URBAN WATER CONSERVATION-LEARNING FROM THE PAST: COMPARATIVE STUDY OF URBAN WETLANDS AND MAN MADE WATER BODIES

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Received: Oct. 2018 Accepted: Nov. 2018 Published: Dec. 2018

Abstract: Through the ages, environmental factors like water, topography and vegetation has influenced man's choice for settlement. Wetlands and water bodies have played crucial role in stemming the human society and have sculpted the human settlements time and again around the world. This dynamic system of water bodies which has been in a constant interaction with cities has contributed in the morphology of cities, its activities and socioeconomic well-being. Urban wetlands have acted as major spine of Indian cities since thousands of years nurturing and feeding millions relentlessly. These water bodies have shaped the cities and societies imbibing rich cultural and religious values to people inhabiting them.It have been observed that, settlements which were not located near or large lakes, humans have constructed tanks or retention ponds to collect and store water from water shed. The rain water was collected and stored during monsoon and used during dry seasons. Presently about 330 million people in India are facing regular water shortage. In 2016, 300 districts spread across 13 states in India , suffered from acute shortage of drinking water. In this paper , various urban wetlands and manmade water bodies in 4 Indian cities have been discussed for understanding the importance of water bodies with respect to the urban life through various determinants. The cities selected for study are Bundi, Bangalore, Hampi and Chandan Nagar. The aim of this research paper is to study the various traditional water conservation techniques used in these 4 cities and to come up with a solution for present day urban water crisis, prevalent in most of the country.

Keywords: Urban Wetlands, Water Bodies, Water Conservation, Urban Water Crisis.

Introduction: The history of human settlement reveals that man has close association with the rivers and water bodies ever since the existence of civilization. Nearly all the great civilizations of the world grew up around water which provided the key not only for consumption but also to agriculture, trade, transport and defense. Water sources, topography and vegetation have always been the major factors influencing the site selection for settlements. There are numerous instances where in absence of natural water bodies like rivers lakes and wetlands, humans have created artificial water bodies utilizing the ground water, local rainfall and runoff water from watershed. Water sources whether natural or manmade have always been the primary factor for origin and growth of human settlements. This paper is focusing mainly on the manmade urban wetlands and water bodies like Step Wells (*Baoli's*) and water tanks (*Pushkarni's*). These dynamic systems of water bodies have always been in constant interaction with cities and have actively contributed in the morphology of cities, its activities and socioeconomic well being.

As per Indian government reports, presently, about 330 million people in India are facing regular water shortage. In 2016, 300 districts spread across 13 states including Uttar Pradesh, Maharashtra, Odisha, Bihar, Jharkhand, Andhra Pradesh, Telangana and Madhya Pradesh suffered from acute shortage in supply of drinking water. As per World Bank, 54 % of the world's population lives in urban area, which is expected to increase to 66 % by 2050. Presently in India, 32 % population lives in urban areas and it is expected that by 2050, India will have the largest urban population in the world. All over the world, cities are facing a wide range of pressure due to population growth, climate change and deterioration or insufficient urban infrastructure. The water demand continues to increase all across the globe, and particularly in developing nations, urban water conflict can be observed in various forms. Lack or insufficiency of water management and complex socioeconomic structures can be assumed to be the major causes of these urban water conflicts. From Table 1 it can be inferred that per capita water availability has reduced by almost $1/5^{th}$ in the last six decades.

TABLE 4: PER CAPITA WATER AVAILABILITY IN INDIA

Year	Population (Million)	Per Capita Water Availability (m3/year)
1951	361	5177
1955	395	4732
1991	846	2209
2001	1027	1816
2011	1210	1545
2025*	1394	1341
2050*[1]	1640	1140

(Source: Census of India)

Urban Water Conflict: The Urban Water conflict can be categorized in accordance with the United Nations typology of Sustainable development i.e. Economic, Environmental, Social and Political Conflict. In India, the primary reason behind urban water conflict is scarcity of resources. There is lack of access to clean water sources for poor, Shortage of water available for public services and quality related issues that are caused either due to over exploitation or industrial pollution. Urban water conflict can be divided into three main categories[2]- (i) Conflict linked to quantity i.e conflict between sectors or users (ii) Conflict linked to quality i.e. Water borne diseases affecting mainly the poor people due to unavailability of safe drinking water (iii) Conflict linked to water access i.e. legal and water rights

Water Management: Man Made Urban Wetlands and Water Bodies: Throughout Indian history, numerous examples of water conservation and management can be seen across the country. Urban wetlands have been a major spine of Indian cities since thousands of years nurturing and feeding millions relentlessly. These water bodies have shaped the cities and societies imbibing rich cultural and religious values to people inhabiting them. In numerous cities, tanks were constructed in the catchment areas of cities that were not located near a

[1] Water Scarcity and security in India, Dr. Narayan G. Hegde,2009

[2] Urban water conflict in Indian Cities: Man made scarcity as critical factor , S. Janakarajan ,Marie-Helene Zérah ,Marie Llorente, 2005

river or a large lake. Rain water was collected and stored in these tanks during monsoon and used for the rest of the year.

Wetlands: These are the areas where water is the primary factor controlling the environment and the associated plant and animal life .As per **Ramsar Convention**, Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meter.

Generally five major types[3] of wetland are recognized: Marine (Coastal wetlands including coastal lagoons, rocky shores, sea grass beds and coral reefs), Estuarine (Including deltas, tidal marshes mud flats and mangrove swamps),Lacustrine (Wetlands associated with lakes), Riverine (Wetlands along rivers and streams), Palustrine (Marshes, swamps , bogs), and Human made wetlands (Fish and shrimp ponds, farm ponds ,irrigated agriculture lands including rice paddies, salt pans, dams, reservoirs, gravel pits, waste water treatment ponds and canal).
Different man made wetlands found across India are: (i)**Talab/ Lakes**: These are found in most of the Indian states. These are an excellent example of rain water harvesting which also helps in ground water recharge. In Bundelkhand region and Rajasthan, when these water bodies dry up after monsoon, the pond beds are used for rice cultivation. (ii) **Johad** : These are small earthen check dams that capture and conserve rain water, improving percolation and ground water recharge. These are mainly found in Rajasthan. (iii)**Rapats**: These are percolation tanks, with bund to impound rainwater flowing through water shed. These recharges wells are present within a distance of 3-5 km downstream. (iv) **Kunds**: These structures harvest rainwater for drinking and are found in western Rajasthan and Gujarat. These are circular underground wells, and have saucer shaped cathment area that gently slope towards the centre where the well is located (v) **Baodis**: These can be found across India. These were mainly used for drinking water and can retain water for long durations due to negligible water evaporation. (vi)**Jhalaras**: These are human made tanks meant for community use and religious practices. (vii)**Baoli/Vav/ Baudi**: These are traditional step wells found in most of the Indian states. These were usually secular structure from which everyone can draw water. (viiii)**Zings:** These are water harvesting structures found in Ladakh. These are small tanks which collects melted glacier water. (ix)**Eri/ Tanks**: These are found in Tamil Nadu. These play an important role in controlling flood, preventing soil erosion and wastage of run off during heavy rainfall. Also, these help in ground water recharge.

The interaction of physical, biological and chemical components of wetlands, plays vital role in water storage, storm protection and flood mitigation, drought buffering, stabilization of shore line and erosion control, ground water recharge , water purification, retention of nutrients and stabilization of local climate conditions particularly rainfall and temperature. Wetlands have special attributes as cultural heritage for human societies. They are related to religious and cosmological beliefs and add to spiritual values. In this paper, we have tried to study and analyze various types of manmade urban wetlands and water bodies found in different parts of the country, their impact on environment and ecology, and social and cultural influence on the societies. The different study areas are Bundi (Rajasthan), Bangalore (Karnataka), Hampi (Karnataka) and Chandan Nagar (West Bengal)

[3] An introduction to Ramsar Conventionon wetlands, Ramsar Handbook, 5th edition,2016

Appraisal of Study Areas:

Study Area 1: Step Wells of Bundi (Rajasthan): The city of Bundi is known for its iconic fort, the Bundi School of painting and step-wells scattered in all directions across the city. The various patrons who ruled the city with their welfare activities have dotted the city with step-wells and kunds.

The step-wells and water structures of Rajasthan are following to a large extent the architectural trends of Gujarat or Western India; one could clearly discover very distinct features with unique and extraordinary styles and idioms in certain regions. One such region is certainly the area of Shekhawati with its typical *joharas* and covered wells. Another distinct group of water structures is found in the town of Bundi and its precincts, which is a region quite different to the dry, arid and barren region of northern Rajasthan. Bundi is situated in the rather lush and forested eastern region of Rajasthan and *baoli's* are unique building typologies. These *baolis* showcase an in-depth knowledge of the local water systems and an immaculate knowledge of construction systems leading to the development of ways to harvest and store water for the dry months of the year. The city of Bundi has 48 *baoli's* and 10 *kunda's*. The ambiguity of these step-wells is fascinating: they were sacred sites and places of worship. But at the same time also secular, catering to the civic needs of the people and fulfilling domestic, agricultural and economic trajectories. These step-wells were dug into the ground and not constructed; they are underground and not rising into the sky as temples were meant to be. A *baoli* or step-well is the most intricate, and from the architectural point of view, the most complex one. The most magnificent one, resembling a subterranean temple, with hundreds of sculptures placed along the side-walls all around the well. The architectural structure of most of the step-wells consists of three elements: the sloping descending stairway, the vertical-well at its end, and internal bridging cross-constructions to counter-balance the inward thrusts of the earth at the side-walls and to ensure structural stability. The well being and prosperity of the community is determined by the purity of the source of water in the neighborhood. Therefore wells were usually not accessible and the water had to be hauled up with buckets through a pulley system, and thus keeps it unpolluted by human touch, whereas ponds and lakes serve more as water storage systems and cater to the domestic needs of the people such as bathing, or watering the animals. A *baoli* or *kunda* could be located at three different places: connected to a temple or mosque, or within an aristocratic residential complex; within or at the edge of a village; and outside settlement on overland routes. The oldest step-well in India has been cut off natural rock on a high mountain range called Uparkot on Mount Girnar near Junagarh in Gujarat dating 2000 years old.

The *baoli's* or step-wells in the town of Bundi not only fulfills water required for domestic use but also served as a communal space for various religious rituals of the local communities. However with the advancement of technology and development of new and easy ways of accessing water and storage, and the availability of tapped water, *baoli's* have lost their importance as source of water. The same communities that respected and preserved these *baoli's*, have started abusing these traditional sources of water dumping garbage and wastes in these structures. Even the flowers and fruits offered to the Gods in the shrines within the *baoli's* are being dumped in the water. The water in the *baoli's* is no longer used for drinking as originally intended.

Study Area 2 - Lakes of Bangalore (Karnataka): Bangalore, located in the southern part of India, is the capital of Karnataka. It is the third most populous Indian City. The naturally undulating terrain of Bangalore with its hills and valleys, has lend perfectly to the development

of lakes and tanks that has been used to collect and store rain water .There are three major water sheds i.e. The Hebbal Valley, The Koramangala Chellaghatta Valley and the Vrishabhavati Valley. The intricate chain of small and medium sized tanks has played a major role in ground water recharging and controlling floods. The earliest known records of construction of artificial surface water catchment areas of Bangalore date backs to 16th century, when Ulsoor Lake was constructed by Kempegowda, the founder of Bangalore. The city once had an excellent monsoon water harvesting system formed by the series of lakes and tanks built to sustain its people. These water bodies not only provided water to its civilians for daily needs but also checked floods, recharged and maintained ground water table and supported agriculture. The lakes in Bangalore form a chain of hydrological connection[4] . The flow of water runs from North to South East as well as South West, along the natural gradient of the land. During monsoon, the surplus water from the upstream lake flows down to the next lake in the chain and from there further down. The connectivity did not allow an over flow of water out of the lake into the surrounding area as the additional quantity of seasonal water was transferred to the other lakes. The lakes thus formed a chain of reservoirs in each of the three Valley systems.

When Bangalore started receiving water from Cauvery River and the agricultural lands were converted into townships due to the increasing population, many lakes were converted into residential layouts, bus stands, parks and playgrounds. As per Karnataka state Pollution Control Board, till 1960, there were 262 major water bodies in Bangalore. Presently the number has decreased to 81 of which only 32 are recognized as live lakes. Most of the water bodies in BBMP area except the developed ones are in state of total degradation which is mostly contaminated with sewage water and wastes. In four decades the urban area of Bangalore has increased by 632%. The Urban growth has led to the encroachment of wetlands and flood plains causing obstruction and loss of natural water storage. Also, the water table level receded more than 4 meters in many parts of Bangalore, which is causing acute water shortage during hot months i.e March till May. On the other hand the city gets flooded during Monsoon (June-September) due to obstruction of the natural drainage pattern, encroachment of water bodies, siltation of storm water drains and lakes. In October 2017, BBMP has identified 96 localities that are prone to inundation and flooding during Monsoon.

Study Area 3: Reservoir System of Hampi (Karnataka): Hampi is located on the banks of Tungabhadra, in the east central Karnataka. The group of monuments at Hampi, is a world heritage site. It was the capital of Vijayanagar Empire which ruled a major portion of Southern India during 14th to 16th century. The chronicles left by Persian and European travelers states Hampi as a prosperous, wealthy and grand city. The ruins of Hampi are spread over 41.8 SqKm and have more than 1600 remains of architectural marvels.
The Vijaya Nagar Kingdom had developed various hydraulic structures by taking advantage of natural topography and scientific techniques to convey water from hilly area to urban habitat. This resulted into large number of storage and conveyance systems. The reservoir system at Hampi sustained a population of half million for hundreds of years with little rainfall. There were stepped water tanks called *Pushkarini's* constructed in Hampi, the largest was located in Vithala temple complex. The archaeological survey reveals a careful placement of ponds in the surrounding dry and rocky hills which collected surface runoff water in a series of filtration pits. The rain water was channelized and collected in the *Pushkarini's*. A series of retention basins, channels and percolation pits were constructed within the city. These retention basins

[4] https://www.karnataka.gov.in/Parisaramahiti/Pages/Lakes-of-Bangalore.aspx

and diversion channels helped in retaining water within the water shed of suburb by slowing down runoff. These water bodies further helped in recharging ground water. There were both public and private water bodies. The semiprivate ones had a free flowing edge profile, while the public ones were defined with steps and sharp and geometric edge profiles. As per landscape architect, Mohan Rao, the series of water systems helps in understanding spatial definition. In the Vitthala precinct, the proximity between adjacent water bodies illustrates the possible intensity of merchant community settlement that is documented to have existed around these water bodies. It is seen that the different types of water bodies changes with altitudes. At higher altitudes, detention ponds were created to store rain water, but as one, recedes to lower levels, diversion channels and wells were found. At the lowest altitudes, step Wells called *Pushkarini's* were constructed to collect surface run off and rain water.

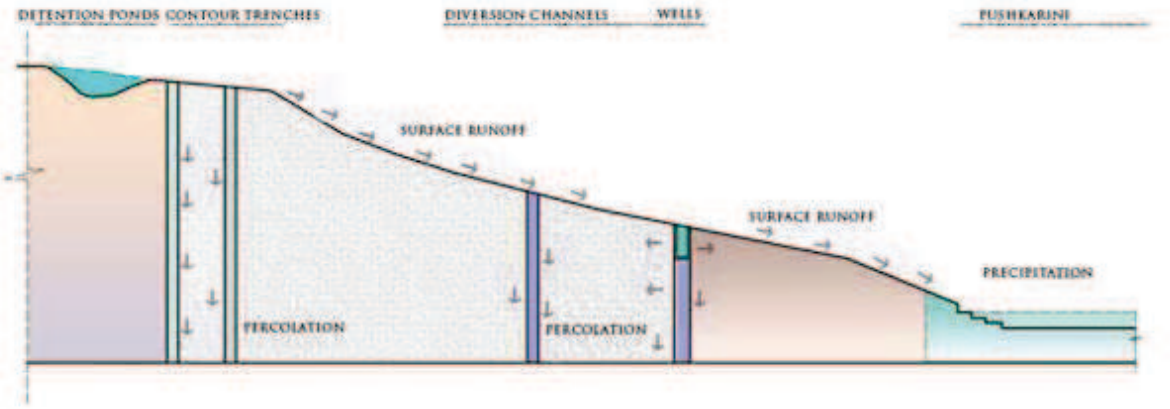

FIGURE 30 : SYSTEMATIC REPRESENTATION OF RAIN WATER HARVESTION SYSTEM

Study Area 4: Pukurs of Chandan Nagar, West Bengal: Chandan Nagar is located on the banks of Hooghly river, towards north of Kolkata. It is a former French colony and was one of the major trading centres. Even though, Hoogly river is the major source of water, there was a tradition prevalent among the locals of excavating ponds next to their houses. This practice can be seen all across the city. The ponds , also known as *Pukur* can be categorized into two types on the basis of ownership i.e. private and community owned. The people owning large plot sizes, excavated their own ponds, whereas people with small plot sizes, pooled their land at community level to construct ponds. These ponds constructed on pooled lands belonged to the entire local community or contributors. The *pukur's* played an important role in day to day activities of local residents. These were used for bathing, washing and pisciculture. These water bodies not only give a distinct identity to the city but also helped the local economically and provided a space for social and cultural interaction. Also the *pukur's* helped in recharging ground water and controlling floods. In present times, the locals have started abusing these traditional water bodies. In certain places these have turned into garbage dump yards, leading to pollution and eutrophication which has lead to loss of aquatic life and contaminated unusable water. More over the layer of garbage has reduced the water absorption capacity of soil, leading to flooding of *pukur's* during monsoon. These The local municipal corporation has made stringent rules to conserve the *pukur's* . As per their guidelines, *pukur's* should not be filled and used for construction.

Inferences: The study of various traditional water bodies across different cities in India show the important role of these structures in the social and cultural beliefs of people. These water bodies, since long had close association with the daily activities of the people and played major

role in ground water recharge and water conservation. The study implicates the consequences humans are facing due to negligence and abuse of these tradition water bodies and urban wetlands. Presently, people are completely ignorant of the importance of the traditional water conservation systems in India.

Conclusion: The wetlands have played a pivotal role in structuring human settlements and had an important role in urban morphology. These urban wetlands and manmade water bodies holds social, traditional, cultural , economical and environmental importance for the resident population. Moreover, these water bodies have also fulfilled the daily needs such as portable water, washing, bathing and other uses for the locals. In spite of holding cultural importance these water bodies are still being abused and polluted by the local communities and ignored by the Urban Local bodies. Considering, the water crisis that Indian cities are facing in present times, it is important to conserve water. These traditional methods of water conservation, like reservoir systems of Hampi, lakes of Bangalore, Step Wells of Bundi or Pukur's of Chandan Nagar can inspire people and governments alike, to conserve water and preserve these traditional structure of water storage and conservation. These local methods can be adapted and modified with modern day technology to resolve the present day urban water conflict.

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