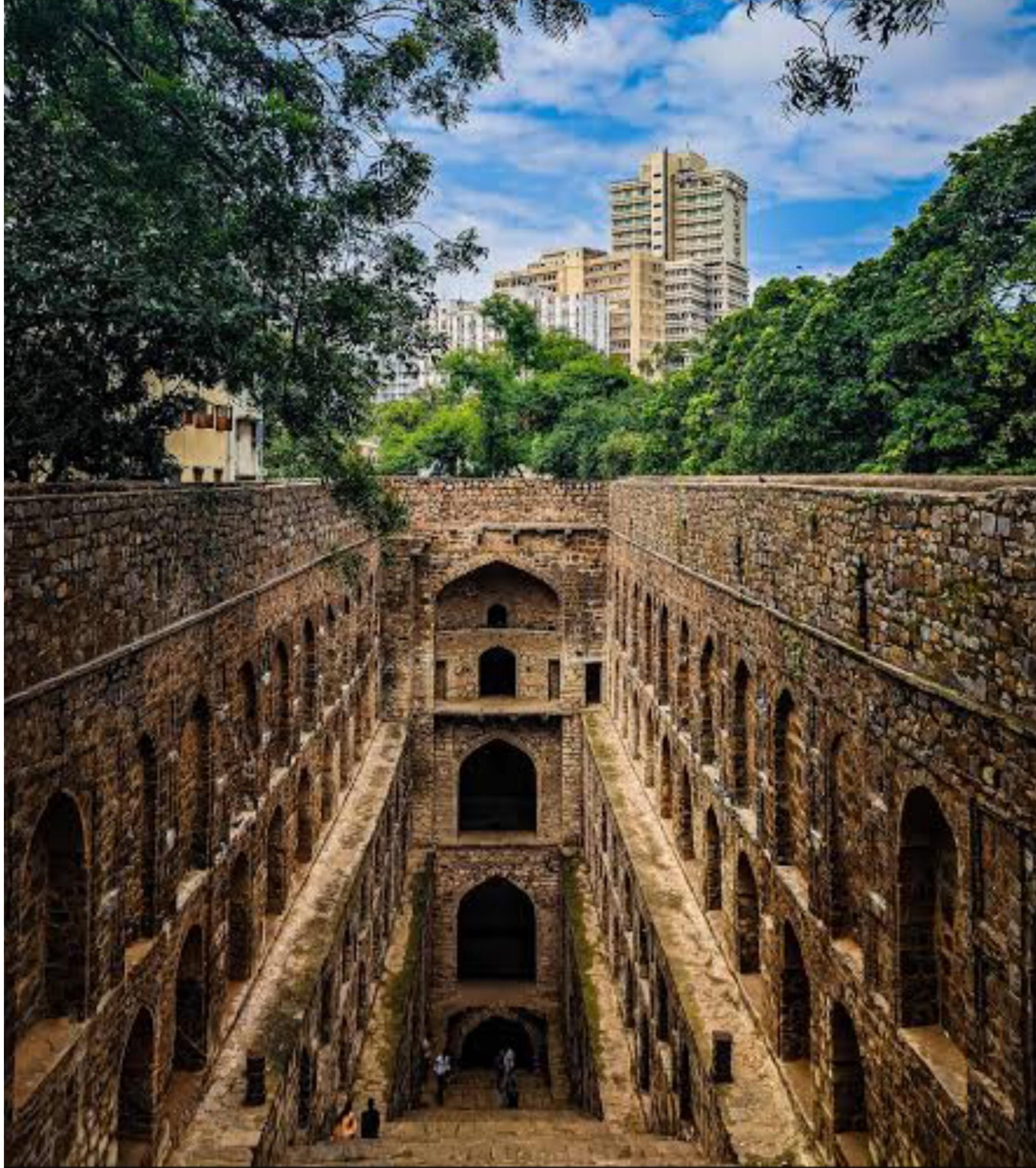

Traditional water conservation:

Reasons for decline and need for revival

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"Even as life on earth cannot sustain without water, virtue too depends ultimately on rain"

Tamil poet Tiruvalluvar says in the Tamil Veda Tirukkural (verse 20)

1. Need for Traditional water conservation:

1.1 Since time primordial, the necessity, the wherewithal, and the ways of water harvesting and conservation have been appreciated, developed, and practiced in India. The processes and structures of traditional water conservation are unique and varied, and depend on the mainland's geographical diversity. But the commonality that runs through all the systems is the end result, which is to collect rainwater, groundwater, stream water, river water, and flood water and to recycle them to optimize usage of scarce water resources.

1.2 Water resources although abundant at some point in history when population was sparce, has been regularly harvested in India since ancient times. Evidences of simple and advanced water conservation and harvesting systems are galore in the existing structures, dilapidated ruins, ancient texts and archeological remains. Even the Puranas, Mahabharata, Ramayana and various Vedic, Buddhist and Jain texts contain references to canals, tanks, embankments and wells. Every water body is revered as God.

1.3 Water is known as *ap* in Vedic Sanskrit. It is said to be of the same age of the Universe itself in the Vedas. The world is spoken of as having been

[1] Shankar Prasad Sarma (IRS) and Himani Aggarwal (Young Professional), EAC-PM

"originally water without light" (Salilam apraketam; Rig Veda X.29.3). Therefore, water is considered Divine by the Vedas, and it was thought to bring peace, happiness, wealth, long-life and good health. Being divine water has been not only worshipped but also collected, conserved and recycled since ages.

1.4 Kautilya's Arthashastra also has several mentions of the need for creating processes and structures for conservation and harvesting of water resources. Archaeological evidences o the period shows that several of his ides were implemented in pursuit of conservation of water resources. The terms used in the original text relating to water harvesting systems are several, namely[2],

i. Setu for embankment or dam for storing water;
ii. Parivaha for channel;
iii. Tataka for tank;
iv. Nadyayatana for water from a river;
v. Nandiniband-hayatana for a structure dependent on a river such as a dam;
vi. Nibadhayatana for canals from a river dam andkhata for a well.

1.5 When the exploring Europeans first set foot in South Asia in the 15th century, it was possibly the richest and most meticulously planned region in the world. The subsequent impoverishment of the region was juxtaposed alongside the launching of the age of discovery in Europe. The setting up of the East India Company in 1600 AD started the balls rolling for turning back the clock of development of India. The flawed processes and biased understanding of ways of Indian life were instrumental in dismantling not only the prosperous and self-sufficient economy but also discontinuing most of the processes for water conservation and harvesting, which we shall see

[2] https://www.india-seminar.com/2016/680/680_sunita_narain.htm

later in this paper.

1.6 Its well documented how the colonial period led to impoverishment of India which at the same time provided the finances for Britain's Industrial Revolution from 1760-1840. In their pursuit of increasing revenues, British administrators hardly noticed the native villages and, therefore their internal capacity to manage their natural resource base.

2. Power and utility of Traditional knowledge: Examples

Victor Hugo had famously said, "No power on earth can stop an idea whose time has come". But the idea of water conservation and water harvesting is so ancient and powerful that people can at most forget about it in better times, only to realize during difficult times of scarcity, how time tested and resilient such structures can be. Nothing can explain better than some real examples.

2.1 The fluctuating fortunes of Sukhomajri[3]:

i. In the year 1979, the people of Sukhomajri were faced with an existential crisis triggered by a debilitating drought that stared at most of India. Sukhomajri is a village nestled in the Shivalik hills. That year the sparse monsoon rains did not let them grow a single crop. The inhabitants' stared at certain starvation.

ii. It was only after the efforts of soil conservationist, P Mishra who persuaded the villagers to resuscitate the watershed areas by refraining from grazing their livestock and thereby de-silting an earlier earthen dam that he had helped build, that water from a nearby dam

[3] Dying wisdom: the decline and revival of traditional water harvesting systems in India, The Ecologist, 1997

could be channeled.

iii. This community approach to water conservation yielded results within a few years by helping the villagers cultivate not one but three crops and eventually converting the village into a food-exporting village from an importing one before. At that time Economist Gopal Kadekodi of the Institute of Economic Growth in New Delhi pointed out that,

"The rate of return of the project cannot be matched even by the corporate sector."

iv. From the late 1970's when Mishra convinced the villagers after much initial hostility and suspicion about the benefits of soil conservation and efficient use of forest wealth, the villagers have participated in the Chakriya Vikas Pranali, a method of sustainable development. Two decades of this programme had seen Sukhomajri become a self-sustaining village. There was enough grass for fodder after the villagers prevented their cattle from overgrazing, there was sufficient mungri or its full-grown version bhabber to harvest and sell as raw material for pulp, there was enough water after four earthen dams were built to collect monsoon water. Sukhomajri had set a rare example of conservation and social planning.

v. Twenty-five years later that green of hope and prosperity seems to have run into trouble due to various reasons hovering over disputes over ownership and control of the land and resources. [4]In 1995 the forest department arbitrarily divided the 400 hectare hill tract between Sukhomajri and its neighbour village Dhamala. Residents of

[4] https://www.downtoearth.org.in/indepth/sukhomajri-at-the-crossroads-22807

Sukhomajri were no longer allowed to collect fodder from the area demarcated for Dhamala.

vi. Its pertinent to note that this division of land apart from ruining the resource management programme has also created social tension in the area.

vii. However, in the topsy turvy fortune of Sukhomajri, the silver lining is the success in community planning that was seen initially which had shown that with community planning, with a blend of knowledge and commitment, the economy of any village can be turned around. Sukhomajri also showed that from self-destruction to rejuvenation was only a short hop if only people are drawn into social programmes and given control of the resources. For instance in Sukhomajri the tree density in the village forest increased from 13 per hectare in 1976 to an amazing 1,272 per hectare in 1992. Moreover, soil from the hilltracts surrounding these villages was no longer silting Chandigarh's Sukhna Lake.

2.2 Averting a drought by indigenous methods:

i. [5]In not very far Rajasthan, a similar success story is repeated. It pertains to a unique traditional water conservation process known as Johads. Its well documented that Rajendra Singh of Tarun Bharat Sangh, an NGO working in the drought prone area of Alwar encouraged and helped villagers to revive traditional Johads, which are earthen dams thrown across the channels of seasonal streams.

ii. In such johads rainwater is allowed to collect and it percolates into the

[5] Dying wisdom: the decline and revival of traditional water harvesting systems in India, The Ecologist, 1997

soil recharging the area and the ground water. Tarun Bharat Sangh revived and rejuvenated more than 4500 johads in Rajasthan that resulted in the manifold increase of ground water storage. The state of Haryana's Water body Management Board manages more than 14000 ponds besides development of 60 lakes in Delhi NCR to cater to the water needs of the people.

iii. Another encouraging anecdote is from the drought year 1987 when there was an acute shortage of water in Rajasthan. Journalist Om Thanvi found out that, wherever households had kept intact their traditional water conserving systems, Kundis, the need for Government assistance was minimal.

2.3 Out of the box thinking for local problems:

i. Aizawl, the capital of Mizoram which was reeling in water scarcity due to rapid modernization resorted to rooftop water collection which became self-sustaining for each household.

ii. [6]The city enjoys an average annual rainfall of 2,500 millimetres. Traditionally, this has been the only source of water and was very popular among residents. Traditional Mizo houses have a sloping roof designed for rainwater harvesting. Water from the rooftops flows through gutters made of bamboo or metal sheets and collects in rainwater tanks made of galvanised tin sheets.

iii. An underground reservoir of 5,400-kilolitre (kl) capacity was constructed on an Aizawl hilltop by British civil servants, a hundred years ago. A major part of the town relied on this reservoir for its

[6] https://www.downtoearth.org.in/coverage/catching-rain-7746

water. But the scenario has changed with increasing population pressure creating a water scarcity.

iv. After various efforts, people of Mizoram are now going back to the basic or the traditional systems. Rain water harvesting being the most potent. R. K Srinivasan writes in Downtoearth that the immense potential of rainwater harvesting can be simply illustrated. A person normally requires 10 litres per day for cooking and drinking. The longest period of dry days or rainless days in Aizawl are 120. A household of eight members with a per capita requirement of 10 litres can survive the entire year by building a storage tank of 9,600 to 10,000-litre capacity. A house with a roof measuring 6 m x 4 m can harvest an astounding 60,000 litres of water annually.

v. Not only rooftop rainwater but also the surface run-off can be harvested. By constructing contour trenches, the sub-surface seepage can increase and enhance the yield. This will provide more water for people downstream. Also, this can stabilise the soil layers and prevent landslides.

2.4 Creating capacity by harnessing knowledge:

i. [7]Elappully panchayat in the rain-shadow area of the district used to suffer extensively from water shortage. It used to depend exclusively on the canal waters from the Walayar dam. In areas like Menonpara, the people used to depend on tanker lorry for drinking water all through the year. The panchayat had witnessed even a farmer suicide because of water scarcity.

[7] https://www.thehindu.com/news/national/kerala/a-water-success-story-in-elappully-success/article65267912.ece

ii. The Jala Subhiksha project begun in 2018 transformed the panchayat by addressing the water issue within three years. After initial surveys and awareness programmes, micro water supply schemes was introduced in the wards hardest hit by the scarcity. Drinking water kiosks were set up in the eight schools and 32 anganwadis in the panchayat.

iii. Rooftop rainwater harvesting was introduced for 600 buildings, including houses and offices, in Elappully. The harvested rainwater was double-filtered and used to recharge more than 1,000 tube wells. The hard water in the zone was improved through the 'reverse flow' mechanism.

iv. As many as 525 wells and 16 ponds abandoned because of water scarcity were salvaged. Multiple injection wells were constructed to recharge the groundwater using the water in the ponds. Water was assured for farmers by cleaning up the canals, deepening the ponds and introducing drip and tap irrigation.

3. Conservation of water: Rationale

3.1 Before delving further it appears imperative to understand the meaning of water conservation, its need and the availability of water resources. Water conservation is the careful use and preservation of the water supply, including the quantity and quality of water utilized. Water is an essential asset for the nourishment of all life[8].

3.2 Water Conservation is the practice of efficiently preserving, controlling, and managing water resources.

[8] https://theberkey.com/pages/a-guide-to-water-conservation

3.3 Water conservation has become essential in every part of the world, even in regions where water appears to be enough. It is the most practical and environment-friendly approach to lessen our need for water. Likewise, using less water puts less weight on our sewage treatment facilities, which use ample energy for heating water.

3.4 As per the UN the following are some of the water related challenges[9],

- 2.2 billion people lack access to safely managed drinking water services.
- Almost 2 billion people depend on health care facilities without basic water services
- Over half of the global population or 4.2 billion people lack safely managed sanitation services.
- 297,000 children under five die every year from diarrhoeal diseases due to poor sanitation, poor hygiene, or unsafe drinking water.
- 2 billion people live in countries experiencing high water stress.
- 90 per cent of natural disasters are weather-related, including floods and droughts.
- 80 per cent of wastewater flows back into the ecosystem without being treated or reused.
- Around two-thirds of the world's transboundary rivers do not have a cooperative management framework.
- Agriculture accounts for 70 per cent of global water withdrawal.

3.5 Water is the most important natural resource that living beings need.

[9] https://www.un.org/en/global-issues/water

But at the same time, it has also been misused and wasted. To better grasp the full significance of water conservation, let's take a look at the few yet key facts about water:

- The Earth has a limited amount of water. The water we have now is all we get, recycled repeatedly.
- Ninety-seven percent (97%) of all water on Earth is saltwater- which is not suitable for drinking.
- Only three percent (3%) of water on Earth is freshwater. Only 0.5% is available is suitable for drinking.
- The other 2.5% of freshwater is found in glaciers, ice caps, the atmosphere, soil, or under the Earth's surface or is too polluted for consumption.

3.6 India accounts for about 2.45 per cent of world's surface area, 4 per cent of the world's water resources and about 16 per cent of world's population. The total water available from precipitation in the country in a year is about 4,000 cubic km. The availability from surface water and replenishable groundwater is 1,869 cubic km. Out of this only 60 per cent can be put to beneficial uses. Thus, the total utilisable water resource in the country is only 1,122 cubic km.

3.7 There are four major sources of surface water. These are rivers, lakes, ponds, and tanks. In the country, there are about 10,360 rivers and their tributaries longer than 1.6 km each. The mean annual flow in all the river basins in India is estimated to be 1,869 cubic km. However, due to topographical, hydrological and other constraints, only about 690 cubic km (32 per cent) of the available surface water can be utilised. Water flow in a river depends on size of its catchment area or river basin and rainfall within its catchment area. The total replenishable groundwater resources in the country are about 432 cubic km. The groundwater utilisation is very high in the states of Punjab, Haryana, Rajasthan, and Tamil Nadu. However, there are States like Chhattisgarh, Odisha, Kerala, etc., which utilise only a small proportion of their groundwater potentials. States like Gujarat, Uttar Pradesh, Bihar, Tripura and Maharashtra are utilising their ground water resources at a moderate rate.

4. Need for water conservation:

4.1 Challenge of management of water resources in India has risen multiple times since independence due to a variety of reasons, but most importantly, rising demand for water usage and growing environmental degradation.

4.2 The UN Sustainable Development Goals which are a call for action by all countries to promote prosperity while protecting the planet has identified 17 SDGs which were adopted by all UN Member States in 2015. It was a part of the 2030 Agenda for Sustainable Development that defines a 15-year plan with 169 targets to achieve the SDGs (UNDESA, n.d.)[10].

4.3 Its interesting to note that although only one SDG target makes explicit reference to groundwater in its wording (Target 6.6), no less than 53 targets appear to be interlinked with groundwater, including – but not limited to – all targets related to SGDs 6, 12 and 13. In the majority of the cases, there is synergy between achieving the target and trends or aspirations regarding groundwater (‘reinforcing linkages’), but in some cases

[10] The United Nations World Water Development Report 2022, UNESCO

they are conflicting or of a mixed character (Guppy et al., 2018).

4.4 It would not be far-fetched therefore to say that, Groundwater is a key resource for achieving the goals of the 2030 Agenda, which implies that adequate groundwater expertise and local hydrogeological knowledge are required for its successful implementation (Velis et al., 2017; IAH, 2017). There is a strong case for defining additional ‘groundwater status indicators’ for several SDG 6 targets, because groundwater is integral to these, but not adequately dealt with so far (IAH, 2017).

4.5 In 2021, the annual water availability per person has decreased from 5200 cubic metres in 1951 to 1486 cubic metres. (Source: Central Water Commission).

2.2 Due to a cyclical pattern of dry and rainy spells brought on by changing weather patterns, India suffers from the "too much and too little water syndrome." India is now the top groundwater extractor in the world, accounting for 25% of the worldwide total. Over 70% of our water sources are contaminated, and our major rivers are dying as a result of pollution.

5. Water availability:

5.1 Water availability per person depends on a nation's population and the availability of water. In India, the country's per capita water availability is declining as a result of the rising population and decreasing water availability.

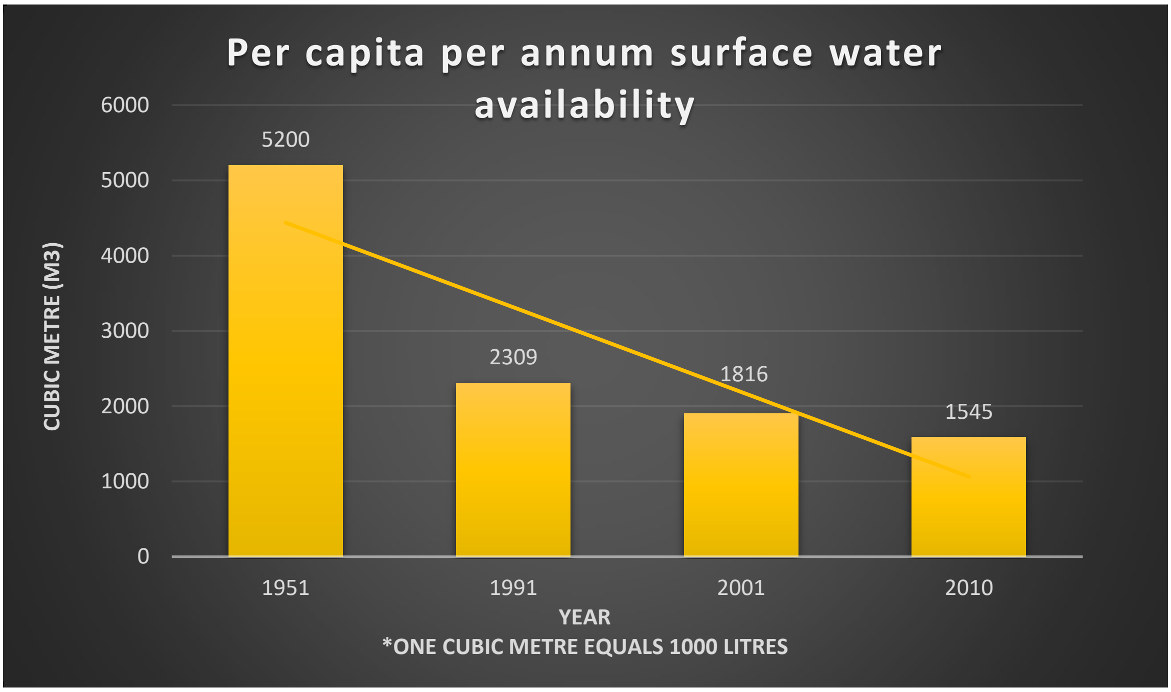
5.2 The average annual water availability per person was estimated to be 5200 cubic metres, 1816 cubic metres, and 1545 cubic metres from 1951 forward to 2001 and 2011, respectively. This amount may further decline to

1401 cubic metres and 1367 cubic metres in the years 2025 and 2031, respectively. It may decline as much as 1191 cubic metres by the year 2050. India now has water stress and is on the verge of experiencing water scarcity.

5.3 Water stress is defined as a per-capita water availability of less than 1,700 cum (cubic metre), while water scarcity is defined as a per-capita availability of fewer than 1,000 cum.

5.4 Figure I and II below explains the trend of present and expected per capita water availability in India. With increase in population the per capita per annum surface water availability has fallen from 5200 cm in 1951 to 1816 cm in 2001 to 1545 in 2010.

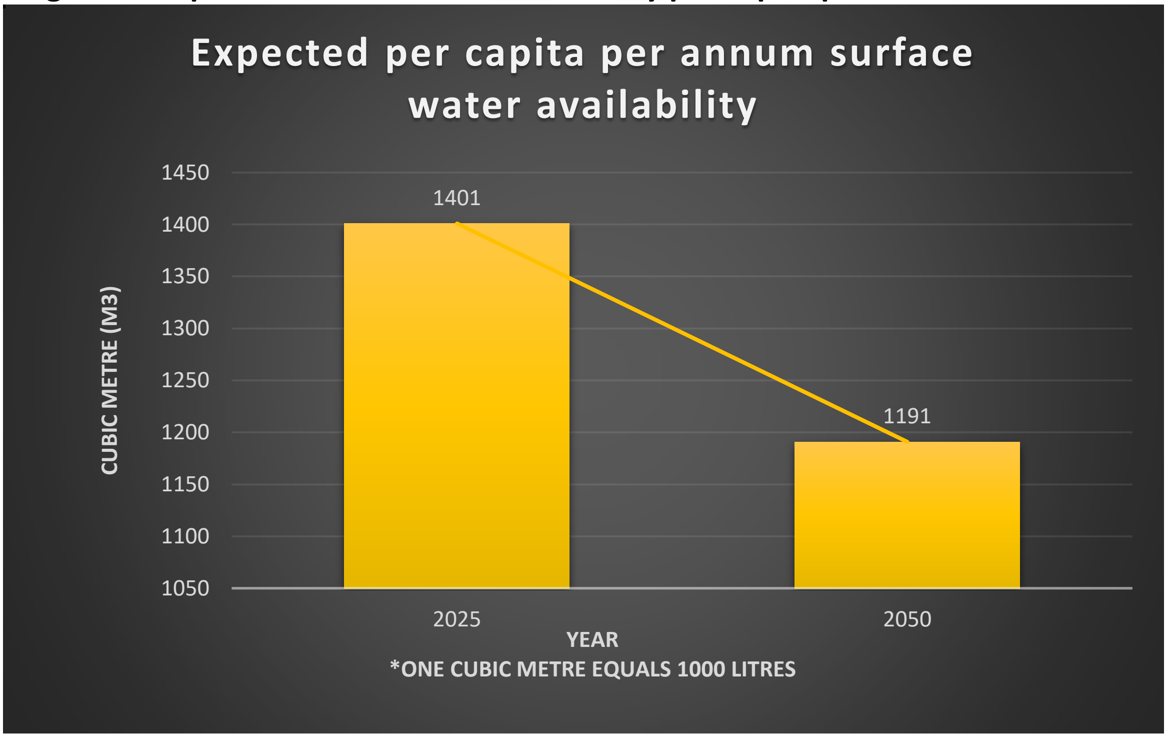
Figure-I: Per capita surface water availability throughout the year across India



Source: Central Water Commission Report 2020-21

5.5 Figure II provides an expected per capita per annum surface water availability in 2025 and 2050. The per capita availability of water has been estimated to be around 1401 cm and 1191 cm respectively. However, water requirement of the country, based on population projection of 1.33 billion and 1.58 billion for the years 2025 and 2050 respectively, as assessed by National Commission on Integrated Water Resources Development (NCIWRD-1999) constituted by Ministry of Water Resources is 843 BCM and 1180 BCM respectively.

Figure-II: Expected Surface water availability per capita per annum across India



Source: Niti Aayog, Central Water Management Index (CWMI) Report 2019

5.6 Evapotranspiration causes the loss of around 53.3 percent of all precipitation, leaving a surplus of 1869 BCM water in the nation. As a result of topographical limitations and an unequal distribution of water resources over time and location, around 40% of the potential is inaccessible. Thus, it is projected that the nation's total usable water potential is 1123 BCM, made up of 690 BCM of surface water and 433 BCM of groundwater.

5.7 The proportion of water utilized for irrigation out of all water consumption for the year 1997–1998 was 83.30%, according to the National Commission for Integrated Water Resources Development (NCIWRD) report.

Furthermore, according to the NCIWRD analysis, 72.48% of the water used for irrigation in 2025 in a scenario of high demand will be used overall.

5.8 The average yearly water resources of India's 20 river basins were estimated by a Central Water Commission study to be 1,999.20 billion cubic metres (BCM). Hydro-meteorological and geological variables affect a region's average yearly water availability. However, the population affects how much water is available per person. It calculated that the country's usable water is 1,126 BCM owing to geographical, hydrological, and other limitations.

5.9 The country's water consumption is anticipated to double by 2030, leading to serious water scarcity for hundreds of millions of people and a potential 6% decline in GDP. In contrast to the current availability of 695 BCM, the water needed by 2050 under a high usage scenario is projected to be a gentler 1,180 BCM, according to the study of the National Commission for Integrated Water Resource Development. At 1,137 BCM, the total amount of water that might potentially be available in the nation is still less than this anticipated demand. Therefore, there is a pressing need to increase our knowledge of our water supplies and consumption and implement measures to make it sustainable and efficient. (Source: WRI Aqueduct; WHO Global Health Observatory).

5.10 Long-term observation of water recharge in both the pre-monsoon and post-monsoon seasons demonstrates a lowering of the water table due to insufficient recharge, even though groundwater supplies a significant portion of the country's water needs (Sakthivadivel 2007). If this pattern holds, India may soon have a severe water shortage, particularly in the agricultural sector. While it is anticipated that per capita available water would either decline or remain unchanged, per capita water usage is anticipated to rise from 99 litres/a day (2009) to 167 litres/a day (2050). Also rising from 85 lpcd in 2000 to 125 lpcd and 170 lpcd in 2025 and 2050, respectively, is the average home water consumption. By 2025 and 2050, respectively, the total industrial water consumption is anticipated to rise to 92 BCM and 161 BCM.

6. Whose responsibility is water-related legislation?

6.1 Entry 17 under List II of Seventh Schedule provides that *"Water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of Entry 56 of List I".*

6.2 As such, the Central Government is conferred with powers to regulate and develop inter-State rivers under Entry 56 of List I of Seventh Schedule to the extent declared by the Parliament by law to be expedient in the public interest. It also has the power to make laws for the adjudication of any dispute relating to waters of Inter-State River or river valley under Article 262 of the Constitution. The individual State Governments are the ones that take the lead on initiatives for the improvement, conservation, and effective management of water resources. The Central Government offers technical and financial support to the State Governments through a variety of schemes and programs to augment their efforts.

6.3 In the present times, the government is making great efforts to guarantee that every part of the nation has access to clean drinking water and sanitary facilities. India was declared to be free of open defecation in 2019 thanks to the Swachh Bharat mission's efforts, which started in 2014. By 2024, Jal Jeewan Mission intends that every rural home in India would have access to clean and sufficient drinking water through individual household tap connections. According to the Ministry of Housing and Urban Affairs, the standard for urban water supply is 135 litres per capita per day (lpcd). Under the Jal Jeevan Mission, a minimum service delivery level of 55 lpcd for rural regions has been set, which states may raise to a higher level.

7. Different traditional ways of water conservation/harvesting[11]:

7.1 Only through sustainable methods of water conservation, water can be saved for present and future generations. Indian culture gives great reverence to Rivers, but still our country faces issues related to water. Since ancient times our ancestors knew the technique of water conservation and also refined the processes over time. They conserved water by collecting rainwater and flood waters and stored it for future use. In India we get to see different harvesting structures or methods based on climate, rainfall, geography of the area, soil, local availability of materials used for making these structures. Some of the popularly used structures are listed below according to geographical regions. Many of the structures can be seen in the regions, although not in their pristine avatar. Perhaps it shows the disappearance of such structures from not only the surface of the mainland but also from our memories!

1. Trans Himalayan Region:

Zings Are structures seen in Ladakh. These are small tanks that collect melted glacier water through channels

[11] https://www.thebetterindia.com/61757/traditional-water-conservation-systems-india/

Source: Google images

2. Western Himalaya:

a) **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.

The crucial portion of a *kul* is its head at the glacier, which is to be tapped. The head must be kept free of debris, and so the *kul* is lined with stones to prevent clogging and seepage. In the village, the *kul* leads to a circular tank from which the flow of water can be regulated. For example, when there is need to irrigate, water is let out of the tank in a trickle. Water from the *kul* is collected through the night and released into the exit channel in the morning. By evening, the tank is practically empty, and the exit is closed. This cycle is repeated daily. The *kul* system succeeds because Spiti residents mutually cooperate and share. The culture also is instrumental in maintaining the carrying capacity of the surrounding cultivable land. However, this system, carefully nurtured through the centuries, now runs the risk of being upset because of various reasons.

From glacier,

through kul,

to tank.

Due to limited water availability, inheritance laws in Spiti traditionally seek to prevent fragmentation of landholdings. The eldest son inherits not only the land, but also the farm implements, the family house and the family's water rights. His siblings either serve in the common household or, more likely, become monks or nuns in Buddhist monasteries. Thus, a sort of population control has been evolved, which serves to stave off pressure on the landholdings.

Water rights are owned exclusively by members of the *bada ghars* (big houses), who are descendants of the original settlers or founders of the village. This system, besides establishing the pre-eminence of the *bada ghars,* has also installed a local social hierarchy. The greater the share of a family's water rights, the more land it controls. In Kaza, for example, water rights over the single *kul,* irrigating 32 ha, are shared by 18 *bada ghars*. Other families in Kaza have to buy water from the *bada ghars*, and payment is generally made in kind or by providing free labour, but often the water is given freely. Water transactions are based on trust and are neither written down nor codified.

When a good snowfall assures abundant water, *kul* water is freely dispensed, but when water is scarce, equality gives way to a preferential system. During a water shortage, *bada ghar* members irrigate their fields first; others get water only later in the season. This practise has the advantage of ensuring that the demand for labour is spread over the entire harvest season because the *bada ghar's* crops ripen early, when other families are free to help in harvesting. This spacing of the need for labour does away with demand peaking at the same time throughout the valley, and provides a firm basis for community labour. These cooperative efforts also mean that time and effort do not become areas of conflict between those who require labour and those offering it.

Nevertheless, water distribution from *kuls* can create tension, for, when there is a water shortage, the *bada ghars* in effect are in a dominant position and suffer the least, unlike those with secondary access who have to await their turn, but are not certain if their share will be adequate.

b) **Naula**

Naula is a surface-water harvesting method typical to the hill areas of Uttaranchal. These are small wells or ponds in which water is collected by making a stone wall across a stream.

Source: Google images

c) **Khatri**

Khatris are structures, about 10x12 feet in size and six feet deep carved out in the hard rock mountain. These traditional water harvesting structures are seen in Hamirpur, Kangra and Mandi districts of Himachal Pradesh. There are two types of khatris: one for animals and washing purposes in which rainwater is collected from the roof through pipes, and the other used for human consumption in which rainwater is collected by seepage through rocks.

d) **Kuhl**

Kuhls are a traditional irrigation system in Himachal Pradesh- surface channels diverting water from natural flowing streams (khuds). The system consists of a temporary headwall (constructed usually with river boulders) across a khud (ravine) for storage and diversion of the flow through a canal to the fields. The kuhl was provided with moghas (kuchcha outlets) to draw out water and irrigate nearby terraced fields. The water would flow from field to field and surplus water, if any, would drain back to the khud. The kuhls were constructed and maintained by the village community.

3. Eastern Himalayas :

a) **Apatani**

This is a wet rice cultivation cum fish farming system. This system harvests both ground and surface water for irrigation. It is practiced by Apatani tribes of Ziro in the lower Subansiri district of Arunachal Pradesh. In Apatani system, valleys are terraced into plots separated by 0.6 meters high earthen dams supported by bamboo frames. All plots have inlet and outlet on opposite sides. The inlet of low-lying plot functions as an outlet of the high lying plot. Deeper channels connect the inlet point to the outlet point. The terraced plot can be flooded or drained off with water by opening and blocking the inlets and outlets as and when required. The stream water is tapped by constructing a wall of 2-4 m high and 1 m thick near forested hill slopes. This is conveyed to agricultural fields through a channel network.

4. North eastern Hill ranges:

a) **Zabo**

The zabo (the word means ‘impounding run-off’) system is practiced in

Nagaland in north-eastern India. Villages such as Kikruma, where zabos are found even today, are located on a high ridge. Though drinking water is a major problem, the area receives high rainfall. The rain falls on a patch of protected forest on the hilltop; as the water runs off along the slope, it passes through various terraces. The water is collected in pond-like structures in the middle terraces; below are cattle yards, and towards the foot of the hill are paddy fields, where the run-off ultimately meanders into.

b) **Cheo-ozihi**

Seen in village of Kwigema in Nagaland. The river water is brought down by a long channel. From this channel, many branch channels are taken off, and water is often diverted to the terraces through bamboo pipes. One of the channels is named Cheo-oziihi - oziihi means water and Cheo was the person responsible for the laying of this 8-10 km-long channel with its numerous branches.

c) **Bamboo Drip Irrigation** Meghalaya has an ingenious system of tapping stream and spring water by using bamboo pipes to irrigate plantations. This 200-year-old system is used by the tribal farmers of Khasi and Jaintia hills to drip-irrigate their black pepper cultivation. Bamboo pipes are used to divert perennial springs on the hilltops to the lower reaches by gravity. The channel sections, made of bamboo, divert and convey water to the plot site where it is distributed without leakage into branches, again made and laid out with different forms of bamboo pipes. Bamboos of varying diameters are used for laying the channels.

5. Brahmaputra valley:

a) **Dongs** are ponds constructed by the Bodo tribes of Assam to harvest water for irrigation. These ponds are individually owned with no community involvement.

b) **Dungs or Jampois** Dungs or Jampois are small irrigation channels linking rice fields to streams in the Jalpaiguri district of West Bengal.

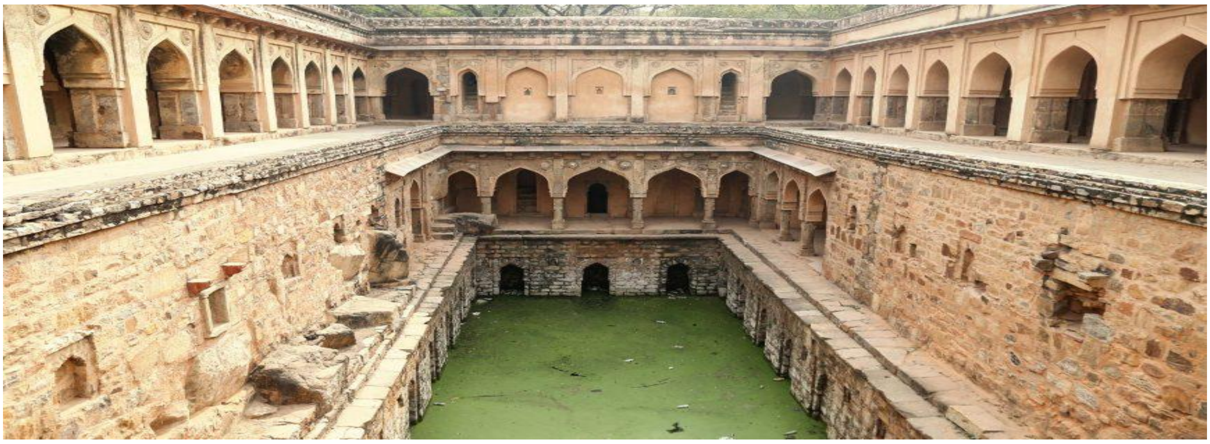
6. Indo- Gangetic plains :

a) **Ahar Pynes**: This traditional floodwater harvesting system is indigenous to south Bihar. In south Bihar, the terrain has a marked slope -- 1 m per km -- 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 artificial channels constructed to utilise river water in agricultural fields. Starting out from the river, pynes meander through fields to end up in an ahar.

b) **Bengal's inundation channel**: Bengal once had an extraordinary system of inundation canals. The canals were broad and shallow, carrying the crest waters of the river floods, rich in fine clay and free from coarse sand, the canals were long and continuous and fairly parallel to each other, and at the right distance from each other for purposes of irrigation; irrigation was performed by cuts in the banks of the canals, which were closed when the flood was over.

c) **Dighis**: Made by emperor Shahjahan. A dighi was a square or circular reservoir of about 0.38 m by 0.38 m with steps to enter. Each dighi had its own sluice gates.Steps to make the surface temperature map

d) **Baolis Baolis** were secular structures from which everyone could draw water. Gandak-ki-baoli (so named because its water has gandak or sulphur) was built during the reign of Sultan Iltutmish. The water of this beautiful rock-hewn baoli is still used for washing and bathing.



7. Thar Desert :

a) **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).

b) **Kuis / Beris** Found in western Rajasthan, these are 10-12 m deep pits dug near tanks to collect the seepage. Kuis can also be used to harvest rainwater in areas with meagre rainfall. The mouth of the pit is usually made very narrow. This prevents the collected water from evaporating. The pit gets wider as it burrows under the ground, so that water can seep in into a large surface area. The openings of these entirely kuchcha (earthen) structures are generally covered with planks of wood, or put under lock and key. The water is used sparingly, as a last resource in crisis situations.

c) **Baoris / Bers** Baoris or bers are community wells, found in Rajasthan, that are used mainly for drinking. Most of them are very old and were built by banjaras (mobile trading communities) for their drinking water needs. They can hold water for a long time because of almost negligible water evaporation.

e) **Nadis Jhalaras** were human-made tanks, found in Rajasthan and Gujarat, essentially meant for community use and for religious rites. Often rectangular in design, jhalaras have steps on three or four sides. Jhalars are ground water bodies which are built to ensure easy & regular supply of water to the surrounding areas .The jhalars are rectangular in shape with steps on three or even on all the four sides of the tank. The steps are built on a series of levels. d) Jhalaras Nadis are village ponds, found near Jodhpur in Rajasthan. They are used for storing waterfrom an adjoining natural catchment during the rainy season. The site was selected by the villagers based on an available natural catchments and its water yield potential. The location of the nadi had a strong bearing on its storage capacity due to the related catchment and runoff characteristics.

f) **Tobas**: Tobas is the local name given to a ground depression with a natural catchment area. A hard plot of land with low porosity, consisting of a depression and a natural catchment area was selected for the construction of tobas.

g) **Tankas**: Tankas (small tank) are underground tanks, found traditionally in most Bikaner houses. They are built in the main house or in the courtyard. They were circular holes made in the ground, lined with fine polished lime, in which rainwater was collected. Tankas were often beautifully decorated with tiles, which helped to keep the water cool. The water was used only for drinking. If in any year there was less than normal rainfall and the tankas did not get filled, water from nearby wells and tanks would be obtained to fill the household tankas. In this way, the people of Bikaner were able to meet their water requirements.

h) **Khadin**: A khadin, also called a dhora, is an ingenious construction designed to harvest surface runoff water for agriculture. Its main feature is a very long (100-300 m) earthen embankment built across the lower hill slopes lying below gravelly uplands.

i) **Vav / vavdi / Baoli / Bavadi**: Traditional step-wells are called vav or vavadi in Gujarat, or baolis or bavadisin 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.

Rani ki vav, Google image

j) **Paar system** Paar is a common water harvesting practice in the western Rajasthan region. It is a common place where the rainwater flows from the agar (catchment) and in the process percolates into the sandy soil. Kuis or beris are normally 5 metres (m) to 12 m deep. The structure was constructed through traditional masonary technology.

8. Central Highlands :

a) **Talab / Bandhis** Talabs are reservoirs. They may be natural, such as the ponds (pokhariyan) at Tikamgarh in the Bundelkhand region. A reservoir area of less than five bighas is called a talai; a medium sized lake is called a bandhi or talab; bigger lakes are called sagar or samand.

b) **SazaKuva** An open well with multiple owners (saza = partner), sazakuva is the most important source of irrigation in the Aravalli hills in Mewar, eastern Rajasthan. The soil dug out to make the well pit is used to construct a huge circular foundation or an elevated platform sloping away from the well.

c) **Johad** Johads are small earthen check dams that capture and conserve rainwater, improving percolation and groundwater recharge.

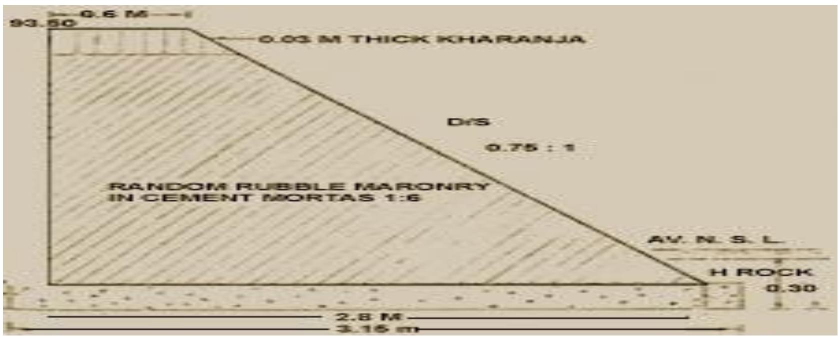
d) **Naada / Bandha:** Naada/bandha are found in the Mewar region of the Thar desert. It is a stone check dam, constructed across a stream or gully, to capture monsoon runoff on a stretch of land.

e) **Pat Bhitada village**, Jhabua district of Madhya Pradesh developed the unique pat system. This system was devised according to the peculiarities of the terrain to divert water from swift-flowing hill streams into irrigation channels called pats. The diversion bunds across the stream are made by piling up stones and then lining them with teak leaves and mud to make them leak proof.

f) **Chandela Tank** These tanks were constructed by stopping the flow of water in rivulets flowing between hills by erecting massive earthen embankments, having width of 60m or more. His earthen embankments were supported on both sides with walls of coarse stones, forming a series of stone steps. These tanks are made up of lime and mortar and this is the reason why these tanks survived even after thousand years but the only problem, which these tanks are facing, is siltation of tank beds.

g) **Bundela Tank** These tanks are bigger in size as compared to Chandela tanks. These tanks had solidly constructed steps leading to water in the tank.

h) **Rapat** A rapat is a percolation tank, with a bund to impound rainwater flowing through a watershed and a waste weir to dispose of the surplus flow.



Source:CRIDA

9. Eastern Highlands :

Katas / Mundas / Bandhas The katas, mundas andbandhas were the main irrigation sources in the ancient tribal kingdom of the Gonds (now in Orissa and Madhya Pradesh). A kata is constructed north to south, or east to west, of a village. A strong earthen embankment, curved at either end, is built across a drainage line to hold up an irregularly-shaped sheet of water.

10. Deccan Plateau:

a) **Cheruvu**: Cheruvu are found in Chitoor and Cuddapah districts in Andhra Pradesh. They are reservoirs to store runoff.

b) **Kohli Tanks:** The Kohlis, a small group of cultivators, built some 43,381 water tanks in the district of Bhandara, Maharashtra, some 250-300 years ago. It is still crucial for sugar and rice irrigation.

c) **Bhanadaras** These are check dams or diversion weirs built across rivers. A traditional system found in Maharashtra. Where a bandhara was built across a small stream, the water supply would usually last for a few months after the rains.

d) **Phad** The community-managed Phad irrigation system, prevalent in north-western Maharashtra, probably came into existence some 300-400 years ago. The system starts with a bandhara (check dam or diversion-weir) built across a rivers. From the bandharas branch out kalvas (canals) to carry water into the fields.

e) **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 (chech dams) built across streams, or by streams in valleys.

f) **The Ramtek model** It has been named after water harvesting structures in the town of Ramtek, Maharashtra. A scientific analysis revealed an intricate network of groundwater and surface waterbodies, intrinsically connected through surface and underground canals. A fully evolved system, this model harvested runoff through tanks, supported by high yielding wells and structures like baories, kundis, and waterholes. This system, intelligently designed to utlise every raindrop falling in the watershed area is disintegrating due to neglect and ignorance.

11. Western Ghats:

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.

12. Western Coastal plains :

Virdas Virdas are shallow wells dug in low depressions called jheels (tanks). They are found all over the Banni grasslands, a part of the Great Rann of Kutch in Gujarat. They are systems built by the nomadic Maldharis, who used to roam these grasslands.

13. Eastern ghats:

Korambus Korambu is a temporary dam stretching across the mouth of channels, made of brushwood, mud and grass. It is constructed by horizontally fixing a strong wooden beam touching either banks of the canal. A series of vertical wooden beams of appropriate height is erected with their lower ends resting firmly on the ground and the other ends tied to the horizontal beam. Closely knitted or matted coconut thatch is tied to this frame. A coat of mud is applied to the matted frame. A layer of grass is also applied carefully which prevents dissolution of the applied mud. Korambu is constructed to raise the water level in the canal and to divert the water into field channels.

14. Eastern coastal plains:

a) **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.

b) **Ooranis**: The tanks, in south Travancore, though numerous, were in most cases oornis containing just enough water to cultivate the few acres of land dependent on them. The irregular topography of the region and the absence of large open spaces facilitated the construction of only small tanks unlike large ones seen in Tamil Nadu.

15. The Islands:

Jackwells The shompentribals here made full use of the topography to harvest water. In lower parts of the undulating terrain, bunds were made using logs of hard bullet wood, and water would collect in the pits so formed. They make extensive use of split bamboos in their water harvesting systems. A full length of bamboo is cut longitudinally and placed along a gentle slope with the lower end leading into a shallow pit. These serve as conduits for rainwater which is collected drop by drop in pits called

Jackwells.

8. Reasons for decline of Traditional water systems:

There is no denying the fact that traditional forms of water harvesting systems have declined over a period of time for various reasons. But the positive thing emerging from the hinterlands of India are the renewed efforts by locals, villagers, civil societies and academicians with or without the support of Governments to resuscitate dying water bodies or bringing back traditional forms of water harvesting systems. It's imperative to understand why such invaluable traditional knowledge faded into oblivion only to be resurrected now with great efforts. Some of the concurrent reasons attributed by scholars are,

i. Neglect of policy makers towards traditional existing structures, lack of innovative methods to deal with water related issues[12]

ii. Growing use of subsidised energized system (subsisidised electrical powers) to exploit deep aquifers

[12] https://terrepolicycentre.com/journal/traditional-methods-of-water-conservation.pdf

iii. Lack of interest on community in participation in preservation of traditional structures

iv. Some tanks have been encroached for farming, sand mining, expansion of city, waste dumping, industry etc

v. Pollution of water due to sewage and industrial waste

9. Role of colonial rule:

9.1 It is a raging debate whether it was the British rule which expedited the decline of the traditional knowledge and practice of water harvesting methods.

9.2 It's a common refrain that the British policies related to centralization and optimizing revenue collection had a decisive role in the demise of the water harvesting systems. The village-based water management systems inflicted a deathly blow by the emergence of state-controlled bureaucracies and increasing land revenue. The land revenue was extracted to an extent that in drought years it frequently meant handing over the entire crop in the form of taxes.[13]

9.3 The impoverished village communities could no longer raise enough internal resources to manage their irrigation structures and thus agriculture and incomes declined to a point that undivided India became a nation chronically affected by famines and destitution. Much of the current crisis of water in the region goes back to these times when traditional systems were substituted for reasons of economic exploitation and the vital link of living in harmony with the environment was snapped. Additionally, lack of holistic

[13] Agarwal, A. and Narain, S. (1997). Dying Wisdom. State of India‟s Environment: A citizen‟s Report. 4. New Delhi. Centre for Science and Environment.

approach to water management due to the compartmentalized administrative structure also exacerbated the decline of traditional knowledge of water conservation.

9.4 The issue has been analyzed in several scholarly reports and research papers. In some it has been argued that the concept of rainwater harvesting was absent in British natural resources policy, mainly because of the drastic difference in the weather conditions of the nations. While India receives most of the rainfall during two months of monsoon, Britain has a temperate rainfall pattern which is equally distributed across the year. The British authority, therefore, could afford to treat water "as given, to be used at will" (Vani 2009).

9.5 Harvesting of water was, therefore, not a requirement in Britain. Due to the harsh cold climatic conditions use of water excessively other than in agriculture was unheard of. Reportedly, the main purpose of water was to for agriculture (Harvey).

9.6 It is not difficult to conclude that in view of the above the British colonizers in India continued to treat water as a prime resource for agriculture only, which can be used to raise revenue at will. Incidentally, traditional water harvesting structures which had multiple uses were de-legitimized and categorized as minor irrigation systems.

9.7 [14]On the reasons for decline of traditional water harvesting systems, the work by Sengupta (1980) and Rosin (1993) are noteworthy. Rosin argued that the local people of western Rajasthan perceived harvesting of rainwater

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[14] Decline of traditional water harvesting systems during British India: Exploring the issues of „knowledge incompatibility‟, „breaking down of commons‟ and „free ridership‟ Saradindu Bhaduri∗ , Anushree Singh∗∗ Center for Studies in Science Policy JNU, New Delhi

through groundwater recharge and established a direct relationship between their surface water storage facilities and quality and supply of soil and groundwater. Furthermore, Rosin discussed that removing accumulated silts in turn improved the permeability of the bed to increase infiltration rates for soaking and recharge according to local understanding. But the British hydrologic engineers‟ viewed high groundwater levels as threat to kinds of irrigation systems they built. They were not in favour of removing silt from the bed of the dam either because soakage through dam bed or through walls of canal may contribute to water logging and high loss of surface water diverted from irrigation.

9.8 [15]Sengupta‟s (1980) work informs that the British changed the existing community organisational structure in South Bihar. There existed interdependency of land and water during pre-British period which was disrupted in the British period after the introduction of land rights in the country. The ahar-pyne system of irrigation practiced in south Bihar decayed primarily because of shift from produce rent system to fixed rent system after the introduction of Tenancy Act (1885), which came into force in Bihar in 1904.

9.9 Before the British rule, the irrigation system was maintained by the local people and patronised by the zamindars. Sengupta (1980: 73) points out that "once the rents were fixed, and the zamindars had nothing to lose by decline in irrigation, they stopped taking care of those works. In addition, in order to increase their income, they sought another course of action by using irrigation works as the level of control."

9.10 It is imperative to note that with time and situation as

[15] do

aforementioned, the zamindars became less interested in maintenance of these structures which led to the decline of ahar-pyne system. Thus, to summarise, while Sengupta (1980) emphasises on how the British rule disrupted the social organisation of such systems, Rosin (1993) focuses on the incomplete understanding of local ecological characteristics by the British.

9.12 Further, it's important to understand the concept of property and property rights in pre-British and British Indian periods. In pre British period, in India property did not reflect ownership rather shared rights on land existed. Although the zamindars or the ruler could sell or lease the land but could not sell various other rights people had on that same piece of land. In the words of Embree (pp. 46)

> *"one might have absolute rights of a certain kind in a piece of land, but others might also have rights of another kind, equally absolute, in it. Alienation of these rights was possible, but not alienation of the land itself in a way that excluded the exercise of the rights enjoyed by others."*

9.13 The idea of claims of interests was apparently in operation. Layers of rights existed on common lands which protected interests of people of the community. As a result, there emerged a variety of land rights, where rights of various kinds were superimposed on each other (Hasan 1969).

9.14 The exercise of rights came with a set of duties for management of land in the pre Mughal and Mughal periods. D‟Souza (2004) argues that the Mughals absorbed the existing infrastructure of the previous regime giving a sense of continuity of the legal framework on land rights through the Mughal period. This showed a strong community ownership of common property.

9.15 Embree (1969) mentions J. H. Nelson in his writings that "ordinary people had no idea of meum [mine] and tuum [yours] and spoke always of ours" not "mine". A thing of value was regarded as being part of an aggregate, rather than belonging to a single person".

9.16 In pre-British India, the questions relating to property were dealt with in caste panchayats or some other form of group organization which was regional and local. The law courts that British inherited in Bengal had one of their functions of settling disputes between landlords and tenants but it did not survive for very long. New concepts and definitions of property gave rise to different kinds of problems, and the new courts were required to solve such property related problems (Embree 1969).

9.17 The British colonizers dismantled the complex yet delicate network of rights to create a clear demarcation of property rights placing land either in individual hands or in the hands of the State. To simplify the system they also took measure which separated the rights on land from rights on water, and made laws to incorporate almost all water bodies under the ownership of the state.

9.18 Arguably, the most adverse impact on the concept of RWH was this separation of land, forest and water resources under different legal and administrative systems. The preamble to the Limitation Acts (1859-71), the Northern India Canal and Drainage Act 1873, the Bengal Irrigation Act, 1876 and the Specific Relief Act, I (1877) reflected that the Provincial Government was entitled to use and control for public purposes the water of all rivers and streams flowing in natural channels and other natural collections of still water. These Acts do not mention about varied patterns of rights on these water bodies that existed in pre-British India, and instead, bestowed the State the exclusive authority to use and control water (Vani 2009). As Vani succinctly puts it:

> *"The colonial period of history abruptly suspended the practice of rainwater harvesting and the modes of governance that enabled it. They were supplanted by an alien „scientific‟ perspective, environmental philosophy, political economy and governance systems" (Vani 2009:169).*

9.19 A separate department of irrigation was formed by the State, creating a centralized government-driven system for maintaining varied water structures in India: tanks, tankas, kunds, baolis, wells, canals and large dams. This department had fixed procedures for maintaining the structures which did not always match the conventional diverse procedures for maintenance and use of the system by villagers (Jacob 2008).

9.20 Thus the basic difference in Indian and British approach was shared responsibility as against individual rights. Thus, the difference in the British and the Indian concept of property rested on historical differences on concept of individual rights. Moreover, Indian system of property rights were often based on shared understanding at a local level. It did not give the absolute supremacy to either the individual or the state as owners of property, rather portrayed complex social relations and responsibilities, facilitated by the State but not to be controlled by the State.

9.21 The British laws brought water bodies under state control which was a death knell to the traditional knowledge. Further alterations in the water bodies were intended only for agriculture which employed, “engineers‟, “labours‟ and “machinery‟-deviating from the earlier practice of employing local people in construction and repair of water harvesting facilities. Thus, use of local knowledge became prohibitively difficult under this new regime of ownership.

9.22 In other words, the layers of rights which existed on common lands among the local people broke down. Since, rights were strongly linked with “duty‟ and “obligation‟ in the Indian legal discourse, a removal of rights got translated in to removal of obligation and duties. The knowledge of rainwater harvesting which existed in the community was shared knowledge which people had and rights existing among the individuals for the common land protected the interests of people.

9.23 Hence it can be concluded that there existed since ancient times a sense of strong community bonding and the subsequent denial of access to commons destroyed community itself as Gudeman and Rivera (2001: 360) argues. They stated that

> *“taking away the commons destroys community, and destroying a complex of relationships demolishes a commons. Likewise, denying others access to the commons denies community with them, which is exactly what the assertion of private property right does.”*

10. Revival of traditional knowledge-Success stories:

10.1 Water Gandhi[16]:

i. Ayyappa Masagi’s popularly referred to as Water Magician, Water

[16] https://www.thebetterindia.com/48298/ayyappa-masagi-water-warrior-conservation-rainwater-harvesting-water-gandhi-water-literacy-foundation/

Gandhi, and Water Doctor firmly believes that soon India can manage its water resources well and be a water-efficient country. Ayyappa Masagi has successfully implemented water conservation projects across states, industries, farms, and homes. He has also recharged more borewells and constructed more lakes than probably anyone else in the country.

ii. An engineer by training who left L & T to work in the field towards his passion. And it is his experiences with agriculture that made him study water in his later years.

"In my childhood we faced plenty of water problems. I used to wake up with my mother at 3 am to go and fetch water. This used to happen so often that I took an oath to try and conserve water every day. In fact, throughout my growing years, I thought of ways to conserve water," he says.

iii. In a brilliant article, India's Water Warrior has a Solution for India's Droughts. The Best Part – We Can Play a Role Too! by Meryl Garcia, his tryst with hardships in pursuit of his dreams are conveyed in his own words.

"In this dry region, I planted crops like rubber and coffee. I wanted to prove that one could grow these crops with whatever rain one gets. Though I was successful in the first two years my crops soon dried up due to a severe drought. The year after that, they were destroyed by floods. Though people mocked me at that point, I didn't take it to heart. I was determined to find a solution," he says.

iv. In 2004, Ayyappa received the Ashoka Fellowship for his conservation efforts.

v. A year later, he established the Water Literacy Foundation, in a bid to reach out to more people and spread the message of conservation.

vi. The article notes that Ayyappa has orchestrated thousands of conservation projects across 11 states. He has also created over 600 lakes in the country, for which he found mention in the Limca Book of Records.

vii. His years of passion associated with water conservation is translated in the following simple understandable language. He considers the earth to be the biggest filter. He captures the water, filters it and then stores it underground. His pit-based rainwater harvesting system is a structure made of boulders, gravel, sand, and mud. When it rains, water trickles through the gravel and sand. It slowly charges the subsoil. This process continues and ensures the soil is always charged with water. This method also prevents water from evaporating.

10.2 Rainwater recharges borewells[17]:

i. Citizens in Pune city facing acute water shortage due to depleting groundwater levels, acute water scarcity and inadequate and erratic municipal supply came together to catch and store rainwater to meet their water needs. Many residential complexes in the area were dependent on water tankers that supplied poor quality water and put a considerable economic burden on people. This is when the citizens decided to do something about it and decided to use rainwater to recharge borewells and raise the water table. The mechanisms for catching, storing and diverting rainwater to recharge borewells were planned depending on the location of the complexes.

ii. Citizens from the residential complexes came together and determined not to waste a single drop of rainwater, made it a reality despite going through several obstacles. The successful

[17] https://www.indiawaterportal.org/articles/stories-change-becoming-water-abundant-harvesting-rainwater

implementation of the model to conserve water, has inspired over 60 other complexes to take up the effort. Moreover, an NGO, Mission Groundwater, has also been started to spread this movement further.

10.3 School shows the way:

i. Bishop Cotton School in Shimla has emerged as an example worth emulating, especially for residential schools in the hills that have high water demand but low supply. The school, which was established in 1859, started experiencing water shortages due to stressed water supply in the region and rising strength of students. Initially, the school managed by hiring water tankers. However, a permanent solution was essential. This is when Mathew Jacob, the estate supervisor at the school thought of undertaking rainwater harvesting.

ii. In 1992, the school implemented rooftop rainwater harvesting and the quantity of water available started to gradually increase. The school can now compensate the inadequate supply of municipal water and dependence on water tankers during the lean months as around 3 lakh litres of rainwater is harvested. In April 2006, the school also set an example by filling its swimming pool with around two lakh litres of water by diverting rainwater flowing out through the open drains to the pool downhill without any expense.

10.4 Service-Learning Program (SLP):

i. Service Learning Program (SLP) initiated in 2014, is a parent-led, student driven and teacher supported program that enables students to gain real life experiences on how to overcome problems efficiently while learning how to treat others with love, respect, compassion and empathy. Also, the program gives students opportunities to work hard to empower the communities around. SLP team in recent times undertook the project known as "Be wise, water wise", where they aimed to restore and provide efficient water supply to Kadusonapanahalli, a village about 2 km away from our school.

ii. While improving and helping fellow society members, they spread out the word and raised awareness of water saving projects through parents and sports meets. They also installed an Aquaponics system, a modern method of farming, which uses only 90 percent of water, in the school.

10.5 The efforts of the Baigas[18]:

i. Nested amongst the Satprura hills lies Kapoti, a village in the Dindori district of Madhya Pradesh. This region is known as Baiga Chak and is inhabited by Baigas, a vulnerable tribal group. Following a simple lifestyle, Baigas have been a self-provisioning, self-determining and nearly self-sufficient community residing in the resource rich highland forest regions in small hamlets for generations.

[18] https://www.indiawaterportal.org/articles/bringing-springs-life-ensuring-water-security-baigas-madhya-pradesh

ii. The dense forest, its flora and fauna and water are the main sources of sustenance for this community. Rice and millets form their staple diet and they supplement it with seeds, grains, roots, leaves and fruits of numerous wild plants, which abound in the forest.

iii. Things have however, changed in the past few decades. The village elders recall the time when streams flowing in the forests were full of water for most part of the year. Springs, which are a major source of drinking water used to yield freshwater all through the year.

iv. Anthropogenic pressures resulting in loss of forest cover coupled with changes in the micro-climate of the region has impacted the availability of water. Declining water tables and degradation of the catchment have made people vulnerable. The impact of water scarcity has manifested in girls and women spending hours to fetch drinking water, often walking miles to reach the source.

v. In 2017, when WaterAid India began work across 52 villages including Kapoti in 3 blocks of Dindori district in Madhya Pradesh, their approach was to revitalise the springs ensuring year-round availability of drinking water for the Baigas.

vi. Engaging communities in each and every activity was fundamental to their aim of ensuring water security. They constructed a spring chamber - a square-shaped mini pond like structure at the source of the spring to ensure its protection. A pipeline bought water from this chamber to the filter tank. This system works on the simple principle of gravity. Water from this spring chamber is directed into a three-chambered distribution tank where it is filtered using the slow sand filtration technique. Finally, the filtered water is stored in a tank having a capacity of 9,600 liters from where it supplied to individual stand posts placed in front of every household in the village.

vii. The 'Managing Aquifer Recharge and Sustaining Groundwater Use through Village-level Intervention' (MARVI) project is being undertaken since February 2012 with the overall aim to improve the security of irrigation water supplies and enhance livelihood opportunities for rural communities in India.

viii. **MARVI – An innovative approach for village level groundwater management**. The MARVI project is focused on developing a village level participatory approach, models and tools to assist in improving groundwater supplies and reducing its demand through the direct involvement of farmers and other affected stakeholders. A unique feature of MARVI is the use of scientific measurements by citizens through the engagement of Bhujal Jankaars , a Hindi word meaning 'groundwater informed' volunteers.

11. The classic case of Delhi:

11.1 Delhi is dependent on other States for its water[19]. 780 out of 900 million gallons supplied everyday is sourced from other states. Delhi's primary source of water is the Yamuna, which travels through water-scarce Haryana before reaching the city. Out of the 900 million gallons of water that the Delhi Jal Board distributes every day, 540 million gallons come from Haryana. Any trouble in the neighbouring state can, and does, spell trouble for Delhi's water supply. The Yamuna, which is barely even a river in Delhi anymore, also feeds and raises the water table in east Delhi.

[19] https://www.sahapedia.org/traditional-water-systems-of-delhi

11.2 The Upper Ganga Canal is the second most important source of water supplying close to 240 million gallons daily. Delhi's own water resources contribute a paltry 120 million gallons. And they come from natural water bodies, underground water and recycled water.

11.3 But historically Delhi had created a name for itself in not only water self-sufficiency but also in unique water harvesting ways. Delhi had some 800 waterbodies, natural and man-made, according to the Indian National Trust for Art and Cultural Heritage. Many still survive but are not recognizable as waterbodies anymore; some are just little puddles while many others are covered with muck and water hyacinth. The city can be broadly divided into the Yamuna floodplains that is mostly sandy and alluvial, and the rocky landscape of the Aravalli Hills. Each had its own take on how to manage water.

11.4 Not only inside the city, but along the trade routes also the roads were replete with water sources, mostly man made. Wells and their sister structures, baolis, formed the centrepiece of oases built by merchants or rulers along trade routes. Called sarais, each was built around a water source for caravans. Some were wells, others were the more spectacular baolis, or stepwells. Several still survive, such as Agrasen ki Baoli in Connaught Place, Gandak ki Baoli in Mehrauli, the baolis of Tughlaqabad Fort, Firozshah Kotla, and something that looks like a baoli in Sanjay Van that probably belonged to Lal Kot, the city of the Anangpal Rajputs.

11.5 Some important historic water sources included a large network of streams which have been reduced to sewage channels now. The most prominent is the Sahibi River, a seasonal stream that rises in the Sirmaur Hills in Rajasthan, flows through Haryana and Delhi before joining the

Yamuna shortly after it enters the city. It used to carry only rainwater, from Haryana to Delhi, in season but now is a sewage canal called the Najafgarh drain, and the biggest source of polluted water in the Yamuna River.

11.6 Another important water harvesting structures were the baolis. The best-preserved baoli is probably Agrasen ki Baoli, built by the eponymous Agrasen who is said to be the founder of the Agrawal clan. The other baolis that are still recognisable are the Gandak Baoli and Rajon ka Baoli in Mehrauli, a small one in the Old Fort and a round one in Ferozshah Kotla.

11.7 Delhi has a lot of ponds, mostly artificial and some natural. The Indian National Trust for Art and Cultural Heritage estimates there are about 700 big and small waterbodies, of which just a few are artificial. Some date back to the Tomar Rajputs who ruled the city from AD 736–1192. The largest surviving one is the Anangpur dam in Faridabad that formed the Badhkal lake. This was made by Anangpal, also of the Tomar dynasty. Nearby there is Suraj Kund. This ancient structure has been rendered infructuous by rampant construction nearby.

12. Conclusion:

12.1 The subcontinent has been mining groundwater which may be as much as 7000 years old. Groundwater subsurface storage dams are small-scale options to conserve and efficiently tap it. Traditional water harvesting systems have passed the test of time and are suited to economic environments but a mere replication of the past may be counterproductive.

12.2 There is an urgent need to review the region's irrigation policies as they have been practiced over the last five decades. It is essential to rehabilitate the traditional systems that already exist. This activity should become part of employment guarantee programmes and other schemes of land and water improvement.

12.3 It may be an opportune time for India to leverage the tenets of LiFE and the G 0 presidency to energize efforts towards this end of water conservation for reversing ill effects of climate change. The tents of LiFE as we shall see are a leitmotif in every major policy goals in recent times.

12.4 In a compendium released in this regard, namely, 'Prayaas Se Prabhaav Tak – From Mindless Consumption to Mindful Utilization' the following traditional best practices from India that form the pivots of LiFE were highlighted,

i. **Responsible Consumption** by taking only as much as is needed, using products to the end of their lives, and repurposing or recycling whatever is left over.

ii. **Circular Economy** to improve resource efficiency, minimize waste and emissions to reduce the carbon footprint and improve ecological handprint.

iii. **Living in Harmony with Nature** by practising the philosophy of *'Vasudhaiv Kutumbkam'* (the World in One Family) and living a life with compassion for all living beings.

iv. **Sustainable Resource Management** through mindful and deliberate utilisation of the available resources and to reduce overconsumption and promote equitable access to resources.

v. **Coexistence and Cooperation** among countries and communities through the promotion of science and innovation, knowledge exchange, dissemination of best practices, and conservation of traditional knowledge systems.

12.4 It's therefore seen that LiFE is a framework to guide governments, institutions, and societies to move towards optimal and efficient utilization of resources. LiFE stands for Learning's, Infrastructure, Facilitators and Enabling conditions for Mindful utilizations.

12.5 At this juncture it is imperative to convert this idea into a mass movement/Jan Andolan by integrating behavioural economics into policies towards its implementation. LiFE requires a nudging approach to include individual and collective actions towards the protection and preservation of the environment and in not only resuscitating water bodies but also creating new ones for the future generations by catching the rain when it falls, where it falls.

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