 55th Session*, Aligarh, 1994, p. 889

[141] Plate 3A

[142] Nawwab Samsam ud Daula Shah Nawaz Khan and Abdul Hayy, *The Maathir-ul-Umara*, *Vol. II*, English translation by H. Beveridge, revised, annotated and completed by Baini Prashad, Calcutta, 1952, pp. 240-241.

[143] *Ibid,* p. 240.

[144] It is quite possible that either this *baoli* was constructed during the period of Akbar, or, as it is very close to Narnaul, someone had constructed it during later period by getting inspiration of the *baoli* of Mirza Ali Zan.

[145] Plate 3B

[146] Plate 3C

[147] For more details please see *Haryana District Gazetteers: Mahendragarh*, Chandigarh, 1988, pp. 6-7

[148] Plate 3D

[149] Plate 3A

[150] Plate 3E

[151] Plate 3E

[152] Plate 3F

[153] Plate 3G

[154] Plate 3H

[155] Plate 3I

[156] Plate 3G

[157] *Inventory of monuments and sites of National Importance, Chandigarh Circle, Vo. I, Part 2,* ASI, New Delhi, 1999*,* p. 79

[158] Plate 4A

[159] Plate 4B

[160] *Inventory of monuments and sites of National Importance, Chandigarh Circle,*p. 79. According to some other sources year of the construction of *baoli*was 1069 *A.H.* (19th September 1658) see Subhash Parihar, *Muslim Inscriptions in* The *Punjab, Haryana and Himachal Pradesh*, New Delhi, 1985, p. 43

[161] *District and States Gazetteers of the undivided Punjab (prior to independence), Vol. IV,* Delhi, 1985 (reprinted), p. 356; Subhash Parihar, *ibid.*

[162] Peter Mundy, *Pen and Pencil sketches, being* the *Journal of a tour in India*, London, 1832, pp. 354-357.

[163] C.J. Rodgers, *Revised List of Objects of Archaeological interest in the Punjab*, Lahore, 1891, p.76; *Inventory of monuments and sites of National Importance, op. cit.,* p. 79. I visited the site on four occasions but due to the renovation work and unfavourable conditions I could not count whole stairs.

[164] Plate 4A

[165] Plate 4C

[166] Plate 4D

[167] Plate 4E

[168] Plate 4F

[169] Plate 4G

[170] Plate 4F

[171] Plate 4H

[172] C.J. Rodgers, *op. cit.*, p. 76

[173] Trabeate has been the traditional method of building construction in India which is primarily based on horizontal beam and vertical pillars. For strengthen the structure, brackets are also utilized. With the establishment of Delhi Sultanate in 13th century onwards a style was promoted by the new ruling class in India which is better known as arcuate style. The arcuate style of building construction is mainly based on arch, vault and dome while lime and gypsum were used as cementing agents.

[174] When Rodgers visited this *baoli* in nineteenth century, it was used only for irrigational purposes. Se R.C. Rodgers, *op. cit.,* p. 76

[175] The *baoli* has been declared as a protected monument by ASI vides its Notification No. PN, 4891 dated 12.02.1923. *Inventory of monuments and sites of National Importance, Chandigarh Circle,*p. 79

[176] *Indian Archaeology 1987-88- A Review*, edited by M.C. Joshi, Archaeological Survey of India, New Delhi, 1993, p. 187

[177] *Indian Archaeology 1988-89- A Review*, edited by M.C. Joshi, Archaeological Survey of India, New Delhi, 1993, p. 148

[178] *Indian Archaeology 1991-92- A Review*, edited by B.P. Singh, Archaeological Survey of India, New Delhi, 1996, p. 173

[179] *Indian Archaeology 1992-93- A Review*, edited by Ajai Shankar, Archaeological Survey of India, New Delhi, 1997, p. 162

[180] *Indian Archaeology 1993-94- A Review*, edited by R. C. Bist, C. Dorje and Arundhati Banerji, Archaeological Survey of India, New Delhi, 2000, p. 170

[181] *Indian Archaeology 1998-99- A Review*, (editor's name is not mentioned in this publication), Archaeological Survey of India, New Delhi, 2004, p. 284

[182] *Indian Archaeology 2000-01- A Review* (editor's name is not mentioned in this publication), Archaeological Survey of India, New Delhi, 2006, p. 226

[183] Plate 5A

[184] C. J. Rodgers, *op. cit*., p. 62

[185] J.F. Blakiston (ed.), *Annual Report of the Archaeological Survey of India, 1935-36*, Delhi, 1918, p.15

[186] *Ibid*, I have counted 90 stairs from the entrance to the fourth level. But this last level which leads to the water level has lost its steps which covers the area of approximately 10 steps.

[187] Plate 5B

[188] Plate 5C

[189] Plate 5B

[190] Plate 5D

[191] Plate 5E

[192] Plates 5A, 5B

[193] Plate 5B

[194] Plates 5F, 5G

[195] Plate 5B

[196] Narnaul is situated in 28°3'N and 76°10'E. It is district headquarter of Mahendergarh district in Haryana state. Also see, S. S. Hussain, 'Some new Mughal inscriptions from Narnaul in Haryana', *Archaeological Survey of India; EpigraphiaIndica; Arabic and Persian supplement, 1977*, edited by N. M. Ganam, Archaeological Survey of India, New Delhi, 2000, p. 60

[197] Plate 6A

[198] Plate 6B

[199] Plate 6C

[200] Plate 6D

[201] H. B. W. Garrick, *Report of a tour in the Panjab and Rajputana in 1883-84, Vol. XXIII***,** Calcutta, 1887, p. 28. No contemporary information is available on the construction of this structure. The main source of information is the structure itself. On the basis of the architectural style the structure can be considered to be of Akbar's period.

[202] Plate 6E

[203] Plate 6A

[204] Plate 6F

[205] Plates 6B

[206] Plates 6G

[207] Plate 6B

[208] Plate 6B

[209] Plate 6B

[210] Plates 6G
[211] Plate 6H
[212] There is no sense of having a huge tank just at the entry point of the *baoli*. It is very difficult to access the *baoli* through this northern side that was the only entry point to access this building. Secondly, this tank is connected to the garden which is setup in terrace style. It is true that Babur and Akbar had patronized the terrace garden in Agra and Kashmir areas but we do not find references that these terrace gardens were developed by the nobility in remote areas till the reign of Jahangir.
[213] Plate 6C
[214] Plate 6I
[215] Plate 6D
[216] Plate 6J
[217] Plate 6K
[218] Plates 6K, 6L
[219] Plate 6J
[220] Plate 6K
[221] Plate 6M
[222] Plate 6N
[223] Plate 6O
[224] Plate 6D
[225] Plate 6J
[226] Plate 6P
[227] Plate 6Q
[228] Plate 6D
[229] Akshat Kumar Kaushik, Garima Kaushik and Gyanendra Nath Srivastava, 'Identification and Analysis of Ancient Water harvesting systems and associated hydraulic structures: A case study of Narnaul', *Proceedings of Indian History Congress, 76th Session* (University of Gour Banga, Malda, 2015), Aligarh, 2016, p. 765
[230] Information received from the official website of this department.
[231] Plate 7A
[232] Abul Fazl, *The Ain-i-Akabari*, *Vol. I*, *op. cit*., pp. 360-61
[233] G. Yazdani, 'Narnaul and its Buildings', *Journal of the Asiatic Society of Bengal, Vol. III, No. 10, December, 1907*, pp. 641-42; SubhashParihar, *Muslim Inscriptions in the Punjab, Haryana and Himachal Pradesh*, II Publication, New Delhi, 1985, p.49; Plate 7C
[234] Plate 7B
[235] Plate 7D
[236] Plate 7D
[237] Zeenut Zaid (editor), *The Magnificent Mughals*, Oxford University Press, Karachi, 2002, p. 195
[238] Plate 7D
[239] Plate 7A
[240] Plate 7E, 7F
[241] Plate 7A, 7G
[242] Plate 7G
[243] Plate 7A
[244] Catherine B. Aisher, *The New Cambridge History of India 1:4, Architecture of Mughal India*, Cambridge University Press, Cambridge, 1992, p. 84
[245] Plate 7H
[246] Plate 7I
[247] Plates 7A
[248] G. Yazdani, *op. cit*., pp. 642-43
[249] S. S. Hussain, *op. cit*., p. 60
[250] Akshat Kumar Kaushik, Garima Kaushik and Gyanendra Nath Srivastava, op., cit., p. 76
[251] Plate 7J
[252] Plates 7K, 7L

[253] A very similar structure (*baradari*) at Shekhupur (Pakistan) was built during the reign of Jahangir which further modified during Shahjahan's period. See Bianca Maria Alfieri, *Islamic Architecture of the Indian Subcontinent*, Laurence King Publishing, London, 2000, pp. 235-236

[254] As described by Mr. Garrick, its name was *NaharNaul*, "the forest of tigers" because of the availability of numerous tigers in the area. H. B. W. Garrick, *Report of a tour in the Panjab and Rajputana in 1883-84, Vol. XXIII***,** p. 27

[255] *Inventory of Monuments and sites of National Importance, Vol. I, part 2, Chandigarh Circle, op. cit.,* p. 65

[256] Plate 8A

[257] *Inventory of Monuments and Sites of National Importance, Vol. I, Part 2,Chandigarh Circle, op. cit.,* p. 60

[258] David Ross, *The land of Five rivers and Sindh : Historical and descriptive sketches*, Patiala, 1970 (first ed. London, 1883), p. 241

[259] *Chehli* was not his real name but merely a title which was used for a person who hadcompleted a special kind of*yoga* for forty days called *chilla*. For detailed description see Hitender Kumar, 'Some prominent Sufi Shrines of South-Eastern Punjab: Astudy of their History and Form', in Surinder Singh and Ishwar Dayal Gaur(Editor), *Sufism in Punjab: Mystics, Literature and Shrines,*New Delhi, 2009, pp. 336 - 355

[260] Alexander Cunningham, *Four reports made during* the *years 1862-65, Vol. II,* Archaeological Survey of India, New Delhi, p. 223. *Inventory of monuments and sites of National Importance, Vol. I, part 2, Chandigarh Circle, op. cit.,* p. 60

[261] Plate 8B; Following the trabeate style, it is the only structure of the complex which is made of undressed stones and rubbles, and thus it is called *Patheriya masjid.* For more details see Sanjay Subodh, 'Medieval remains in Thanesar- An exploration in Medieval Archaeology' in *Proceeding of Indian History Congress, 59th Session,* 1998, p. 990.

[262] Alexander Cunningham, *op. cit.*, p. 222

[263] Plate 8C

[264] Sanjay Subodh, 'Medieval remains in Thanesar', p. 990.

[265] Plate 8A

[266] Plate 8A

[267] Plate 8D

[268] Alexander Cunningham, *Four reports made during* the *years 1862-65,* p. 221

[269] Sanjay Subodh, *op. cit*., p. 990

[270] Plate 8E

[271] Plate 8E

[272] Plate 8F

[273] Plate 8G

[274] *Inventory of Monuments and Sites of National Importance, Vol. I, Part 2,Chandigarh Circle, op. cit.,* p. 60

[275] Plate 8H

[276] Plate 8I

[277] Sanjay Subodh and Amit Chaudhary, *Material Remains and Historical Secnse: A Study in Medieval Archaeology, Proceedings of the Indian History Congress, Vol. 61, Part One, Millennium (2000-2001),* Kolkata, 2001, p. 532

[278] C. M. Villiers Stuart, *Gardens of the Great Mughals*, Delhi, 1983 (first edition 1913), p. 202; Sylvia Crow, Sheila Haywood, Susan Jellicoe and Gordon Patterson, The *Gardens of Mughal India: A history and guide,*Delhi, 1973, p. 185*;* Ebba Koch, *Mughal Architecture: An Outline of Its History and Development (1526-1858)*, Oxford University Press, New Delhi, 2002, p. 126.

[279] Fidai Khan was grand master of the artillery at the time of war of succession. He supported Raushan Ara Begum at the time when she formed a party in favour of Aurangjeb. Francois Bernier, *op. cit*., p. 124; C. M. Villiers Stuart, *op. cit*., p. 202

[280] *ibid*, pp.199-200

[281] Sylvia Crow, Sheila Haywood, Susan Jellicoe and Gordon Patterson, *op. cit*., p. 187

[282] *District and States Gazetteers of the undivided Punjab (Prior to Independence), Vol.IV, Ambala District*, Delhi, 1985 (reprinted), p. 63 (139)
[283] C. M. Villiers Stuart, *op. cit.,* p. 205
[284] Catherine B. Asher, *op. cit*., p. 272
[285] Bakhshish Singh Nijjar, *Panjab under* the *Great Mughals, 1526-1707 A.D*., Bombay, 1968, p. 202
[286] Plate 9A
[287] Plate 9B
[288] C. M. Villiers Stuart, *op. cit.,* pp. 210-211
[289] Plate 9C
[290] Plate 9D
[291] *Ibid,* p. 212
[292] *Ibid*, p.211, Bianca Maria Alfieri, *op.cit.*, p. 272
[293] Plate 9E
[294] Plate 9F
[295] Plate 9F
[296] Plate 9G
[297] Plate 9H
[298] Plate 9I
[299] Plate 9I
[300] Plate 9J, Plate 9J a
[301] Plate 9K
[302] Plate 9L
[303] Plate 9M
[304] Plate 9N
[305] A. P. Singh, *Forts and Fortifications in India (with special reference to Central India)*, Delhi, 1987, p. 54
[306] William Irvine, *The Army of the Indian Moghuls; its Organization and Administration*, London, 1903, pp. 263-264
[307] Maximum Information related to the foundation of the HissarFiroza was received by Afif from his father. According to which its foundation was laid out "in the second year after the Bengal campaign." Earlier there were two villages which were used for construction, called Great Laras and Little Laras. For more details please see, Sams-i-SirajAfif, *Tarikh-i-Firozshahi*, English translation by H.M. Elliot and John Dowson, *the History of India as told by its Historian, Vol. III*, London, 1871, pp. 298-300; R.C. Jauhri, *Medieval India in Transition- Tarikh-i-Firozshahi: A First-hand Account,* New Delhi, 2001, pp. 90-93
[308] *Inventory of Monuments and sites of National Importance, Vol. I, Part 2, Chandigarh circle, op. cit.,* p. 31
[309] Sams-i-SirajAfif, *op. cit., p. 299;* R.C. Jauhri, *op. cit.,* p. 91
[310] R.C. Jauhri, *op. cit.,* p. 91
[311] This was the most common method prevalent throughout medieval India. See Mehrdad Shokoohy and Natalie H. Shokoohy, *Hisar-i-Firuza; Sultanate and early Mughal architecture in* The *district of Hisar,* India, Monographs on Art Archaeology and Architecture (South Asian Series), London, 1988, p. 8
[312] Abha Singh, 'Irrigating Haryana: The Pre-Modern History of the Western Yamuna Canal', in *Medieval India 1;Researches in* The *History of India 1200-1750*, edited by IrfanHabib, Oxford University Press, New Delhi**,**1992, p. 50 (fn. 3)
[313] M.S. Randhawa, *A History of Agriculture in India, Vol. II, eight to eighteenth century*, ICAR, New Delhi, 1982, pp. 79-80
[314] Sams-i-SirajAfif, *op. cit., p.* 300
[315] MehrdadShokoohy and Natalie H. Shokoohy, *op. cit*., p. 8
[316] Sams-i-SirajAfif, *op. cit., p. 299*
[317] *Ibid*.
[318] The name is symbolic as there is a *Lat* of Ashoka, the famous Maurya king, in the courtyard of the mosque so it is known after its name *Latki Masjid* (mosque of *Lat*). Plate 10A

[319] Plate 10B
[320] Plate 10C
[321] Plate 10D
[322] Plate 10E
[323] Plate 10F
[324] Plate 10G
[325] MehrdadShokoohy and Natalie H. Shokoohy, *op. cit.,* p. 24; A channel passes through this apartment which was used for cooling the chamber during summers. See Plate 10H
[326] Afif has mentioned about a huge tank inside the fort. The water of this tank used to fall into the ditch. See Sams-i-Siraj Afif, *op. cit., p. 299*
[327] *Inventory of Monuments and sites of National Importance, Vol. I, Part 2, Chandigarh circle, op. cit.,* p. 31
[328] Francisco Pelsaert, *op. cit.,* p. 56
[329] Julia A.B. Hegewald, *op.cit.,* pp. 1-5
[330] Robert Hillenbrand, *Islamic Architecture; Form, function and meaning*, Edinburgh University Press, Edinburgh, 1994, pp. 7-8

Figures

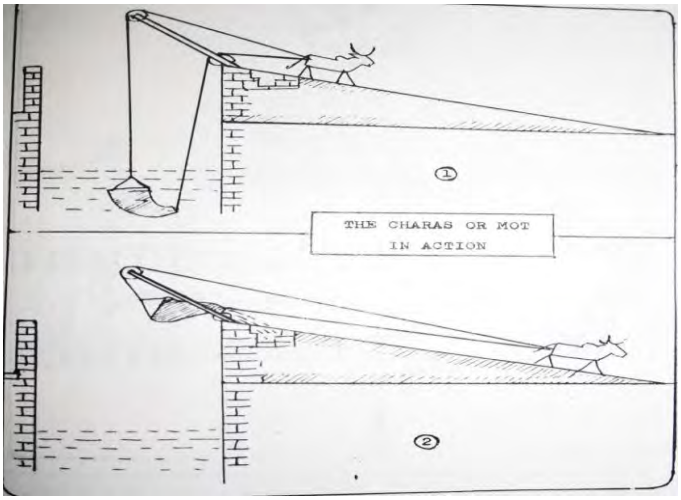

Figure **Error! Main Document Only.**: *Chadas*, *charas* or *Mot* in action.
Source: M.S. Mate, *A History of Water management and Hydraulics Technology in India, 1500 BC- 1800 AD*, p. 93

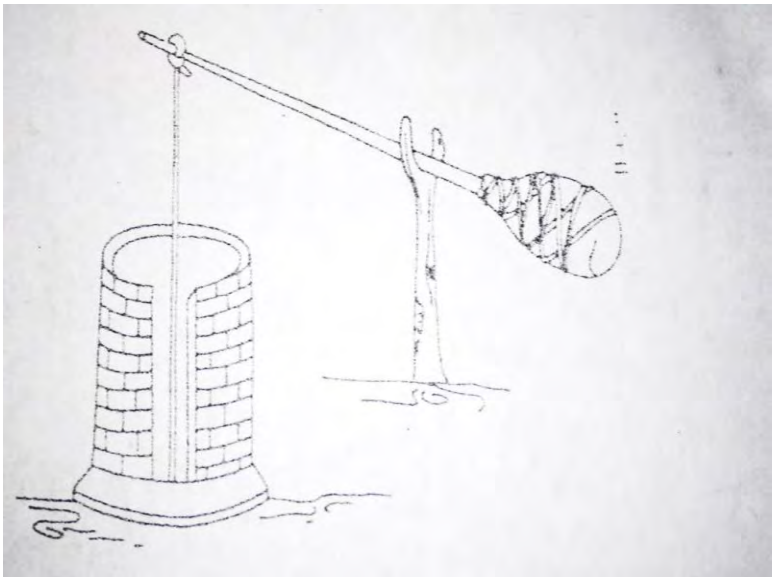

Figure **Error! Main Document Only.**: *Dhenkali*
Source: S.P. Verma, *Art and Material Culture in the Paintings of Akbar's Court*, New Delhi, 1978, plate LXVII

Figure 3: *Noria*
Source: Irfan Habib, *Technology in Medieval India*, c 650-1750, p. 9

Figure 4: Saqiya (ungeared)
Source: Irfan Habib, *Technology in Medieval India*, p. 10

Figure 5: Persian wheel with gearing from the painting by Sanwla, Akbar's atelier.
Source: Irfan Habib, *Technology in Medieval India*, p. 12

Plates

Plate 1A

Plate 1B

Plate 1C

Plate 1D

Plate 2A

Plate 2B

Plate 2C

Plate 2D

Plate 3A

Plate 3B

Plate 3C

Plate 3D

Plate 3E

Plate 3F

Plate 3G

Plate 3H

Plate 3I

Plate 4A

Plate 4B

Plate 4C

Plate 4D

Plate 4E

Plate 4F

Plate 4G

Plate 4H

Plate 5A

Plate 5B

Plate 5C

Plate 5D

Plate 6A

Plate 6A a

Plate 6B

Plate 6C

Plate 6D

Plate 6E

Plate 6F

Plate 6G

Plate 6H

Plate 6I

Plate 6J

Plate 6K

Plate 6L

Plate 6M

Plate 6N

Plate 6O

Plate 6P

Plate 6Q

Plate 7A

Plate 7B

Plate 7C

Plate 7D

Plate 7E

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Plate 7H

Plate 7I

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Plate 7L

Plate 8A

Plate 8B

Plate 8C

Plate 8D

Plate 8E

Plate 8F

Plate 8G

Plate 8H

Plate 8I

Plate 9A

Plate 9B

Plate 9C

Plate 9D

Plate 9E

Plate 9F

Plate 9G

Plate 9H

Plate 9I

Plate 9J

Plate 9J a

Plate 9K

Plate 9L

Plate 10A

Plate 10B

Plate 10C

Plate 10D

Plate 10E

Plate 10F

Plate 10G

Plate 10H