Chapter

Ensuring Water Availability in Future through Revival of Indian Traditional Water Culture

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Abstract

After the recurrent spells of weak monsoons, a big part of the country's population, are affected by a severe drought obliging India to walk towards a water-stressed future. The drought has dried up wells and other water reservoirs already stressed by overuse resulting into crop failure to a reasonable extent of more than 60 per cent. The current water management systems particularly in rural areas are poorly equipped to deal with the issue in significant part because they do not promote distributed water collection, water conservation, and water reuse. Providentially, a combination of often forgotten traditional water practices and more recent innovations in water use and management can help resolve this growing water crisis. These include rainwater capture, water recycling and reuse, and innovative technologies to purify water. India's history is witness to how well-planned cities of our ancient civilization were equipped with outstanding systems of water harvesting and drainage. These ancient structures synergized with well validated water practices were the strong support systems during the times when the modern infrastructural marvels did not exist, but they were more than efficient in managing the water resources even at the time. Today the traditional water practices and ancient but ignored water sources of the country are yearning to discharge the ancient traditions to revive the glorious history of their past for the dire need of the hour. If water strategists aim to spread the message of water conservation to the common people and want to ensure that every drop of water is conserved, then the proven and scientifically validated Indian traditional water culture will have to be revived. Coincidently, customary water bodies have always been subject of reverence for Indians, reviving these traditional water bodies by involving locals could be a strategy that every region needs to adopt. Stepping up these revival options will indispensably require change in legal and regulatory framework but will perceptibly offer policy makers a better chance to meet present demands and future needs in an increasingly water-constrained India.

Keywords: Water crisis, traditional water culture, water bodies, heritage, community approach

1. Introduction

India is endowed with rich biodiversity, natural beauty, and sound climatic as well as edaphic suitability. The country has a strange diversity of climatic regions, ranging from cold temperate and alpine in the Himalayan north to the hot and

humid tropical in the south. The country also cherishes a rich history of water heritage. The tradition of water harvesting in India is centuries old, this shows how much respect people have for water since ancient times. Traditionally water was worshiped, stored and conserved. Although there was diversity in the water harvesting systems, but on a large scale, reservoirs were constructed on a coordinated basis, the main objective of which was to create a wide range of water storage systems. In spite of all these bounties, the unfortunate aspect is that presently, India has become a house of a huge proportion of the world's 'water poor' population. It holds only 4 per cent of the world's freshwater resources, but 18% of the global inhabitants [1]. Presently in the country, agitating climate variability, rapid urbanization, and competitive demand of water for agriculture, industry, energy production, and municipal supply puts tremendous pressure on underground reservoirs and is hence making it increasingly tough to meet the water challenges of the near future.

The chapter finds defects in the current water distribution and utilization systems which specifically aim at realizing immediate results without respecting ecological boundaries. Additionally, it argues that there is an urgent need to revive India's traditional water culture to better cope with the worsening water conditions prevalent across the country. The chapter also signifies that the shortcomings of current water system can be well addressed by regaining the old wisdom of traditional water culture, and by integrating it with current state of scientific methods and technologies. A blend of traditional water culture and advanced water technologies can lead to a transformation into a more relevant water infrastructure that integrates development within the sustainable water cycle.

2. The upcoming water crisis India faces and factors blamed

Water scarcity, like the entire world, has also become a common concern in India. Declining ground water levels and lack of adequate water resources to meet demands affects every state. No doubt that in view of increasing population and global climate change, the problem will increasingly amplify unless something instrumental is done. In a study conducted by central government in the year 2018, the country held 120th position on the list of 122 countries facing a water crisis [2, 3]. Four of the Indian cities [Chennai is first, Kolkata is second, Mumbai is at 11th and Delhi is at 15th position] are among the 400 cities in the world facing acute water crisis. The same study revealed that 21 cities of the country will reach zero ground water level as per the composite water management index. That is, these cities will not even have their own drinking water in near future. The major commercial metropolis like Bangalore, Chennai, Delhi and Hyderabad will be the worst affected, putting the lives of 100 million people at stake [4]. Water crisis in rural areas is the prime reason, the people are obliged to migrate to the cities already fighting with population pressure. Apart from this, the urban areas are already under numerous anthropogenic pressures, ranging from industrial development to desertification, pollution and loss of biodiversity. This fact itself necessitates an urgent action towards the conservation of the already scanty resources in rural areas, deprived of which the situation is bound to worsen day by day and will soon be out of control in the times to come.

The root cause behind tough scenario of water crisis is vital to be explored first in order to deal with it. It's not the delayed monsoon or the lack of rain as claimed by most of the people including media and policy makers. It is rather the consistent ignorance of the governments for years. Overlooking non-judicious distribution system, promoting dire habits and misusing the country's water resources are the

core realities behind the current water crisis. These factors are more prominent ones in addition to unavoidable factors such as rapid urbanization, population growth and industrialization that can be held equally responsible for the upcoming crisis. Although factors like climate change have taken an unmanageable form, but various human activities are also responsible for its origin. Apart from this and above all, the situation of water crisis has become even more worse due to the gross neglect of the traditional water culture of India. Herein we review some of the major perpetrators as follow.

2.1 Irrational approach towards farming

Farming has always been the engine of the Indian economy; however, looking at it with full sensitivity and rational mindset, it is known that over the years, India has seen many changes in its cropping pattern and the approaches of irrigation. With the decreasing availability of water in reservoirs like canal, ponds and rivers along with the development of advanced techniques, there has been a vast change in the method of irrigation. The share of canal irrigated area in the total irrigable land has been continuously decreasing since last few decades. At present, the share of land irrigated by ground water has increased to more than half of the total land [5]. This misuse of groundwater resources in the north-western parts of the country is the biggest reason for the water crisis in the country. In addition, heavy water intensive crops such as paddy and sugarcane are cultivated in north-western parts of the country particularly in Punjab, Uttar Pradesh and Maharashtra. Rice is the most important staple grain of the country. It takes 3500 liters of water to grow one Kg of rice [6]. The Punjab is entirely dependent on ground water for rice cultivation. Although in terms of rice productivity, performance of this state is exceptionally good, but it is far behind the states of the Northeast in terms of better use of water. Punjab uses two to three times more water in comparison to Bihar and West Bengal to produce one Kg of rice [7]. Farmers in Punjab have the privilege of cheap electricity and input subsidy. Besides, the government also implements favorable policies to procure farmers' crops. In such a situation, rice cultivation becomes very beneficial for the farmers of Punjab. On the other hand, farmers of the north east states such as Assam, Tripura, Bengal and Bihar do not get such facilities. Similar is the story of sugarcane, which again demands a lot of water. Sugarcane is primarily grown as cash crop that demands 1500–3000 liters of water to produce a kg of sugarcane [8]. Farmers in Maharashtra state cultivate sugarcane on a large scale and use ground water for its irrigation. Farmers take the advantages of having sugar mills of the state which buy their fresh produce. At the same time, where Bihar extends quite favorable environment for sugarcane cultivation, ironically, only 4% of the total sugarcane production of the country is produced.

The methods of irrigation which are commonly adopted in the country are as well not judicious. Despite being numerous demerits of flood irrigation like water wastage, nutrient leaching, and weed growth, majority of farmers in India still prefer it over other water saving methods. A big reason for this natural selection is that more than 80% of the farming community falls under the marginal and small farmers' category. They do not have the money to afford the cost of equipments required to install drips or sprinklers in their fields. Moreover, they own considerably small pieces of farmland which are more suitable for subsistence farming rather than commercial farming.

2.2 Explosive population growth

When the population reaches an explosive state in any country, it starts growing disproportionately with the resources, and so is the case with ground water. The

population of India in 2019 was reported to be 13.4 billion with an annual growth rate of 1% [9]. Owing to this explosive growth, the biggest impact has been on groundwater in terms of its indiscriminate exploitation. Many states in India have either enacted or are about to enact laws regarding underground water harvesting to deal with the emergent problem. But it is quite unfortunate that even if laws are in force, they themselves have become the victims of ignorance. As a matter of fact, the total requirement of ground water was 252 billion cubic meters [BCM] in 2010 and is projected to be 282 BCM in 2025 and 428 BCM in 2050 [10]. The total domestic and public need for water includes the water requirement of animals, for irrigation, domestic and public use, industry, power generation, inland shipping and ecological purposes. An unruly population growth near urban areas has put a bonus pressure on groundwater resources. Given the growing imbalance between demand and supply, indiscriminate and excessive use of ground water requires urgent attention.

2.3 Rapid urbanization

Over the years, the increasing population has directly impacted the demography of urban India [11]. According to the census released in the year 2001, urban population was 26.75 per cent, which after ten years i.e. in 2011, increased to a tune of 30 per cent at the annual growth rate of 3.35 per cent [12]. It is anticipated that by the year 2030, Indian cities will have 40 per cent of total country's population. Thinking on the number of people having access of clean water by then is quite panicky. With the expansion of cities, there has been an unprecedented increase in buildings, roads and other construction works. Most parts of the metropolitan cities are either residential areas or commercial spaces. It is hence very hard to find open, fallow land in the cities. Almost the entire ground surface is covered with asphalt roads and that too at the cost of massive deforestation. There is an inextricable relationship between forest and rain, due to which the water storage areas do not irrigate the underground aquifers and create conditions like drought in summer and flood in monsoon. These conditions make it almost impossible for the rainwater to percolate into the soil and recharge the groundwater tables. Furthermore, most of the metropolitan cities of India majorly depend on groundwater reserves as their primary source of water. This juxtaposition of ignorance and reality is the key reason why most of these cities now have to confront a tough predicament.

2.4 Over and non-judicious use of water resources

Wastage of water does not only mean using it more than what we require when it is scarce, rather it encompasses failing to conserve it when it is in abundance. Lack of awareness and poor infrastructure towards water conservation is the foremost driver behind the water wastage problem. It's pretty regrettable that despite realizing the horrific situation of water crisis in the future, man has not stopped using the available ground water indiscriminately. The crisis seems even more daunting when the numbers related to the wastage of water are shockingly high. Inside the 1.3 billion tons of food wasted every year worldwide involves 45 trillion gallons of water [13]. This fairly represents a staggering 24 per cent of all water used for agriculture. For a majority of the countries, the primary source of irrigation is groundwater, India being one of them. Sadly for India, the picture is not a happy one, as far as groundwater resources are concerned and the data speak more eloquently and loudly than words. In fact, groundwater is being exhausted at a mean rate of $4.0 \pm 1.0\,\mathrm{cm\,yr.^{-1}}$, that implies an equivalent height of water [$17.7 \pm 4.5\,\mathrm{km3\,yr.^{-1}}$] is being depleted every year across the Indian states of Rajasthan, Punjab and Haryana

[including Delhi] [14]. The study revealed that the lessening of groundwater in a period of August 2002 to October 2008 was equivalent to a net loss of 109 km^3 of water, which in fact, is double of the capacity of India's largest surface-water pool. Additionally, bitter competition between rural and urban consumers is increasing and at some places even conflict has come to the fore. This problem is more severe in areas where the rocks are hard or the level of recharge is very low. Poor farmers are deprived of irrigation sources, while rich farmers are successful in drilling deep wells. Massively falling water table increases energy consumption as more energy is expended in pumping water from higher down. Roughly 30.5 per cent of India's electricity generation is currently spent on pumping groundwater [15].

The efforts of the government are also proving to be insufficient and short-sighted in this direction. Instead of meeting the needs of the agricultural sectors, water is being brought through intensive pipelines from various water sources not only for the population of the city but also for industrial need. For example; water is being carried to the capital Delhi from Tehri dam in Uttarakhand that is 300 km away. Water is being supplied to Hyderabad; the IT hub of India from NagarjunaSagar Dam of Krishna river built at a distance of 116 km. Whereas the Kaveri river is supplying water to Bengaluru that is 100 km away. In this way, water needs are being met in the expanding city and industrial areas that otherwise were ought to be for farming.

2.5 The broken water management systems of rural India

The rural India has proven to be resilient even in the hardest of times like the pandemic of 2020. Unlike their urban counterparts, people of rural India were able to contain the spread of the virus, during the first wave of the pandemic. Such response was made possible by the cooperative efforts of the villagers. With only a little help from the administration, the residents took steps like sealing their respective villages as and when cases rose, forbidding non-residents from entering their village, setting up makeshift quarantine centers for taking care of residents developing symptoms of illness. As a result, the death toll in villages was remarkably less than what it was in the metropolitan cities. These incidents are evidence that rural India is not a setup that should be mistaken as a group of people with little knowledge of worldly affairs. However, the anatomy of Indian villages is anything but that simple. During times of crisis, they proactively work together as a unit with a common goal for the mutual benefit of their village. This is just one among the many examples wherein the villages have faced a great calamity on the strength of cooperatives and traditions. Similarly, water management had a rural style of its own, which, till a few decades ago, defied any likelihood of water crisis in rural arena, however, in the recent past, the water management systems of a sizable chunk of rural India appears to be perpetually broken. Modern systems, in fact based on market principles have broken communities and have proved to be cruel and biased on the distribution front.

Rural India cherishes a long history of water resources management. The collective style of water use and its conservation used to be an integral part of it. A variety of structures were also built for diverse uses of water including domestic purposes and irrigation. Since ancient times, the Indian priests [locally known as Bhagiraths], along with the development of civilization and culture, took into account the climate, soil nature and other variations for maximally utilizing and conserving the rain water, rivers, streams and underground water resources. This approach was suitable for the specific and local conditions of the north-eastern region from snow-capped Laddakh to the plateau in the south and the arid desert of Thar to the high rainfall for most of the year. Keeping in view the climate and availability of water or

ice at all these places, methods of water harvesting, its disposal and use in irrigation were discovered and time-tested methods were developed. Strong evidence of these achievements is available in every nook and corner of the country. In fact, these evidences reflect the advanced knowledge, vision and excellent understanding of the circumstances of the ancient rural Indians and are also relevant in the present context. The systematic approach of ancient people is well exemplified by the practices that were followed during the rule of several rulers of ancient and medieval India. Being well versed in the knowledge related to hydrology and water management, the society also carried out the work of building, running and maintaining the structures. The function of the ruler or king of that period was to help in running the system smoothly. The rural peasants were also well acquainted with the work of flood control [some examples are cited in the coming section]. They built interconnected structures of canals and ponds to avoid the floods of the over floating rivers.

2.6 Climate unpredictability

The critical levels of climate change are alarming. The changes in weather over the years have been very apparently noticed in the form of dryer summers and recurrent droughts. Then comes dripping winters too that cause flooding. The dryer and hotter summers simply mean a greater amount of water evaporating back into the atmosphere leading to lesser availability of ground water for abstraction when it is urgently required, particularly in times of drought. Unpredictable and sudden heavy rainfalls cause flooding that lakes, rivers and reservoirs cannot cope with and thus affecting all forms of human activities directly including structural and environmental damage. The unpredicted rainfall, abrupt drought or heat waves makes it quite difficult to plan for water availability on one hand, while on the other lower or scanty rainfall reduces water levels in rivers, ponds and reservoirs across the country. During the first half of year 2018, a total of 91 major reservoirs in India recorded 32% drop in their water capacity [16]. These all scenarios indicate the need to understand potential impacts of climate unpredictability on water dynamics.

3. Risks envisaged: apprehension of appalling future

The situation of water emergency is that approximately 2 lakh people die every year in India due to consumption of inadequate and polluted water [17]. The threats looming overhead due to water scarcity are not only confined to the human race. Depleting water levels coupled with many anthropogenic activities has put our biodiversity in an extremely vulnerable position. Almost everywhere, watersheds appear to be dying and shrinking because of their reduced rainwater harvesting capabilities. The storage areas of the catchments were either diverted to other uses or became deforested. As a consequence, the situation is getting tough day by day. In those areas of the country which are facing the dire situation of water crisis, the cost of a pitcher of water is more than the life of a person or human being. During the summer, women in several parts of Rajasthan, Maharashtra and Bundelkhand start arranging water from very early morning. Last year, drinking water was transported by train to the people of drought-hit Latur district of Maharashtra and Bundelkhand region of Uttar Pradesh. These days, the news of water disputes at various locations has become quite common. This crisis may increase further in the coming times. Analysts have been expressing apprehension that the use of water in the form of a weapon is also possible in the near future. Some time ago, due to tension with Pakistan, India had threatened

to disrupt the availability of water by stopping the flow of the Indus River. In this section we will discuss the potential dangers arising out of water crisis.

3.1 Agriculture at the center of the crisis

Agriculture is a major contributor in the country's economy, where out of total available land, 51 per cent is agricultural, 4 per cent is pasture, 21 per cent is forested and 24 per cent is barren. The livelihood of 52 per cent of the country is dependent on agriculture and allied industries. The share of agriculture sector in total water use is more than other sectors. The agriculture sector alone consumes 80 per cent of water resources in India and is responsible for almost 90 per cent of groundwater withdrawals. Tube Wells and canals are the most common modes of irrigation throughout India. These methods have allowed the farmers to conveniently extract water on a large scale and flood their fields with all the water they can get. Subsidy is also provisioned by the government for boring in the fields by the farmers. Massive abstraction of ground water very clearly reflected into drying up in many parts of the country. The problem of water crisis in Bundelkhand, Rajasthan, Maharashtra and Karnataka are now very recurrent. At some places, the problem is so severe that the prevailing conditions coerced the farmers to give up farming.

The problem is aggravated by climate unpredictability. Due to the spatial–temporal variation of rainfall most of the country remains rainless and drought prone. North-Western India and the Deccan Plateau are the most affected. Besides, in most parts of the country, more or less dryness is found in winter and summer, so it is difficult to cultivate without irrigation in dry seasons. On the other hand, in areas with sufficient rainfall, such as West Bengal and Bihar, segmental rainfall during the monsoon season creates a drought-like situation, which is harmful to agriculture. The scarcity of water makes irrigation necessary for some crops. For example, rice, sugarcane, jute etc. require a lot of water which is possible only through irrigation. Secondly, regular moisture supply is necessary for high yielding varieties of crops which is again dependent on developed irrigation system. In Punjab, Haryana and western Uttar Pradesh, 85 per cent of the net sown area is under irrigation [18]. Wheat and rice are mainly grown in these states with the help of irrigation. In Punjab, 76 per cent of the net irrigated area and 51 per cent in Haryana, is irrigated by wells and tube wells [19]. In fact, in some states, such as Rajasthan and Maharashtra, the concentration of fluoride in ground water has increased due to excess water withdrawal and this has led to an adverse impact on agriculture as well on human health.

3.2 Deteriorated drinking water quality and health concern

The falling groundwater levels are not the only red flag that we see today. Rather, the issue of quality of drinking water is also a big concern. Approximately 785 million people lack even a basic drinking-water service, including 144 million people who are dependent on surface water [20]. Cases related to water borne diseases like typhoid, cholera and jaundice have been on the rise in recent years in developing nations. Contaminated drinking water is estimated to cause 485 000 diarrhoeal deaths each year [21]. For a developing nation like India, the challenge of supplying clean drinking water is even bigger due to the vastness of the population. What fuels the apprehensions is an unfortunate truth that despite the increased awareness regarding water safety, sheer negligence towards contamination of water bodies does not seem to take a toll. Farmers across India unmindfully carry on with their habit of applying heavy doses of chemicals to ensure a good yield from their crop.

Little do they realize that these very chemicals get washed away and canals and rivers gets contaminated by lethal chemicals. These reservoirs are not only used by humans as a source of drinking water but also by the animals and livestock of that area. As a result, we end up consuming not just unhealthy water, but also unhealthy food, milk, eggs and meat, all grown using the very same toxic water.

3.3 The rising cost of water

In view of tough situation, an extensive and quite expensive infrastructure is needed to ensure water availability to the common people may it be for digging very deep or supplying water from a long distance to a big city through an extensive pipeline. Although due to the fundamental right of the people to access free water and some political obligations, the tax on water cannot be increased directly. Policy makers around the country face a tight situation in recovering the expenses incurred in the development of infrastructure. Government recovers the expenses either in the form of inflation of other essential commodities or heavy taxes are imposed by the Municipal Corporation. People are expected to pay as the infrastructure development fees. In some states, separate tax provisions have been made for the supply of drinking water and water for other uses. In this way, low- and middle-income families carry most of the load of the mounting expanses indirectly.

4. Management through harnessing traditional water heritage

The practice of water harvesting and management in India is incredibly old. Traditional systems are a characteristic hybrid of the ecology and culture of the region in which they develop. They have not only stood the test of time, but also met the local needs keeping in sync with the environment. Unlike modern systems that exploit the environment, these ancient systems emphasize on ecological conservation. Traditional systems have been benefiting from shared human experiences since time immemorial and this is their greatest strength. Traditional systems based on community also emphasize social harmony and self-reliance. In these, decision-making authority was often given to individuals, groups or local communities, who were working together. This increased economic independence and made full use of local resources at the lower level.

Historical and archeological evidences show that since the 400 BC, small communities in many areas of the country have been making effective arrangements for water harvesting and distribution. The Nanda rulers [363–321 BC] built canals and community-dependent irrigation systems. The Gaur rulers [600–1303 AD] of central India not only created better systems of irrigation and water supply, but also developed necessary social and administrative arrangements for their maintenance. It is noteworthy that all the traditional systems built by these rulers were not small. Large systems were also constructed to meet the needs of the cities but they were coordinated with smaller systems, as observed in the Chola period [848–1279 AD] and the medieval Vijayanagara period [1336–1646 AD]. These systems used contemptible but simple technology that the local people could easily maintain. These systems are also important because they have given life to communities even during long periods of drought or famine. Although, sometimes smaller systems would fail when there was no rain for years. This would have created the need for larger systems, but the balance between small and large systems was carefully maintained. This cannot happen unless both rural and urban communities participate in the

planning and implementation of systems. In this way, without glorifying antiquity, it can be said that traditional systems were more effective then and still are in terms of water supply and return on capital.

4.1 Indian water bodies: a precious estate

India is endowed with extraordinarily diverse and distinctive traditional water-bodies known by their different names in different parts of the country, such as Khadin and Baolis [Rajasthan], Dung or Jumpois [Jalpaiguri district, West Bengal] Bhandaras [Maharashtra], Vavdi [Gujarat], AharPynes [Bihar] and Zing [Ladakh, Kashmir]. These water bodies are vital for sustenance to Indian agriculture and have been playing important role in the overall management of water resources of the country. Religious significance are also adhered with the water bodies. Several Indian lakes such as Gurudongmar in Sikkim and Pushkar in Rajasthan are renowned for their religious magnitude. These lakes provide an adequate water in the form of large storage tanks to the monsoon-dependent areas of the country where there exist quite a short spell of rainfall and a long dry period with very high deviation of annual rainfall. The small storage tanks are called ponds or locally bundhis which, as a rule, are community owned, while on the other, the large storage tanks with command areas from 20 to 2000 hectares were usually built by the regional rulers. These water bodies reflect the regional style of construction and typically were based on the provincial demand of water. Some key examples of classical water bodies are presented as follow:

i. In the mountain areas, a diverse pattern of natural depressions are used for rainwater harvesting. The most familiar examples are chaals or lakes. Chaals are the depression found in the saddle between two adjacent crests along mountain ridge tops. It can store several thousand cubic meters of water. They were believed to be formed by the glacial action of snowmelt in the past, leading to the formation of small lakes with a relatively thick soil bed.

ii. Chappris, in Himachal Pradesh, are usually shallow dug ponds without any masonry work and located on the hill sides where the slope tends to flatten out.

iii. Simars are water-logged flat lands found in the high-altitude areas of Uttarakhand.

iv. Canals in western Himalayan regions were built with contours to draw water from hill streams or springs. These canals may vary in length from 1 to 15 km.

v. Ponds are fairly common in the Jammu region. They serve the purpose of livestock and irrigation need.

vi. Tanks of variable sizes with depth not more than five to six metres were also built in plateau region.

vii. Other sources of irrigation were dams that were built across a river, a stream, or an estuary to hold water. Kallanai dam is particularly interesting that was built during the second century AD by Karikalan, a king of southern India's old Chola Dynasty. It is one of the oldest irrigation systems in the world that

is still in use [22]. The dam has been built with uneven stones and is 329 m long and 20 m wide (**Figure 1**). The purpose of the dam was to divert the waters of the Kaveri across the fertile Thanjavur delta region for irrigation via canals.

After independence, the government has taken control over these water bodies and making structural changes as needed. However, since last few decades, water bodies have been under continuous and unrelenting stress, caused primarily by unplanned growth and rapid urbanization.

4.2 Traditional water culture: lessons from the past

The first evidence of water management was found during excavations in the Indus Valley [23]. A good quality arrangement was made for the drainage of flood water in this area. Similarly, the art of making wells also developed during the Harappan period [2600 to 1900 BCE] [24]. It is known from the excavations and surveys in this area that there was a well in every third house. About 300 BC, the people of Kutch and Balochistan [now in Pakistan] were familiar with the art of building dams. They built very strong dams with the help of pebbles and stones and stored rainwater in them. This water stored in dams was used to meet drinking water and irrigation needs and people were skilled in managing the water collected in the dam. The systematic approach of ancient people is also well exemplified by the practices followed during the reign of Chandragupta Maurya [321–297 years BCE]. During this tenure, the Indian farmer was not only familiar with the means of irrigation, such as ponds, dams, etc.

4.2.1 Regional diversity in traditional water culture

Diverse ranges of approaches for water conservation have been developed in different regions of India that is mainly divided into five parts on the basis of climatic and physical characteristics.

Figure 1.
Kallanai dam.

4.2.1.1 Himalayan Mountains

The states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Assam, Nagaland, Meghalaya, Manipur and Tripura are included in the Himalayan mountain region. These states have different types of water practices as per the different geographical conditions and water availability. The canal system has been developed in these areas since ancient times. These mountain streams are up to 15 km long. The canals are connected to uncooked drains locally called Mogha. Through this system, the melt water of the glacier flows and is stored in the ponds, it flows at a fast speed during the snowfall and less amount of water comes in it during the cold season. The system was depended on mutual cooperation and partnership for water distribution. The construction of canals and Mogha in ancient times was the responsibility of merchants and upper class of the society. Similar systems were developed in Lahol and Sfiti regions through which the snow melts and reaches the villages in the form of water. Their main part of the system is the glacial estuary where water is preserved. Stones were laid on the sides and floor to prevent the leakage of water on its way. In many places, the local administration is also getting them repaired, but their appearance is becoming modern.

In the state of Uttar Pradesh, ancient ponds and other small wells, called Naula used to be a suitable system of traditional water harvesting of the region. Religious organizations have also been considered to contribute in their construction. Presently, massive plantation is being done on both sides of these just to reduce the evaporation loss.

The Darjeeling, Arunachal Pradesh and Meghalay region in the eastern Himalayas is traditionally irrigated by springs. Here, water is carried through bamboo pipes to the terraced fields. This system is similar to the current drip irrigation system. These drains release 18 to 20 liters of water per minute. Bamboos of different diameters are used to make waterways. Before making this system, the bamboo is peeled and thinned and the knots formed in the middle are removed. After this, small drains are used to carry and distribute water from the main road to different places. This system is prevalent in Gara, War and Khasi areas. This method has been kept alive by the local tribes like Lepya, Bhotia and Gurung people. In Subansiri district of Arunachal Pradesh, traditional dams have been built by Apatanitribals on Banana River to conserve water of the springs as well as for fish farming. A unique point here is that the Apatani people make water harvesting routes near the village so that the sewage and urine of humans and animals mix with this irrigation water to convert it into manure.

4.2.1.2 Ganges-Brahmaputra plain

The Gangetic plain in India is a vast area of small rivers. In Punjab, canals, wells and skirts are prominent in the traditional systems. Skirts are wide wells with less depth. It has been a tradition to draw water and irrigate with the help of pulleys and ropes. In Haryana, apart from wells and canals, water is stored in the abyss. Abyss is a type of pond in which rainwater is stored. Delhi's Surajkund is also a classical example of traditional water harvesting, in which water comes from the northern part of the Aravalli. Similar water harvesting is done in the Shamsi lake near the capital Delhi.

The Ahar-Pin system of Bihar is also an excellent example of traditional water harvesting. Ahar is rectangular in shape surrounded by water on three sides from which water is carried to the fields by pine. Earlier, people used to exploit it together, but due to continuous floods, their ancient form has distorted. In the high

mountainous regions of Assam, puddles were built by the tribes called Dogs. Water is stored in the Brahmaputra plain by the Jampoi method. In the Jampoi method, small drains called Doong are made to store water. Owing to the excessive deforestation led recurrent floods, their shape is altering.

4.2.1.3 Plateau regions

The Haveli system of Madhya Pradesh and the Kere system of Karnataka are prominent in the plateau parts. The arrangement of water management during the Mughal period [1526–1761 AD] is found in Madhya Pradesh. In Jabalpur, high dams were constructed to carry rain water, which remains in the fields till the crop is sown. To prevent this, a ridge called Bandhare is built around the fields. Phad system in Maharashtra is a suitable system of water harvesting in the traditional way. Its history is 300 to 400 years old, when they were first developed in northwest region of Maharashtra.

4.2.1.4 Coastal Plains and Islands

In the western coastal parts of Gujarat in the Kathiawar region, the groundwater is very high and here for water harvesting stepwells are made which are called vavs. Many ponds were built in the 15th century in Gujarat, most of which were built by Sultan Qutbuddin [1150–1210]. The Mansar lake spread in 6 hectares is famous, in which water remains throughout the year. A number of rivers namely Vaitarni, Ulhas, Tasan, Savitri and Vashishti flow across the vast plains of Maharashtra, originating from the Western Ghats. Apart from these, they also collect rainwater in ponds and lakes. Here, by making bunds of the fields, they stop the water of the years in the traditional way. There are many reservoirs in Konkan, which were built by Hindu rulers and philanthropists, among them Borala, Pathardi, Nageshwar and Kashar reservoirs are famous. In Thane and Colaba in Maharashtra, water from sea tides was stored in dams to irrigate the fields.

In Karnataka Kasam system prevails. The Kasam is a long pond, which is built below the river bed. In which the water of the river seeps and gets stored. In this river basin, people have made arrangements for many types of water harvesting. In which Revu, Don, Odu, Gokutan, Kutan and Cheruvu are the main ones. Revu system was a system of collecting water from springs which were made of stone, mud and grass.

The traditional water harvesting techniques of Tamil Nadu are found in ponds. 35 per cent of Tamil Nadu is irrigated by ponds locally knows as Erie. The control of floods through the construction of the Erie prevents soil erosion and collects waste rainwater, which has raised the groundwater reserves. Historical data reveals that 20th of the total production of each village was engaged for the maintenance and irrigation of Erie. Over time, these traditional water sources started to decline.

The tribes of the Andaman and Nicobar Islands are skilled in preserving the traditional water harvesting methods, where the Sopan and Jarawa tribes collect water by ripping bamboo and using it. The bamboo is cut and placed at low places according to the slope, through which the scattered rain water gets stored in shallow pits, which are called 'Jackwells'. Torn bamboos are also laid under the trees to store water from the leaves. Jackwells stay connected to each other. In which filling one pit keeps burning in the other and finally gets deposited in the big jackwell. In addition to the bamboo technique, water harvesting is also done by placing pots or pots under coconut trees.

It is clear from the above examples that the traditional water harvesting systems have stood the test of time. These systems have emerged in their effective form due

to various social, economic and political conditions. These systems developed in different regions of India have emerged in their own special form, in whose development the influence of various geographical factors along with historical elements is prominent.

4.2.2 Water culture: temporal diversity

Today, the center of the definition of big cities in the country is its population, business and industry, whereas in ancient Indian tradition, the definition of a big city or village included its ponds. The size of the population, volume of the business and industrial presence was never asked, rather how many ponds a village or a city had used to be in the core of identity. A comprehensive study of various Indian traditions tells us the integral linkage of ancient Indians with water resources.

In the Madhubani area of Bihar, in the sixth century, the villagers altogether had made 63 ponds in the entire area. It thrills us to think that how big an organization that too of people from diverse communities would have been formed and how many resources would have been mobilized to complete such a big but social project. These ponds in Madhubani are still alive and people keep on remembering them with gratitude. The only secret of the long life of all these ponds was the importance of these ponds in the minds of the people and a kind of family attachment.

The story of the creation of ponds in the tribal-dominated areas of Madhya Pradesh, Chhattisgarh and Orissa is linked to the judicial system prevailing in that era. Somewhere in villages, a pond was made as a reward of timely payment of taxes, while in some cases, the reward for constructing a pond was extended by the Gond kings [From the 14th to the 18th century] in the state of Madhya Pradesh, in addition, the land below the newly built pond did not have to be rented, this practice was especially observed in the Narmada region of Madhya Pradesh, the entire Chhattisgarh and Sambalpur region of Orissa.

Similarly, construction of a pond used to be a part of the penal legislation in certain areas of central India. In Bundelkhand region, when the community panchayats used to punish for the unforgivable mistake of one of their members, they had often asked them to build a pond in the residential area. There has been another interesting tradition; it was believed that everyone has to undertake a pilgrimage in their life. Those who could not go on pilgrimage due to any compulsion, they can do religious work by making a pond near their house. The people who put their resources and energy for the construction of pond were regarded as a virtuous soul. The person who raised resources and labor for the ponds in the society was looked upon with respect and counted in the category of a priest.

It has been a tradition in Chhattisgarh that out of the 13 full moons of the year, 11 were kept for collective labor work by the community people, but on the full moon of the month of Pauṣa [a month of the Hindu calendar that corresponds to December/January], there was a tradition of collecting paddy or in turn money for the pond. It has been a tradition to celebrate an annual festival in this month with the spirit of paying an honor to preceding rainy season. In this festival, groups of people used to go out, sing songs and collect money from individuals. The funds deposited in this way were kept in the village fund. From this fund, repairs and new works of ponds and other public places were completed. In this area, there was a unique tradition related to the respect of ponds. Ponds were also married with complete rituals. This practice continues in Chhattisgarh even today. The pond could not have been used before the said marriage, neither to drain it nor to cross it. People used to bring the soil of all the surrounding temples of the area, water from other five or seven ponds nearby and holy Ganges water on this ceremonial day. The marriage was said to be completed by mixing all these water and soil. At

some places, the people used to arrange dowry according to their ability, the annual anniversary of marriage was also celebrated on the pond. Much later, when the pond was cleaned and excavated again, there was a tradition of erecting pillars in memory of that ceremony.

This tradition is still being carried out on a large scale in some areas of India. In BinduSagar, near the famous JagannathPuri temple of Orissa, water from every water source across the country has been piously mixed, even from far and wide. Devotees who come to the temple of JagannathPuri from different directions bring some water from their area with them and offer it to Bindusagar. BinduSagar is a symbol of the unity of the whole of India.

In northern, Bihar, there was a custom to build a pond by the rich people of the society after the acquisition of education. This tradition continued for a long time in Madhubani and Darbhanga regions of the state. There also existed a system of nomenclature of these ponds which were scripted on the copper plate, on which the complete details of the pond were also engraved.

In Gujrat, the full filling of the pond was not only considered an event, but was also considered an indicator of happiness and good luck. It came under the category of a festival. An elephant statue built in the Ghat of Hamirsar, the largest pond in Bhuj or Kutch of Gujarat used to represent the level of water. When the water touched this idol, news spread throughout the city and the townspeople would gather at the ghats of the pond. This event was celebrated as a festival, the kings of Bhuj would come to the ghat and worship the pond in the presence of the whole city and return with the blessings of the full tank.

5. Community approach of the day towards water management: illustrations of grassroots practices

India and Indians have always taken pride in coming up with unconventional and innovative approaches towards problem-solving. For example; the will and determination of the tribal population of India is apparently seen in their efforts towards water management and sustainability. One interesting example of collective effort is "Halma", which is commonly practiced in the Jhabua district of Madhya Pradesh. Halma is a traditional yet sustainable approach towards water harvesting that was initiated by the people of the Bhil community many years back wherein a day or two were marked each year when every member of the community [including women and children] would come together with spades, shovels and pickaxes to deepen the contours of their village trenches and ponds or dig new ones if necessary. The spirit of this joint operation was that since all residents of the village utilized water from the pond throughout the year, then it was their moral obligation towards the pond to contribute at least a single day in reviving it. This practice was vastly adopted across the whole district of Jhabua so much so that in 2018, approximately 12000 people or more from almost 400 villages across Jhabua participated at the Halma. A big share of the credit for getting such a massive response from the people of Jhabua goes to the ShivgangaSamagraGramvikasParishad, which is an NGO that motivates the people through the mythological tale of river Ganga arriving on earth through lord Shiva's Jata [hair locks] after King Bhagirath prayed to him.

A parallel example is of NGO namely the Tarun Bharat Sangh, that has been actively working by restoring and reviving the water conservation structures across many water-stressed states of India for more than two decades now. It is due to their efforts that the Arvari river in the Alwar district of Rajasthan was revived and now is a reliable source of irrigation for the people living in its vicinity. The Tarun

Bharat Sangh, in two decades, has built 402 structures over an area of 500 square kilometers to revive the Arvari river. As a result, water availability through wells and tube wells has increased substantially in the nearby villages that have now shifted from subsistence to commercial farming. The ecosystem of the area has also been rejuvenated through these efforts. The NGO is actively working in other states like Uttar Pradesh, Bihar, Jharkhand and Uttarakhand along the same lines. It is through the efforts of groups of like-minded people like these that sustainable approaches towards water conservation can be used as weapons to combat the upcoming water crisis. Similarly, in many areas of the country, many social and religious organizations are running intensive programs of public awareness for water conservation.

Another inspirational example comes from the Lapodiya village, which is two hours away from Jaipur, the capital of Rajasthan. Prior to 1977, the place was known to be an arid region with acute water shortage in summer seasons. Agriculture and cattle rearing had started to diminish due to a lack of water. The rainfall pattern was so erratic that food and fodder for cattle had to be bought from the market. But thanks to the initiative of a few villagers, the 300-household strong Lapodiya has now turned into a green oasis. A joint operation carried out with coordinated efforts from all the villagers has enabled the village to construct three major community ponds that serve their domestic as well as agricultural requirements throughout the year. Suitable slopes and systematic drains have been constructed in the entire village so that the rain water is stored in the pond itself. There is no more shortage of green fodder in the village as grazing land is now available for the cattle in the village itself. The ponds have recharged the water table and water shortage in the village has now become a thing of the past. During the time of good rains, the water is stored in the ponds and then reused for subsequent seasons. This stored water lasts for up to three whole years and protects the villagers against distress arising from scanty or no rainfall at all. The efficient water management system of Lapodiya has earned for itself the recognition of a model village for rainwater harvesting by the authorities. Several villages in diverse parts of country too have demonstrated similar examples.

6. Water policy and social change

India is traditionally an agrarian economy, therefore, since the very first Five Year Plans; a high priority has been given to the development of irrigation facilities to increase agricultural production. Several multipurpose river valley projects such as Bhakra Nangal, Hirakud, Damodar Valley, NagarjunaSagar, Indira Gandhi Canal Project etc. have been started. All these measures take credit for the fact that today the share of agriculture sector in total water use is more than other sectors. Nevertheless, the use of water in the industrial and domestic sectors in the country is likely to continue to increase with the growth in future. In view of the dire situation of water crisis, emphasis of the government is also on water conservation and many steps have been taken in this direction in the last few decades. The initiative of the Jal Shakti Abhiyan, a time-bound, water conservation movement under the ministry of water resources of government of India is a convivial step focusing on rainwater conservation, rejuvenation of water bodies, reuse of wastewater after proper treatment, and serious afforestation. It is extremely important for us to meet the rising demand for water expansion, civilizing the health of water bodies as they are required to manage microclimate, biodiversity and nutrient cycling. Besides, Wetlands Authority is being established in many states for notifying and conserving natural water bodies.

Undoubtedly all these are welcoming steps, but apart from this, there are some common expectations from the government. As described earlier the heavy water intensive crops are irrationally grown in the water scarce state, the state governments should promote the cultivation of less water consuming crops like pulses, jowar-millet and oilseeds. Rice and sugarcane cultivation should be allowed only in those areas where water is available in plenty. The government should also take immediate steps to encourage the efforts being made at various levels for water conservation and to set strict legal provisions on its misuse.

7. Conclusion

The water crisis is pushing the entire human race to such a corner, from where it is difficult to return. Nature gives warnings from time to time, but we are deaf in the noise of modernity. It is very complicated to convey a message to the people is the inevitability to take measures that seem to ask people to adopt old customs. We need to understand that the current technology backed system alone cannot provide us the solution. Depending on the purpose, ecological services, livelihood and socio-cultural practices, an integration of modern technology synergized with traditional culture can ensure the return of water to the water bodies. Any effort for revival of water bodies has to be made on the social front by motivating local people specially youths to collaborate with other stakeholders to efficiently utilize resources for protection and conservation of traditional water bodies. Customarily, water was considered as a social responsibility and the people cooperatively took the responsibility of building and maintaining the water bodies. This trend needs to be brought back into the system today. Thus, an incorporated approach for the revival of Indian traditional water culture with long-term sustainability is inevitably required.

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References

[1] Dharminder R K S, Kumar V, Devedee A K, Mruthyunjaya M, Bhardwaj R. The clean water: The basic need of human and agriculture. IJCS. 2019; 7(2): 1994-1998.E-ISSN: 2321-4902

[2] NitiAayog. Composite water management index. National Institution for Transforming India, Government of India 2018. pp. 239. http://social.niti.gov.in/uploads/sample/water_index_report2.pdf

[3] NitiAayog, (2018). Composite Water Management Index: a tool for water management.http://social.niti.gov.in/uploads/sample/water_index_report2.pdf

[4] Chatterjee A, Chattopadhyay R N. Metropolitan Regions of India: Rapid Growth, Changing Landuse and Challenges. In: Satellite Towns in Neo-metropolitan Development in India. Springer; 2020. p. 87-100. DOI: 10.1007/978-981-15-1502-6_4

[5] Fishman R. Groundwater depletion limits the scope for adaptation to increased rainfall variability in India. Climatic change, 2018. 147(1): 195-209. DOI:10.1007/s10584-018-2146-x

[6] Mahajan G, Kumar V, Chauhan B S. Rice production in India. In: Chauhan B S,Jabran, K, Mahajan G, editors. Rice production worldwide. Springer, Cham. 2017. p. 53-91.DOI:10.1007/978-3-319-47516-5

[7] Kaur J. Rice production in Punjab: Depletion of water resourced environmental problems. Indian Journal of Economics and Development, 2020. 16(2s): 294-299.Article DOI: 10.35716/ijed/NS20-007

[8] Etienne G. EKSAL. In Studies in Indian Agriculture. University of California Press.2020. P. 241-255. ISBN: 9780520323780

[9] Srivastav A. Energy Dynamics and Climate Mitigation: An Indian Perspective. 1st ed. Springer Nature, 2020. P 194. ISBN: 978-981-15-8940-9

[10] Reddy K Y, Reddy L N. Incentivizing Water Use Efficiency-Virtual Water Approach. IWRA (India) Journal (Half Yearly Technical Journal of Indian Geographical Committee of IWRA) 2017. 6(1): 35-42.ISSN: 2277-1301

[11] Jiang L, O'Neill B C. Determinants of urban growth during demographic and mobility transitions: Evidence from India, Mexico, and the US. Population and development review. 2018. 44(2): 363-389. https://doi.org/10.1111/padr.12150

[12] Kundu D, Pandey A, Sharma P, Bhusan S, Mondal B, Lahiri B, Sharma T C, Vijh S. India: National Urban Policies and City Profiles for Delhi and Madurai. GCRF SHLC. 186 p. 2018.

[13] Ebikade E, Athaley A, Fisher B, Yang K, Wu C, Ierapetritou M G, Vlachos D G. The future is garbage: repurposing of food waste to an integrated biorefinery. ACS Sustainable Chemistry and Engineering. 2020. 8(22): 8124-8136. doi/10.1021/acssuschemeng.9b07479.

[14] Bhanja S N, Mukherjee A, Rodell M, Wada Y, Chattopadhyay S, Velicogna I, Pangaluru K, Famiglietti J S. Groundwater rejuvenation in parts of India influenced by water-policy change implementation. Scientific reports. 2017. 7(1) :1-7.DOI: 10.1038/s41598-017-07058-2

[15] Singh Y, Sidana B K. Water and Energy Use Efficiency of Maize vis-à-vis Paddy Crop in Punjab Agriculture: A Move towards CropDiversification. Indian Journal of Economics and Development. 2018. 14(1a): 87-95.DOI: 10.5958/2322-0430.2018.00041.0

[16] Sharma P J, Patel P L, Jothiprakash V. Impact of rainfall variability and anthropogenic activities on streamflow changes and water stress conditions across Tapi Basin in India. Science of the total environment. 2019. 687: 885-897.DOI: 10.1016/j.scitotenv.2019.06.097

[17] Pradhan P, Irshad N. Media coverage of swachhbharatabhiyan in mainstream dailies of India. Mass Communicator: International Journal of Communication Studies. 2018. 12(2): 14-21. DOI: 10.5958/0973-967X.2018.00010.8

[18] Shiksha, Mittal P. A Study of the Impact of Production Variables on Indian Food Grains Productivity. Pacific Business Review International. 2017A 9(12):1-6.

[19] Kasana A, Singh O. Groundwater irrigation economy of Haryana: A glimpse into spread, extent and issues. Journal of Rural Development. 2017. 36(4): 531-555.DOI: 10.25175/jrd/2017/v36/i4/120624

[20] Ekumah B, Armah F A, Yawson D O, Quansah R, Nyieku F E, Owusu S A, Odoi J O, Afitiri A R. Disparate on-site access to water, sanitation, and food storage heighten the risk of COVID-19 spread in Sub-Saharan Africa. Environmental research. 2020. 189: 109936.DOI: 10.1016/j.envres.2020.109936

[21] Nischal P M. Billions of people still lack safe drinking water, sanitation facilities and basic hygiene. The National Medical Journal of India. 2019. 32(4): 255-256.DOI: 10.4103/0970-258X.291311

[22] Agoramoorthy G, Hsu M J. Small size, big potential: Check dams for sustainable development. Environment: Science and Policy for Sustainable Development. 2008. 50(4): 22-35.DOI: 10.3200/ENVT.50.4.22-35

[23] Khan S, Dialynas E, Kasaraneni V K, Angelakis A N. 2020. Similarities of Minoan and Indus Valley hydro-technologies. Sustainability. 2020. 12(12): 4897.DOI: 10.3390/su12124897

[24] Voudouris K, Valipour M, Kaiafa A, Zheng X Y, Kumar R, Zanier K, Kolokytha E, Angelakis A. Evolution of water wells focusing on Balkan and Asian civilizations. Water Supply. 2019. 19(2): 347-364.DOI: 10.2166/ws.2018.114