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Urban Water Crisis: Negotiating the Challenges through Sustainable Practices

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Abstract: Water conservation is important for 'ecological sustainability' therefore what we consume needs to be replenished back in some way. Rainwater harvesting (RWH) system is one such conservation policy and it uses the principle of conserving rainwater. In the process we help in the recharge of groundwater. Traditional RWH systems were built to suit the specific environments in which they evolved and worked efficiently in different economic and political environments. The issue of water is not about scarcity but about its careful use and its equitable and distributed access. Water is our basis therefore water conservation is the need of the hour. Illegal boring has led to depletion of groundwater reserves. Not only this but urban water bodies which served the needs of the city since early times are now dump yards for garbage and refuse. Since surface water bodies are getting polluted by the day and usage of this water is only possible after thorough treatment, people opt for ground water resources since treatment of water is also an expensive proposition.

Lessons can be derived from traditional practices of water usage and its conservation. To be able to implement RWH techniques in the present day we can look at some traditional rainwater harvesting systems in various parts of India to get a few practical lessons in the methodology. Lessons can be taken from places like *Zings* of Ladakh, *Khuls* of Jammu in NorthIndia, *Naula* or *Hauzi* in the hills of Uttar Pradesh, practices of Northeastern states like Mizoram, Meghalaya and Nagaland, The *Baoris, jhalaras* and *tankas* of Rajasthan and *kulams* of Tamil Nadu. The Research paper will emphasize on the traditional methods of rainwater harvesting and their regional innovations from which the practice of rainwater harvesting is applicable in the urban situations of the country. This will be aimed at achieving not only water conservation but also restoration of traditions and clues for working out desirable solutions.

Keywords: Water resources, Water conservation, Rainwater harvesting (RWH), Traditional practices, urban storm water managment.

I. INTRODUCTION

Even though the rate of urbanisation in India is among the lowest in the world, the nation has more than 300 million city-dwellers. Experts predict that this number will rise even further, and by 2030, about 50 per cent of India's population will be living in cities [1]. This is going to put further pressure on the already strained centralised water supply systems of urban areas.

A wide range of ecological and human crises result from inadequate access to, and the inappropriate management of freshwater resources. These include destruction of aquatic ecosystems and extinction of species, millions of deaths from water-related illnesses, and a growing risk of regional conflicts over scarce water supplies. Rapid urbanisation has also resulted in surface waters getting contaminated or lost through watershed mismanagement. For example, animal grazing or excessive human use at high elevations can lead to fecal contamination of surface runoff in mountain streams. Urbanization has lead to storm runoff that is lost to sewers rather than feeding streams or recharging groundwater. Also over pumping of groundwater that is the extraction of groundwater at a rate that exceeds the rate of natural recharge can only allow some time with no adverse consequences on the aquifer but problem arises if natural recharge of the aquifer is not enough during wet periods.

It is therefore desired to replenish water resources and maintain 'ecological sustainability'. Rainwater harvesting system is one such conservation policy and it uses the principle of '*conserving rainwater where it falls'* [2]. In the process groundwater gets recharged. The traditional systems we are exploring in this paper were built to suit the specific environments in which they evolved and worked efficiently in different economic and political environments. They used low cost simple techniques and were maintained by local communities.

II. DEPLETION OF WATER RESOURCES BECAUSE OF URBANISATION

In the past the primary goals of water development policy were to support increasing levels of economic development and to figure out ways of increasing the availability of fresh water to meet anticipated demands. Excluded from these policies we note were considerations of -

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i. Basic human needs
ii. Ecological water requirements
iii. The roles of communities and culture
iv. Desires and needs of future generations

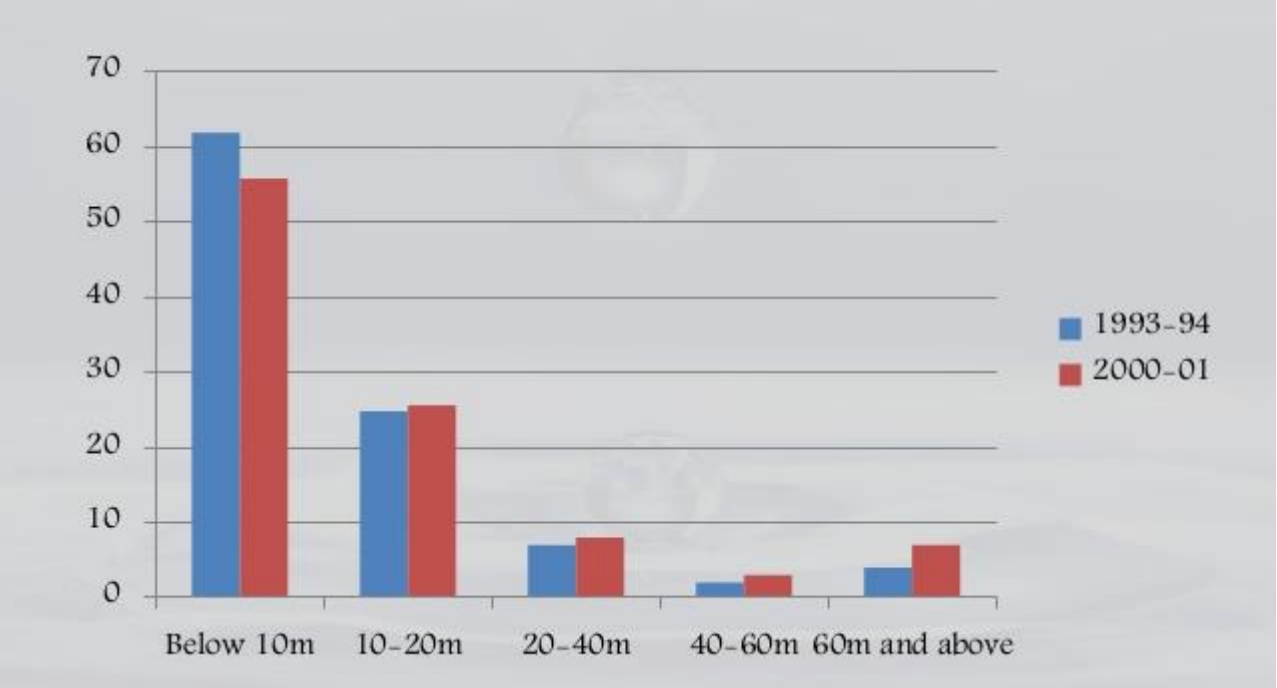

Figure 1: Depletion in water table in India. *Source: http://jalshakti-dowr.gov.in/national-hydrology-project-reports-manuals; Ministry of Water Resources, India.*

Existing urban water bodies which served the needs of the city at one time are now dump yards for garbage and refuse. There catchment area has been encroachment upon by illegal settlements which discharge their sewage water leading to further pollution of the water body.

In urbanised areas it is now increasingly difficult to build major new water supply systems because of both environmental and economic constraints therefore new approaches to long-term water planning and management that incorporate principles of sustainability need to be outlined. Most importantly it is needed to minimize alterations of natural ecosystem processes and losses of biodiversity and integrity, and preserve remaining natural freshwater habitats with high bio- diversity and many endemic species.

III. THE NEED TO HARVEST RAIN WATER

Water is not only essential to sustain life, but it also plays an integral role in supporting our ecosystems, economic development, community well-being, and cultural values. Water use is unsustainable if the services provided by water resources and ecosystems as desired by society, diminish over time. In theory, practically unlimited quantities of fresh water are available , in practice, however, increases in overall water supply should occur only where the value of water exceeds the economic and environmental costs of supplying that water through new technology [8].

The potential alternative to the problem of sustainable water conservation is to harvest rainwater. Following are some of the benefits of harvesting rain water : -

i. Rainwater harvesting helps us to replenish ground water resources.
ii. Today, cities are suffering from water logging because of clogging of drains and inadequate capacity of drains to carry storm water. Storm water that gets carried away mixes with sewage water before being discharged into the river. Firstly storm water only contains suspended impurities. Secondly, for example in the case of the city of New Delhi the inadequacy of sewage treatment plants leads to pollution of the river Yamuna.

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iii. Water harvesting can help channelize storm water from the surrounding catchments areas (which are open surfaces exposed to rain e.g. roads, paved areas like driveways, parking lots, open plazas and roof tops. This water may be stored for ready use in containers or underground tanks or may be directed into the soil for withdrawal later.

iv. Rain water collected for reuse after filtration may be used for domestic purposes like for flushing water in toilets, washing and cleaning and may be extremely useful in industries having high water consumption.

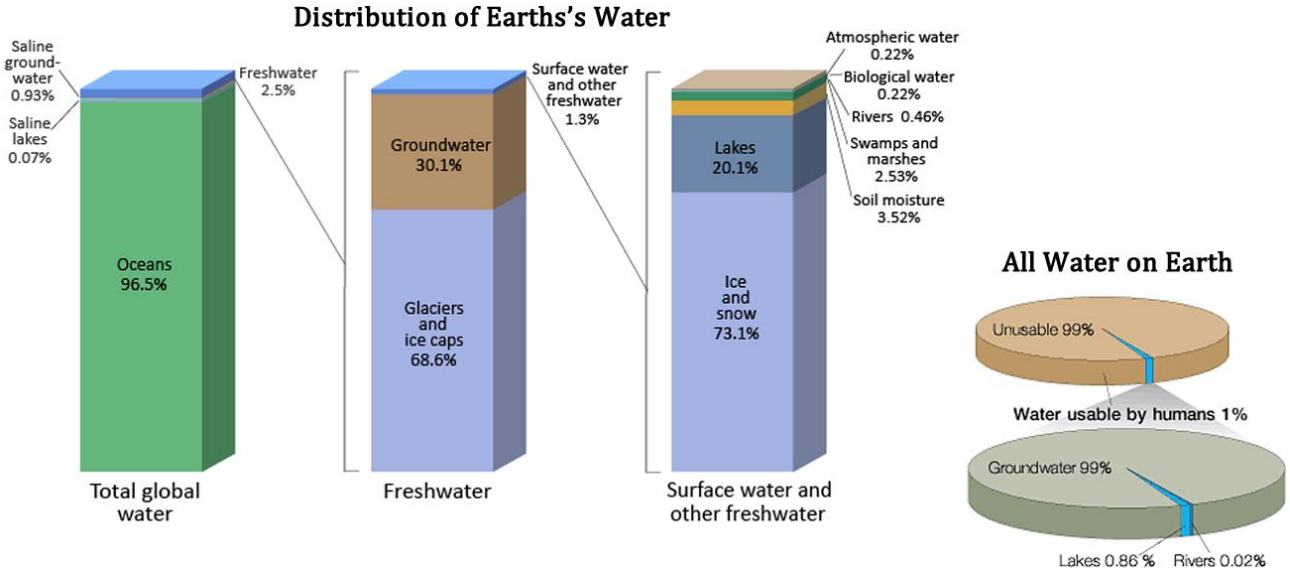

Figure 2: Earth's Water Reservoirs Bar chart Distribution of Earth's water including total global water, fresh water, and surface water and other fresh water and Pie chart Water usable by humans and sources of usable water. *Source: United States Geographical Survey Igor Skiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources*

IV. TRADITIONAL METHODS OF RAIN WATER HARVESTING (RWH)

To be able to implement RWH techniques in the present day we can take a look at some traditional rainwater harvesting systems in various parts of India to get a few practical lessons in the methodology. In some parts these are still the present day sources of water and at other places these have fallen into ruins and decay [2].

i. North India

Ladakh gets annual rainfall of 140mm.Hottest months are July and August when temperature does not exceed 30°C. Hence, the growing season in Ladakh is restricted to less than six months in a year. The entire cultivated area of Ladakh, depends upon assured irrigation from the waters of melting snow through long winding streams from the upper mountain reaches. Snow and glaciers melt slowly through out the day and water is available for irrigation in the late evening. This water is collected in tanks locally called zings and used the next day.

Jammu which lies in the sub-Himalayan hills and the adjoining plains also had a tradition of building canals aligned roughly with the contours to draw water from hill streams or springs. These canals are known as *khuls* and were used for irrigation. Drinking water in the region was taken care of by ponds. These ponds needed frequent desiltation. But desilting beyond a particular depth was avoided as it would expose the highly porous strata of the Kandi terrain and allow seepage of water through the bottom of the pond. Another interesting feature is that all Kandi ponds had Banyan and Pipal trees on their banks. These trees were accorded religious significance. Local community maintained the upkeep by ensuring cleanliness of surroundings [1].

In the hill region of Uttar Pradesh people drew water from *Naula* or *Hauzi.* These were ponds made by making a stone wall across a groundwater stream. It was a method of ground water harvesting. For treatment and purification of the *Naula* water, leaves of medicinal plants and fruits like *anwla* were added periodically. Big shady trees were planted near *Naulas* to reduce evaporation. It was a custom to worship these ponds – which made people keep it clean and conserve water.

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ii. East and Northeast India has an indigenous rainwater harvesting system.

In Nagaland an interesting system of cultivation called *Zabo system* prevails. This indigenous system is a combination of forest, agriculture and animal husbandary with a well-founded conservation base, soil erosion control, water resources development, management and protection of environment. The components of the system comprise of a *Forest Land* which acts as a catchment area. It is kept under natural vegetation to serve as a water source during monsoon. The slope of the catchment area is usually very steep. Below the catchment area water harvesting ponds are dug and an earthen embankment constructed. Silt retention ponds are constructed at several points to prevent silt entering the pond with runoff. A little below the water harvesting pond a cattle yard is maintained. Cattle yard gets washed with runoff water. This runoff carries the manure with it to the fields down below.

In Meghalaya, an ingenious system of tapping the stream by using bamboo pipes to irrigate plantations is widely prevelant. The system works on gravity such that 18-20 litres of water entering the bamboo pipe system per minute gets transported over several hundred metres and finally gets reduced to 20-80 drops per minute at the site of the plant. The diversion from one channel to the other is the key to the success of the system.

Mizoram has a high rainfall averaging to 2500mm over eight months in a year. The water retention capacity has been reduced due to deforestation and soil erosion. For domestic consumption each household has tanks made out of tin or concrete. Horizontal rain gutters are placed along the sides of the sloping roof and water is directed to the tank.

The traditional system of irrigation prevalent in Bihar was *ahar and pyne* system. The natural terrain of the area was utilised for the construction of an ahar. It had embankments on the three sides. Unlike tanks the beds of the *ahars* were not dug out and were built at the end of artificial channels. *Pynes* were channels which lead excess water from rivulets during monsoon season agricultural fields.

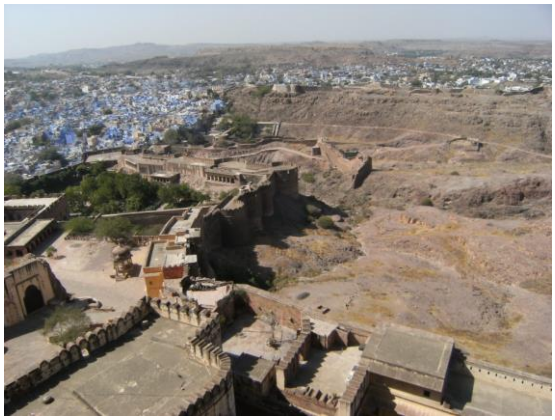

Figure 3: Mehrangarh Fort at Jodhpur is situated on the *Chonka-Daijar* Plateau. The fort and its surroundings have several depressions allowing seasonal collection of water from the large rocky catchment area.

Figure 4: The Gadisar Lake is located in the Jaisalmer district of the Indian state of Rajasthan. It was built by the founder of Jaisalmer, King Rawal Jaisal in 1156 AD and later rebuilt by Gadsi Singh in the year around 1367 AD. It is said that this lake once provided water to the entire city. Cultural practices ensured that lake environs were kept clean.

iii. Western regions of India

In Rajasthan people evolved ingenuous methods incorporating ecologically sound cultural patterns to fulfil their basic needs. Water needs of cities like Jaisalmer and Bikaner was met by urban tanks. These tanks had large catchment areas which were cleaned before the monsoon period. Canals bringing water into the tank were also cleaned. Cattle was not allowed to enter the catchment area , the area was considered sacred and human defecation was also prohibited. Water needs were further fulfilled by *tankas* in individual household, this water was solely used for drinking. These were traditionally built for harvesting rainwater from rooftops.

City of Jodhpur is an excellent example having an extraordinary water management system that conserved every drop of rainwater. The *Chonka – Daijar* plateau is an important physical feature of the region , the whole plateau serves as the water catchment for surface water bodies like *nadis, talabs,* tanks and lakes and indirectly for ground water bodies like wells, *baoris and jhalaras.* The surface water bodies were main source of water in the city and also

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provided water through seepage to wells, *baoris and jhalaras.* the city had an extensive system of canals consisting of numerous water courses, channels and aquaducts to carry rainwater to nadis, tanks and lakes. Presently the canals are in a bad shape.

In Gujarat traditional stepped wells and stepped ponds were principal means of rainwater harvesting.

iv. South India

The old water works of Bhuranpur town situated on the banks of the tapti in khandwa district of Madhya Pradesh is one of the most glorious relics of Mughal engineering skills. It was a groundwater based scheme consisting of *bhandaras* or storage tanks which collect water from underground springs flowing from the hills to the river. The groundwater is intercepted at four places. Water is carried through subterranean conduits with a number of connected wells to a collection chamber called *jal karanj* and from there to the town. Along the way from the source to *jal karanj* air shafts have been provided. People use these as wells.

In parts of Kerala there is a special water harvesting structure called *surangam.* They are dug in hard laterite formations. The excavation continues till a good amount of water is struck.

In Tamil Nadu tanks or *kulams* were constructed to trap rainwater, act as flood control devices and recharge groundwater. But urbanisation has taken its toll – stormwater courses feeding these tanks have disappeared and water flows directly into the sea without filling these tanks.

V. Lessons from Traditional Water Management Systems

An insight into the traditional rainwater harvesting system informs us of the ingenuity of these systems and how implementation of rainwater harvesting practices even today draws clues for its methodology from these systems. Only Rainwater water harvesting today are more energy consumptive. To enlist a few points that made these systems sustainable.

i. The systems made use of local materials for construction eg local stone, lime, mud, bamboo etc.
ii. The systems allowed for community participation through construction and maintenance (catchments area were cleaned and compacted to reduce permeability and ensure maximum runoff).
iii. The systems adhered to geological, topographical condition and thus caused least disturbance to the environment.
iv. People did not have to rely on seasonal rains or monsoons for water.
v. In rural areas crops got their regular water supply.
vi. People had clean drinking water available in scarcity months also.
vii. Since people had reverence for water, they worshipped it in the process they took care of not polluting it by prohibiting disposal of garbage in water, bathing in water and even animals from going near the tanks [9].

VI. Conclusion

Rain water harvesting systems in urban areas help in storm water management. From the environmental point of view we also need to conserve forest areas as they not only contribute to evapo-transpiration but also allow gradual percolation of water into the ground. This becomes a natural means to ground water recharge. More over any kind of new development should have an environmental impact assessment so as to be able to analyse if any construction would disrupt the natural drainage pattern. Lastly surface materials in urban areas play a big role in determining runoff quantities and permeable surfaces allow greater amounts of water to percolate naturally. Where as hard surfaces having low permeability should have proper drainage. There are various considerations on macro and micro level of planning but the least we can do is to generate awareness and work towards water conservation.

The man and the city are symbols of an illusion that progress is measured in terms of money and aggrandizement. Material progress is certainly to be desired - it is one of the necessities of a better life - but it is not to be held up as an ideal in itself. World Commission on Environment and Development, 1987 quoted:

Humanity has the ability to make development sus- tainable-to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.

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