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Water Management and Conservation Practices in Indus Valley Civilization

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ABSTRACT

The Indus valley civilization was one of the world's first great urban civilizations. It flourished in the vast river plains and adjacent regions in what is now Pakistan and western India. Excavations during the twentieth century have revealed well-planned cities and towns built on massive mud brick platforms to protect the inhabitants against seasonal floods. In the ancient city, Mohanjo-daro was quite known to huge bath structures and rainwater was harvested in tanks and brought to the wells of each house through efficient drainage system flowed down the center of the streets to the Indus. In Lothal (Gujarat) and other places in north and western India small bunds were built by the local people to store rain water for irrigation and drinking. The dock-yard at Lothal is a remarkable lined structure, with evidence of channels for inlet and outlet of water. Dholavira is the sophisticated water conservation system of channels and reservoirs. The sewage was disposed through underground drains built with precisely laid bricks, and a sophisticated water management system with numerous reservoirs was established. The ancient techniques of water conservation can thus provide an insight of applying these techniques for future water conservation technology. At present most water harvesting structures are built under the holistic program of watershed development.

Key Words : Indus Valley Civilization, Water harvesting, Water conservation, Water management

INTRODUCTION

The Indus valley civilization was one of the most extensive of the old World civilizations, covering an estimated 1,000,000 km^2. Since its discovery in the 1920s, excavations have been carried out at a large number of sites. The history of water management in India goes back a long way, before some civilizations had even begun settling down as organized societies (Wright, 2010). Mohanjo-Daro and Harappa were old yet developed cities in the ancient times. These cities were well-organized and built of brick and stone. The drainage systems, wells and water storage systems were ahead of its time. These organized systems set them apart from all other ancient civilizations. There was enough evidence to show that ancient people were not only able to conserve and manage their water resources equitably, but also meet the local needs through community-owned systems of water management. Each of these unique systems based on the local environment ensured that individual needs were met through an equitable management of the collective resource. Documenting indigenous methods of water conservation is today a stark necessity. The Indus valley civilization in Asia showed that early evidence of public water supply and sanitation practices adopted in ancient period. The system the Indus developed and managed included a number of advanced water distribution features (Agrawal and Narain, 1997).

The ancient Indus Valley Civilization of South Asia, including current day Pakistan and Northwest India was prominent in hydraulic engineering and had many water supply and sanitation devices that were the first of their kind. Among other things, they contained the world's first earliest known system of 'flush toilets' along with a number of courtyard houses having both a washing

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platform and a dedicated toilet along with waste disposal hole. The toilet holes would be flushed by emptying a jar of water, drawn from the houses central well, through a clay brick pipe and into a shared brick drain that would feed into an adjacent soak pit (cesspit). The soak pits would be periodically emptied of their solid matter, possibly to be used as a fertilizer. Most houses also had private wells. City walls functioned as barrier against floods. The urban areas of Indus valley civilization provided public and private baths, sewage was disposed through underground drains built precisely with laid bricks and a sophisticated water management system with numerous reservoirs was established. In the drainage systems, drains from houses were connected to wider public drains. The elaborate drainage system of the Harappa people showed that they had developed a high sense of health and sanitation. The drainage system and drains were covered with bricks or stones and were provided with inspection traps and main holes at regular intervals for inspection to check the continuous flow of waste water. Every house had its own soakpits, which collected all the sediments and allowed only the water to flow into the street drains.

The various methods of water conservation and water supply systems in terms of the following are described as drains and water sewage systems, wells in ancient structures, water harvesting systems, public bathing areas, cisterns at Kanheri, and Baolis, recorded as evidences from mainly different archaeological excavated sites.

Mohanjo-Daro:

The first major human settlements started in the Indus Valley (3000-1500 B.C.) also called as Harrapan civilization demonstrated a high degree of water management and conservation skills. One of the best known examples of this is the Great water bath at the site of Mohanjo-daro and located in Sindh, Pakistan is one of the best excavated and studied settlements from this civilization (Marshall, 1931 and Mackay, 1938). It was a tank, accessed by steps, to which wooden covers were fixed by bitumen, the floor and sides of tank were waterproofed through the addition of gypsum in the building mortar, with a backing of bitumen course for further damp proofing. The sides of the pool were backed by a secondary set of walls, with the intervening space between the two being filled with a bitumen coating and earth, to ensure total waterproofing. Water for filling the Great Bath came from a large well situated in one of the rooms fronting the open courtyard of the building- complex, while a corbelled baked-brick drain in the south- western portion of the bath served to carry away the used water. The Great Bath might be the first of its kind in the pre-historic period. This ancient town had more than 700 wells, and most houses in Mohenjo-Daro had at least one private well (Singh, 2008).

The "great bath" is without doubt the earliest public water tank in the ancient world. The tank itself measures approximately 12 meters north-south and 7 meters wide, with a maximum depth of 2.4 meters. Two wide staircases lead down into the tank from the north and south and small sockets at the edges of the stairs are thought to have held wooden planks or treads. At the foot of the stairs is a small ledge with a brick edging that extends the entire width of the pool. People coming down the stairs could move along this ledge without actually stepping into the pool itself (Jansen, 1989).

The floor of the tank is water tight due to finely fitted bricks laid on edge with gypsum plaster and the side walls were constructed in a similar manner. To make the tank even more water tight, a thick layer of bitumen (natural tar) was laid along the sides of the tank and presumably also beneath the floor. Brick colonnades were discovered on the eastern, northern and southern edges. The preserved columns have stepped edges that may have held wooden screens or window frames. Two large doors lead into the complex from the south and other access was from the north and east. A series of rooms are located along the eastern edge of the building and in one room is a well that may have supplied some of the water needed to fill the tank. Rainwater also may have been collected for these purposes, but no inlet drains have been found (Ratnagar, 2014 and 2015).

Most scholars agree that this tank would have been used for special religious functions where water was used to purify and renew the well being of the bathers.

Lothal :

Lothal is supposed to have the earliest dock in world history. The dockyard at Lothal is a remarkable lined structure with evidence of channels for inlet and outlet of water. Small bunds were built by local people to store rainwater for irrigation and drinking. Lothal engineers provided corbelled roofs and an apron of kiln-fired brick face of the platform, where the sewerage entered the cesspool for their renowned draining system. Wooden screens inserted in grooves in the side drain walls held back solid waste. The well was built of radial bricks, 2.4 meters (7.9 feet) in diameter and 6.7 meters (22 feet) deep. It had an immaculate network of underground drains, silting chambers and cesspools, and inspection chambers for solid waste. The extent of drains provided archaeologists with many clues regarding the layout of streets, organization of housing and baths. On average, the main sewer is 20-46 cm (7.9 -18.1 inch) in depth, with outer dimensions of 86 x 68 x 33 cm (34 x 27 x 13 inches). Lothal brick makers were used a logical approach in manufacture of bricks designed with care in regards to thickness of structures. They used as headers and stretchers in same and alternate layers (Hegewald, 2001). In Lothal, all houses had their own private toilets, which were connected to a covered sewer network constructed of brickwork held together with a gypsum-based mortar that emptied either into the surrounding water bodies or alternatively into cesspits, the latter of which were regularly emptied and cleaned.

The dominant sight at Lothal is the massive dockyard, which has helped make this place so important to international archaeology. Spanning an area of 37 m from east to west and nearly 22m from north to south, the dock is said by some to be the greatest work of maritime architecture before the birth of Christ. All archaeologists are convinced that the structure was used as a dockyard and some preferred to refer to it as a large water tank that may have been a reservoir. It was excavated near Sabarmati River, which has since changed water course. The structure's design showed a thorough study of tides, hydraulics and the effect of sea water on bricks. Ships could have entered into the northern end of the dock through an inlet channel connected to an estuary of the Sabarmati River during high tide. The lock gates could then have been closed so the water level would rise sufficiently for them to float. An inlet channel 1.7m above the bottom level of the 4.26m deep tank allowed excess water to escape. Other inlets prevented siltation of the tanks and erosion of the banks. After a ship would have unloaded its cargo the gates would have been opened to allow it to return to the Arabian Sea waters in the Gulf of Cambay. The hydraulic knowledge of the ancient Harappans can be judged by the fact that boats had docked at Lothal in year 1850. In Lothal (Gujarat) and other places in north and western India small bunds were built by the local people to store rain water for irrigation and drinking. The Dock-yard at Lothal is a remarkable lined structure, with evidence of channels for inlet and outlet of water. Towards the southern part of the eastern wall of this dock-yard there is a 7m wide gap (Rao, 1979). Excavations further to the east, have surmised that this spill-channel connected the Lothal dockyard with the nearby Bhogavo river, and thence with the Gulf of Cambay. It has been suggested that boats could enter the Lothal dock at high tide using this channel, when the tide water's swelled the channels natural flow and pushed the extra water upstream. In a like manner, the boats could make the return journey back to the river when the tide ebbed. To take care of the problem of the discharge of extra water, a sizeable spill channel was built in the southern wall of dock. The water level could be partially regulated by means of a wooden sluice gate fitted across the spill-channel. A mud-brick platform adjoining its western embankment helps in loading society and Environment in Ancient period.

Dholavira:

The Dholavira site was discovered in 1967 -1968 and is the fifth largest of eight major Harappan sites mentioned by Joshi (1996). It has been under excavation since 1990 by the Archaeological Survey of India, which opined that Dholavira was indeed added new dimensions to personality of Indus valley civilization. Dholavira is an archaeological site in Bhachau Taluka of Kutch district, in the state of Gujarat in western India. The kind of efficient system of Harappans of Dholavira, developed for conservation, harvesting, and storage of water speaks eloquently about their advanced hydraulic engineering, given the state of water technology. The kind of efficient system of Harappans of Dholavira, developed for conservation, harvesting and storage of water speaks eloquently about their advanced hydraulic engineering given the state of technology in the third millennium BCE. Dholavira storm water flowed through drainage system in the castle. Dholavira is the sophisticated water conservation system of channels and reservoirs, the earliest found anywhere in the world, built completely of stone. The city has massive water reservoirs, three of which are exposed. They were used for storing fresh water brought by the rains or to store water diverted from two nearby rivulets. This clearly came in response to the desert climate and conditions of Kutch, where several years may pass by without rainfall or drought conditions. A seasonal water stream which runs in a North-South direction near the site was dammed at several points to conserve the water. The inhabitants of Dholavira were created sixteen or more reservoirs of varying sizes. Some of these took advantage of the slope of the ground within the large settlement, a drop of 13 meters (43 feet) from northeast to northwest. They are about 7m deep and 79 m long. Reservoirs skirted the city while Citadel and bath are centrally located on raised ground. There were two local seasonal rivulets the Mandsar (which lies to north- west of Dholavira) and the Manhar (lies to south eastern part of the walled area), which help in collecting the rainwater in the catchment areas of the sites and brought to the reservoirs. This was achieved through an ingenious system involving stone bunds of dams that were raised across the streams at suitable points. From these, the monsoon runoff was carried to a series of reservoirs, gouged out in the sloping areas between the inner and outer walls of the Harappan period city, through inlet channels. These water reservoirs were separated from each other by bund-cum-causeways, which also served to facilitate access to different divisions of the city (Bisht, 1999).

The Dholavira excavations reveal that at least 16 water reservoirs were created within the city walls. A network of storm water collection drains was also laid out, cris-crossing the citadel area to collect rainwater. These brick and stone built drains were not used for sullage at all, but only to collect and carry rainwater to a receptacle for later use. There were apertures served as air ducts to help the easy flow of storm water. Household drains were linked to soakpit at Dholavira. In this manner every effort was made to preserve rainwater in an area where there is no perennial source of surface water and ground water is largely brackish (Bisht, 1991).

At other Harappan sites like Kalibangan, Surkotda and Chahnudaro consisting buildings have also yielded evidence of individual water wells serving domestic utilities for residential units. Many archaeological surveys suggested that every third house had a well. Besides private wells, there were also public wells. Beside this, individual houses possessed paved bathrooms with drains to carry out waste water from the houses into the local city drainage system. This drainage system entailed well-covered street drains made of Kiln- baked bricks, with covered manholes at intervals for purposes of cleaning and maintenance (Francfort, 1992). Thus the techniques involved in the ancient Indus system of sewerage or drainage were developed and used in cities throughout the civilization were far more advanced than any found in contemporary urban sites of world. This shows that science applied in those times were unique and was highly advanced which led to the rise of complex, urban societies in ancient India. Archaeological evidence shows that the practice of water conservation and management is deep rooted in the science of ancient India. Excavations show that the cities of the Indus valley civilization had excellent systems of water conservation, harvesting and drainage system. Other reservoirs were excavated, some into living rock. Recent excavation works have revealed two large water reservoirs, one to the east of the castle and one to its south. They were used for storing the fresh water brought by rains or to store the water diverted from two nearby rivulets contributed clearly came in the wake of the desert climate and conditions of Kutch, where several years may pass without rainfall.

Rock Cut Reservoir:

The water reservoirs are cut through stone vertically, and are about 7 m (23 ft) deep and 79 m (250 ft) long. They skirt the city, while the citadel and bath are centrally located on raised ground. There is also a large well with a stone- cut trough connecting it to a drain meant for conducting water to a storage tank. The bathing tank had steps descending inwards. Wells in Harappa and Mohenjo-Daro-used as large public well and public bathing platforms were found in the southern part of Mound at Harappa. These public bathing areas may also have been used for washing clothes as is common in many traditional cities in Pakistan and India today (Krishnamurthy,1996).

Cisterns at Kanheri :

The Kanheri caves invariably contain evidences of 'Podhis' or water cisterns, which were excavated ingeniously to trap the rain water and store them for use during summer periods. Such Kanheri structures play a significant water conservation practices in ancient periods of Indian subcontinent.

Baolis :

These are rightly referred to as India's forgotten water temples, many of which are almost redundant today. Many baolis are still popular and are sightings for various tourist and filmmakers. The most popular among these are 'Agrasen ki Baoli', 'Chand Baoli' etc. Baolis are basically the stepwells more commonly found on forts and ancient heritage structures (Pande, 1997). One of the most crucial requirements of a fort was a regular supply of water to ensure self-sufficiency during a siege, which could last for months. The source of water was a closely guarded secret to prevent the unscrupulous enemy from poisoning it. Varahmir stated in his Brihat Samhita that arteries of flowing water lie at various depths beneath the surface of the earth, and these can be located by an understanding of the topography and environment of particular dry climatic regions.

There are several evidences revealed that a lot of wonderful knowledge of hydraulic techniques in ancient India, which are in present time is considered to be advanced techniques over modern period. Indians continued to build structures to catch, hold and store monsoon rainwater for the dry seasons to come. Water has been conserved and managed in India since antiquity, with our ancestors perfecting the art of modern hydrological conservation technology.

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