NEED FOR INDIGENOUS WATER MANAGEMENT SYSTEMS TO REDUCE THE STRESS ON WATER

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Abstract: Nature has provided the mankind a blessing in the form of water. The quantum of available water is limited. Our ancestors were very wise to realize this fact and devised methods and practices so as to conserve this scarce commodity; resulting thereby we were inherited with enough of the resources to survive. In the name of progress and greed of prosperity we have blindly over extracted the ground water, forgotten water harvesting practices, inculcated habits of excess use of water in domestic and other purposes.

Key Words: Water Harvest, Rainwater, Sustainable Development, Traditional Practices, Stress on Water

Introduction: Water is a prime natural resource, basic human need and precious natural asset. Optimum development and efficient utilisation of water resources assume critical significance. Access to fresh water is a pre-requisite for achieving the goal of sustainable development. Although water is an abundant and renewable natural resource covering two thirds of the planet, a very small proportion of this is effectively available for human use.

India is today facing a huge water crisis. There is an enormous unmet demand for water. Even as clean water sources are being viciously attacked by pollution and over exploitation, hardly any river or a groundwater aquifer near a city today escapes the perils of pollution. While agricultural lands go thirsty, many thousands of villages find it difficult to get clean drinking water, thus affecting our march towards sustainable development. In India, as a result of development, the demand for water is increasing both in urban and rural areas. This may increase tensions and disputes over sharing and command of water resources. The emerging scarcity of water has also raised a host of issues related to sustainability of the present form of economic development, environmental sustenance, sustained water supply, equity and social justice, water financing, pricing, governance and management.

Water Availability and Stress:

According to the United Nations Educational, Scientific and Cultural Organisation (UNESCO) (1999) estimates, the total volume of water on earth is about 1.4 billion cubic-kilometers (km^3), which is enough to cover the earth with a layer of 3 km depth. However, World's oceans cover about three-fourths of earth’s surface while the fresh water constitutes a very small proportion of this enormous quantity available on the earth. It is only about 35 million km^3 or 2.5% of the total volume. Of these, 24 million km^3 or 68.9% is in the form of ice and permanent snow cover in mountainous regions, and in the Antarctic and Arctic regions and another 29.9% is present as ground water (shallow and deep groundwater basins up to 2,000 meters). The rest 0.3% is available in lakes, rivers and 0.9% in soil moisture, swamp water and permafrost atmosphere.

India has about 16 percent of the world's population as compared to only4 per cent of its water resources. According to the provisional census data of 2011, the population of India is 1.21 billion. The per capita water availability of water has decreased from 2,309 cubic meters (m^3) in 1991 (Sharma and Bharat, 2009) to around 1,170 m^3(NIH, 2010).India does not fall under the category of a water scarce country per se, rather it can be termed as a country under **'water stress'**[1]. Considering the projected population growth in 2025, the per capita water availability in India can further decrease to 1,000 m^3, which would then be termed a 'water scarcity' situation (UNICEF, 2013).

The long-term average rainfall for the country is 1,160 mm, which is the highest in the world for a country of comparable size (Kumar et al., 2005). But it is pertinent to note that there exists a considerable temporal and spatial variation within the country with respect to water availability. Owing to physiographic factors, rainfall in India is highly variable. There were widespread variations among different sub-divisions in terms of rainfall received. Maximum rainfall was recorded in Coastal Karnataka (379.8 cm), followed by Kerala (281.6 cm), Konkan and Goa (273.8 cm) and Andaman & Nicobar (261.4 cm). The rainfall was recorded less than 50 cm in Rajasthan East & West, Punjab and Haryana, Chandigarh and Delhi. The distribution of number of districts with levels of rainfall received during 2009 gives that only 9% of districts received excess rainfall in the country while 51% of the districts received deficient rainfall (CWC, 2010).

This wide temporal and spatial variation in availability of water in India may increase substantially due to a combination of climate change, causing deepening of water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc. Climate change may also increase the sea levels. This may lead to salinity intrusion inground water aquifers / surface waters and increased coastal inundation in coastal regions, adversely impacting habitations, agriculture and industry in such regions.

Crisis, despite large-scale investments:

Since independence, India has made significant progress in developing its water resources and supporting infrastructure. Post-independence years have witnessed large-scale investments in water storage structures which have contributed considerably in making India a self-sustaining economy. Today, India has the capacity to store about 200 billion Cubic Meters (BCM) of water, an irrigated area of about90 Million Hectares (Mha), and an installed hydropower capacity of about 30,000 MW (World Bank, 2005). However, due to rapid development, increasing population and iniquitous distribution of water, the demand for this natural resource far outweighs its supply. In addition, and for a while now, the water sector in India has faced significant and problematic issues related to management. In spite of a sizeable water resource base and vast land resource, India continues to struggle to meet its water sector infrastructure requirements, including operation and maintenance costs.

Large-scale dams are now being used to transform hydropower and irrigation, and yet water storage infrastructure in India remains one of the lowest in the world. Even after constructing 4,525 large and small dams, the per capita storage in India is 213 cubic meters (m^3) as against 6,103 m^3 in Russia, 4,733 m^3 in Australia, 1,964 m^3 in the United States, and 1,111 m^3 in China. Per capita storage may touch 400 m^3 only after the completion of all the on-going and proposed dams (Planning Commission, 2008).

[1]UNDP (2006): Annual water availability under 1700 m^3 per capita constitutes conditions of 'water stress', less than 1,000 m^3 per capita represents 'water scarcity' and below 500 m^3'absolute scarcity'.

A progressive movement towards universal coverage of rural habitations with safe drinking water has been reported over the years. The difficulty has been that even as coverage increases, there is the growing problem of 'slip back', with habitations suffering a fall in the water table and water quality, especially given the growing dependence on groundwater. The fact that the same aquifer is being tapped for both irrigation and drinking water, without any coordinated management of the resource, has greatly aggravated availability of drinking water. Indeed, we are close to entering a 'vicious infinite regress' scenario, where an attempt to solve a problem reintroduces the same problem in the proposed solution. If one continues along the same lines, the initial problem will recur infinitely and will never be solved. Thus, tube wells drilled for irrigation are more and more drying up the aquifers being used for drinking water.

Table 1: Physical Coverage of Drinking Water Supply: Five Lowest Covered States

STATE	Percentage habitation level coverage as on 1 April 2011
Tripura	28.59
Karnataka	34.33
Jammu and Kashmir	43.12
Chhattisgarh	46.06
Manipur	48.29

Source: Department of Drinking Water and Sanitation (DDWS), (2011)

Above Table reveals that Karnataka is the second lowest covered state in terms of drinking water supply.

Think Globally, Act Locally:

Historically, Indians have been the world's greatest water harvesters. Over centuries they had developed a range of techniques to harvest every possible form of water from rainwater to groundwater, stream to river water and flood water.

As the source of all water, rain is decentralized. Therefore, the management of water is best undertaken at local levels, by the people, in tune with local physical and natural landscapes. It is certainly not nostalgia to recall the holistic system of a society which has been able to build water systems which are still functional in order to bring back this empowerment. It is in fact in direct line with the modern slogan of 'think globally, act locally'. The country should use its traditional wisdom of rainwater harvesting together with future technological advances to prevent pollution and to treat and reuse polluted water.

Indigenous Water Culture:

Water has been paid high esteem in our culture in as much as it is regarded as God (*Varun Devta*). At innumerous places in Vedas and Upanishads happiness, vigor, and prosperity of mankind has been prayed to water God (*Jal Devta*). On all the occasions of prayer, *Kalash* – a small pitcher full of water had an essential place. There was hardly any folk song sung by ladies on religious and auspicious occasions that did not have respectful mention of water. Wastage of water was considered as a worse as a crime in the traditions. Construction of a well or establishment of a water hut was considered as a deed of dharma – biggest religious practice. All these practices were to pay respect and to conserve the precious commodity, which the Mother Nature had provided to the mankind in whatever quantity it may be.

This functional management of water had wisdom of every drop of rain. These drops of rain were the life of the Indians. The indigenous knowledge in India has always developed practical ways for society to live in a sustainable manner with nature, in full respect with the diversity of agro-ecological climatic zones, and had developed a specific science, a relevant engineering and a technology appropriate to each and every part of the country, even those that seems the most difficult and inhospitable.

The ancient indigenous engineering was not much documented in the modern sense, because the technical aspects were transmitted through practice and words of mouth, and gradually perfected by tradition. But in some cases the legal and administration aspects were written, for example in Kautilya's Arthashastra (Treatise of Administration written by Kautilya, advisor and minister of Indian emperor Chandragupta Maurya, 321-297 BC). One chapter of the Arthashastra gives a testimony of very comprehensive and detailed administrative rules, covering the whole range of legal and economic implications of a decentralized community-driven water management, facilitated by the state.

The ruler had to provide land, roads, trees and equipment to those who participated in the construction of waterworks. Those who did not participate were made to pay a contribution, but were not entitled to benefit directly from the structure. All users of irrigation facilities had to pay a tax, even when they had their own waterworks. But exemption of tax was granted for a number of years to those who build new structures. However, these administrative rules were only safeguards and practical provisions for the economic consequences of the implementation of waterworks. The real motivation came from another side. The participation in the construction of community ponds, tanks and waterworks was a matter of pride and was considered as a religious work.

A Few Indigenous Models[2]:

Johad: Johads are small earthen check dams that capture and conserve rainwater, improving percolation and groundwater recharge. Starting 1984, the revival of some 3000 johads spread across more than 650 villages in Alwar district, Rajasthan has resulted in a general rise of the groundwater level by almost 6 meters and a 33 percent increase in the forest cover in the area. Five rivers that used to go dry immediately following the monsoon have now become perennial, such as the River Arvari, has come alive.

Kunds / Kundis: A kund or kundi looks like an upturned cup nestling in a saucer. These structures harvest rainwater for drinking, and dot the sandier tracts of the Thar Desert in western Rajasthan and some areas in Gujarat. Essentially a circular underground well, kunds have a saucer-shaped catchment area that gently slopes towards the centre where the well is situated. A wire mesh across water-inlets prevents debris from falling into the well-pit. The sides of the well-pit are covered with (disinfectant) lime and ash. Most pits have a dome-shaped cover, or at least a lid, to protect the water. If need be, water can be drawn out with a bucket. The depth and diameter of kunds depend on their use (drinking, or domestic water requirements).

Khadin: A khadin, also called a dhora, is an ingenious construction designed to harvest surface runoff water for agriculture in Rajasthan. Its main feature is a very long (100-300 m) earthen embankment built across the lower hill slopes lying below gravelly uplands. Sluices and spillways allow excess water to drain off. The khadin system

[2]This section is based on the report 'Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems, published byCSE, New Delhi. See bibliographyAnil Agarwal et al. (1997).

is based on the principle of harvesting rainwater on farmland and subsequent use of this water-saturated land for crop production.

Vav / vavdi / Baoli / Bavadi: Traditional **stepwells** are called vav or vavadi in Gujarat, or baolis or bavadis in Rajasthan and northern India. Built by the nobility usually for strategic and/or philanthropical reasons, they were secular structures from which everyone could draw water. Most of them are defunct today. Sculptures and inscriptions in stepwells demonstrate their importance to the traditional social and cultural lives of people.

Ahar-Pynes: This traditional floodwater harvesting system is indigenous to south Bihar.In south Bihar, the terrain has a marked slope from south to north. The soil here is sandy and does not retain water. Groundwater levels are low. Rivers in this region swell only during the monsoon, but the water is swiftly carried away or percolates down into the sand. All these factors make floodwater harvesting the best option here, to which this system is admirably suited.

An ahar is a catchment basin embanked on three sides, the 'fourth' side being the natural gradient of the land itself. Ahar beds were also used to grow a rabi (winter) crop after draining out the excess water that remained after kharif (summer) cultivation.

Pynes are articificial channels constructed to utilise river water in agricultural fields. Starting out from the river, pynes meander through fields to end up in an ahar. Most pynes flow within 10 km of a river and their length is not more than 20 km.

The ahar-pyne system received a death-blow under the nineteenth-century British colonial regime. The post-independent state was hardly better. In 1949, a Flood Advisory Committee investigating continuous floods in Bihar's Gaya district came to the conclusion that 'the fundamental reason for recurrence of floods was the destruction of the old irrigational system in the district.'Of late, though, some villages in Bihar have taken up the initiative to re-build and re-use the system.

Bengal's Inundation Channel: Bengal once had an extraordinary system of inundation canals. Sir William Willcocks, a British irrigation expert who had also worked in Egypt and Iraq, claimed that inundation canals were in vogue in the region till about two centuries ago. Floodwater entered the fields through the inundation canals, carrying not only rich silt but also fish, which swam through these canals into the lakes and tanks to feed on the larva of mosquitoes. This helped to check malaria in this region. According to Willcocks, the ancient system of overflow irrigation had lasted for thousands of years. Unfortunately, during the Afghan-Maratha war in the 18th century and the subsequent British conquest of India, this irrigation system was neglected, and was never revived.

Bandharas: These are check dams or diversion weirs built across rivers. A traditional system found in Maharashtra. Their presence raises the water level of the rivers so that it begins to flow into channels. They are also used to impound water and form a large reservoir.

Where a bandhara was built across a small stream, the water supply would usually last for a few months after the rains. They are built either by villagers or by private persons who received rent-free land in return for their public act. Most Bandharas are defunct today. A very few are still in use.

Kere: Tanks, called kere in Kannada, were the predominant traditional method of irrigation in the Central Karnataka Plateau, and were fed either by channels branching off from *anicuts* (check dams) built across streams, or by streams in valleys. The outflow of one tank supplied the next all the way down the course of the stream; the tanks were built in a series, usually situated a few kilometers apart. This ensured no wastage through overflow, and the seepage of a tank higher up in the series would be collected in the next lower one.

Zings: Zings are water harvesting structures found in Ladakh. They are small tanks, in which collects melted glacier water. Essential to the system is the network of guiding channels that brings the water from the glacier to the tank. As glaciers melt during the day, the channels fill up with a trickle that in the afternoon turns into flowing water. The water collects towards the evening, and is used the next day. A water official called the *churpun* ensures that water is equitably distributed.

Kul: Kuls are water channels found in precipitous mountain areas. These channels carry water from glaciers to villages in the Spiti valley of Himachal Pradesh. Where the terrain is muddy, the kul is lined with rocks to keep it from becoming clogged. In the Jammu region too, similar irrigation systems called kuhls are found.

Eri: Approximately one-third of the irrigated area of Tamil Nadu is watered by eris (tanks). Eris have played several important roles in maintaining ecological harmony as flood-control systems, preventing soil erosion and wastage of runoff during periods of heavy rainfall, and recharging the groundwater in the surrounding areas. The presence of eris provided an appropriate micro-climate for the local areas. Without eris, paddy cultivation would have been impossible.

Till the British arrived, local communities maintained eris. Historical data from Chengalpattu district, for instance, indicates that in the 18th century about 4-5 per cent of the gross produce of each village was allocated to maintain eris and other irrigation structures. Assignments of revenue-free lands, called manyams, were made to support village functionaries who undertook to maintain and manage eris. These allocations ensured eri upkeep through regular desilting and maintenance of sluices, inlets and irrigation channels.

The early British rule saw disastrous experiments with the land tenure system in quest for larger land revenues. The enormous confiscation of village resources by the state led to the disintegration of the traditional society, its economy and polity. Allocations for maintenance of eris could no longer be supported by the village communities, and these extraordinary water harvesting systems began to decline.

Bamboo Drip Irrigation: Meghalaya has an ingenious system of tapping of stream and spring water by using bamboo pipes to irrigate plantations. About 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. This 200-year-old system is used by the tribal farmers of Khasi and Jaintia hills to drip-irrigate their black pepper cultivation.

Katta: Earthen dam constructed across a stream for irrigation and other purposes in coastal regions of Karnataka. Every year they were constructed after the slow-down of monsoon.

Surangam: Kasaragod district in the northern Malabar region of Kerala is an area whose people cannot depend directly on surface water. The terrain is such that there is high discharge in rivers in the monsoon and low discharge in the dry months. People here depend, therefore on groundwater, and on a special water harvesting structure called surangam.

The word surangam is derived from a Kannada word for tunnel. It is also known as thurangam, thorapu, mala, etc, in different parts of Kasaragod. It is a horizontal well mostly excavated in hard laterite rock formations. The excavation continues until a good amount of water is struck. Water seeps out of the hard rock and flows out of the tunnel. This water is usually collected in an open pit constructed outside the surangam.

Surangams are similar to qanats which once existed in Mesopotamia and Babylon around 700 BC.1,2 By 714 BC, this technology had spread to Egypt, Persia (now Iran) and India. Traditionally, a surangam was excavated at a very slow pace and was completed over generations. Today, engineers such as Kunnikannan Nair are faster and keep the tradition alive.

Conclusion:

It has been realized that mankind is running fast on the dangerous tract of increased ground water extraction, indiscriminate use of water and over reliance on the conventional piped water supply scheme forgetting the old wisdom of water harvesting. It has also been realized that if the same conditions prevail, we shall soon reach a point of no return.

Mother Nature has provided the mankind a blessing in the form of water. The quantum of available water is limited. Our ancestors were very wise to realize this fact and devised methods and practices so as to conserve this scarce commodity; resulting thereby we were inherited with enough of the resources to survive. In the name of progress and greed of prosperity we have blindly over extracted the ground water, forgotten water harvesting practices, inculcated habits of excess use of water in domestic and agriculture purposes, etc. It has deteriorated conditions on account of which the water resources are fast depleting. Therefore, it is need that we join hands together, to not only save whatever is left but to enhance it further so that we may also proudly transfer it to next generation both in adequate quantity and quality.

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