JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Various Conventional Water Recharging Systems and Conservation Structures

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ABSTRACT :-

Civilizations in the Indus Valley were far more advanced than we may think nowadays. In many of the ancient cities that still remain, we can still find huge vats that were cut into the rock to collect water when there was torrential rainfall. These were used to keep the population and local vegetation going in hotter, dryer times and were fed by numerous stone gullies that weaved their way through the city. Some of these rock vats are still used today in parts of India.

During the time of the Roman Empire, rainwater collection became something of an art and science, with many new cities incorporating state of the art technology for the time. The Romans were masters at these new developments and great progress was made right up until the 6th Century AD and the rule of Emperor Caesar.

KEYWORDS :- Rain water harvesting, water conservation structures, civilization in Indus valley, Art and science, etc.

INTRODUCTION :-

---- History of Rainwater Harvesting.

Civilizations in the Indus Valley were far more advanced than we may think nowadays. In many of the ancient cities that still remain, we can still find huge vats that were cut into the rock to collect water when there was torrential rainfall. These were used to keep the population and local vegetation going in hotter, dryer times and were fed by numerous stone gullies that weaved their way through the city. Some of these rock vats are still used today in parts of India.

---- Contemporary Practices adopted to harvest rainwater in India.

[A] Check dams:- A check dam is generally constructed on small streams and long gullies formed by the erosive activity of water. The ideally a check dam is located in a narrow stream with high banks. A check dam serves many purposes. 1, It cuts off the runoff velocity and reduces erosive activity. 2, The water stored improves soil moisture of the adjoining areas and allows percolation to recharge the aquifers.

While constructing a series of check dams on along stream course, the spacing between two check dams should be beyond their water spread. The height of the check dam should such that even during the highest flood, water does not spill over the banks.

[B] Percolation ponds :- A percolation pond, like an irrigation tank, has a structure to impound rainwater flowing through a watershed, and a waste weir to dispose of the surplus flow in excess of the storage capacity of the lake created. The section of the bund is similar to that of an irrigation tank, except that the cut-off trench is taken to a depth equal to half the height of the bund. The purpose of the cut-off in the case of the percolation tank is just to prevent erosion of the downstream slope of the bund due to piping. The cut-off should be shallow enough to permit the percolating water to pass downstream into the aquifer. The percolation tank bund has a hearting and a casing, and is provided with stone pitching on the upstream face and turfing on the downstream slope. A masonry waste weir is also necessary to pass surplus water. Drains are provided under the bund to lead water percolating into the bund safely downstream. The storage capacity of percolation pond is around 30 to 60 million liters. The percolation tanks of Maharashtra have, on an average, a larger storage capacity than the rapats of Rajasthan.

[C] Geographical Information System:- Remote sensing coupled with the use of Geographical Information Systems [GIS] can be used to identify runoff potential zones and location of suitable sites for water harvesting. They can also be used to identify sites in watersheds that have not been gauged, and where, due to very steep slopes, the runoff drains out fast. This system was used to identify 18 suitable sites for rainwater harvesting structures in the watershed of the Song river at Bandal, Uttaranchal.

The methodology consisted of preparing various resource maps such as land use/land cover by using IRS-1C, LISS data by digital image processing techniques, coupled with ground truth data. Digital elevation model, slope map, aspect map, classified map, soil map, drainage

and buffer maps for village and agriculture areas were created in a GIS environment. Input parameters deduced from the basic thematic maps were then integrated with field data to generate runoff potential zoning. This model uses rainfall data, temperature data, soils, land use and rooting depth of different types of vegetation for calculating the soil moisture deficit, soil moisture surplus, evapo-transportation, surface runoff and other parameters.

[D] Rain Water Harvesting [RWH] :- Rain water harvesting is simply the capturing and storing the rain water, when and where it falls, by different methods for infiltration and percolation into underground to augment the ground water reservoir. RWH is the only long term solution to chronic water shortage in urban area. In urban area, recharge of ground water through storm runoff and roof top water collection, and the diversion and collection of runoff into dry tanks from playgrounds, pavement, parks and other vacant places can be implemented. Several methods of RWH for artificial recharge are in vogue, the selection being dictated by local hydrogeological and soil conditions [Todd, 1980].

[E] Rejuvenation of Ponds and Lakes:- During the past years there is a realization that these ponds/lakes have to be restored with a view to making them reliable source of fresh water all through the year. With increased urban activities and population, the need of potable water has diversified as well as gone up. The lakes help recharge groundwater, support livelihood by way of fishing and grazing and quench the thirst of the bovine population simply by harvesting rainwater, ensuring its storages and making the overflow seep into ground the best insurance against water scarcity and water logging[Gowda and Sridhara, 2013].

[F] Water Recycle/Reuse of Sewage Water :- All water based activities in urban do not always require good quality water. Some activities may be performed with 'grey water' [re-used/recycled water]. It is important to identify opportunities for the collection and reuse of gray water [domestic, industrial, waste water, except from the toilet] wherever possible. Possible uses for grey water include toilet flushing, washing cars and patio, watering plants, etc. Some techniques are described below.

1, Omini Water Treatment Plant :- Omini Water Treatment Plant may be a alternative technology for drinking water crisis in countries like India. In this process 86,000 liter drinkable water can be obtained from the sewer of 1,00,000 people. Electricity can produced in this plant as a by-product. In Omini Water Treatment Plant the squalor send to drier by machine through conveyer belt to separate it from water in high temperature. The water of sewage [excreta] evaporated and send to cooling tube through pipe. Here squalor becomes dry. The vapor of second face moves in cleaning system pipe till getting the clean water [Hari Bhoomi, 2015].

2, Intermediate Technology [Reed bed Channel System]:- In almost all cities and towns of India, waste water flowing through long open drains that is either redirected for use in agricultural field or collected in ponds [meant to store storm water run-off] for later use, is common. By converting these terminal [trunk] drains into gravel media beds supporting commonly found

Indian wetland plants such as Phragmites carca and Typha latifolia, surface flow reed bed channels for treatment can be developed. During lean flow periods of the day, the beds will function as sub-surface flow reed beds. A detritus tank pretreatment preceded by storm water overflow structure to bypass the flow in excess of twice the peak dry weather flow are the other requirements.

[G] Interlinking of Rivers in India:-

The interlinking of rivers has two components, the Himalayan component and a Peninsular one. All interlinking schemes are aimed at transferring of water from one river system to another or by lifting across natural basins. The project will build 30 links and some 3000 storages to connect 37 Himalayan and Peninsular rivers to form a gigantic South Asian water grid. The canals planned to be 50 to 100 meters wide and more than 6 meters deep, would facilitate navigation. The estimates of key projects variables-still in the nature of back –of-the-envelope calculations-suggest it will cost around 5,60,000 crores Indian rupees, at 2002 prices, handle 178 km of inter-basin water transfer/per year, build 12,500 km of canals, create 35 giga watt of hydropower capacity, add 35 million hectares to India's irrigated areas, and create an unknown volume of navigation and fishery benefits.

CALCULATING ANNUAL RAINWATER HARVESTING POTENTIAL [ARHP]

ARHP = R X Rf X A, where ARHP = Annual Rainwater Harvesting Potential [in cubic meters]

R = Annual rainfall [in mts.]

Rf = Run-off Co-efficient [% age]

A = Area [in sq. mts.]

The Run-off Co-efficient [Rf] is taken as.

--- For Roof Catchments :- Tiles = 0.8 - 0.9, Corrugated Metal Sheet = 0.7 – 0.9

--- For Ground Surface Covering :- Concrete = 0.6 – 0.8, Plastic Sheeting [Gravel covered] = 0.7 – 0.8, Butyl rubber = 0.8 – 0.9, Brick pavement = 0.5 – 0.6.

---- For Treated Ground Catchments :- Compacted and Smoothened soil = 0.3 – 0.5, Clay/cow-dung threshing floors = 0.5 – 0.6, Silicone treated soil = 0.5 – 0.8.

---- For Untreated Ground Catchments :- Soil on slope less than 10% = 0.0 – 0.3, Rocky = 0.2 – 0.5.

[The above averages are taken for the sake of simplicity. An intense rainfall generates more run-off than a light but prolonged rain. Also the slope, surface hardness and lack of vegetation cover of the catchment contribute to increased run-off. An increase in slope and hardness of the hard catchment area will yield greater run-off].

----Various traditional water recharging systems and conservation structures.

1, 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. The tanka system is also to be found in the pilgrim town of Dwarka where it has been in existence for centuries. It continues to be used in residential areas, temples, dharamshalas and hotels.

2, Khadin – A khadin, also called a dhora, is an ingenious construction designed to harvest surface run-off 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. Sluices and spillways allow excess water to drain off. The khadin system is based on the principle of harvesting rainwater on farmland ad subsequent use of this water-saturated land for crop production.

First designed by the Paliwal Brahmins of Jaisalmer, western Rajasthan in the 15^{th} century, this system has great similarity with the irrigation methods of the people of Ur [present Iraq] around 4500 BC and later of the Nabateans in the Middle East. A similar system is also reported to have been practiced 4,000 years ago in the Negev desert, and in southwestern Colorado 500 years ago.

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

Stepwell locations often suggested the way in which they would be used. When a stepwell was located within or at the edge of a village, it was mainly used for utilitarian purposes and as a cool place for social gatherings. When stepwells were located outside the village, on trade routes, they were often frequented as resting places. Many important stepwells are located on the major military and trade routes from Patan in the north to the sea coast of Saurashtra. When stepwells were used exclusively for irrigation, a sluice was constructed at the rim to receive the lifted water and lead it to a trough or pound, from where it ran through a drainage system and was channeled into the fields.

4, 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 --- fro 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 utilize river water in agricultural fields. Starting out from the river, pynes meander through fields to end up in an ahar. Most pynes flow within 10 km of a river and their length is not more than 20 km.

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

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

6, Dungs or Jampois – Dungs or Jampois are small irrigation channels linking rice fields to streams in the Jalpaiguri district of West Bengal.

7, Cheruvu – Cheruvu are found in Chitoor and Cuddapah districts in Andhra Pradesh. They are reservoirs to store runoff. Cheruvu embankments are fitted with thoomu [sluices], alugu or marva or kalju [flood weir] and kalava [canal].

8, Kohli Tanks – The Kohlis, a small group of cultivators, built some 43,381 water tanks in the district of Bhandara, Maharashtra, some 250 – 300 yeaqrs ago. These tanks constituted the backbone of irrigation in the area until the government took them over in the 1950s. It is still crucial for sugar and rice irrigation. The tanks were of all sizes, often with provisions to bring water literally to the doorstep of villagers.

9, Bandharas – These are check dams or diversion weirs built across rivers. A traditional system found in Maharashtra, their presence raises the water level of the rivers so that it begins to flow into channels. They are also used to impound water and form a large reservoir. Where a bandhara was built across a small stream, the water supply would usually last for a few months after the rains. They are built either y villagers or by private persons who received rent – free land in return for their public act. Most Bandharas are defunct today. A very few are still in use.

10, Phad – The community – managed phad irrigation system, prevalent in northwestern Maharashtra probably came into existence some 300 – 400 years ago. The system operated on three rivers in the Tapi basin – Panjhra, Mosam and Aram- in Dhule and Nasik districts [still in use in some places here].

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. The length of these canals varies from 2-12 km. Each canal has a uniform discharge capacity of about 450 litres/second. Charis [distributaries] are built for feeding water from the kalva to different areas of the phad. Sarangs[field channels] carry water to individual fields. Sandams [escapes], along with kalvas and charis, drain away excess water. The phad system has given rise to a unique social system to manage water use.

11, Kere – Tanks called kere in Kannada, were the predominant traditional method of irrigation in the Central Karnataka plateau, and were fed either by channels branching off from anicuts [check dams] built across streams, or by streams in valleys. The outflow of one tank supplied the next all the way down the course of the stream; the tanks were built in a series.

12, The Ramtek model – 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 utilize

every raindrop falling in the watershed area is disintegrating due to neglect and ignorance.

Constructed and maintained mostly by malguzars [landowners], these tanks form a chain, extending from the foothills to the plains, conserving about 60 -70 percent of the total runoff. Once tanks located in the upper reaches close to the hills were filled to capacity, the water flowed down to fill successive tanks, generally through interconnecting channels. This sequential arrangement generally ended in a small waterhole to store whatever water remained unstored.

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

14, 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.

15, 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.

16, Khatri – Khatris are structures, about 10 X 12 feet in size and six feet deep carved out in the hard rock mountain. These traditional water harvesting structures are found in Hamirpur, Kangra and Mandi districts of Himachal Pradesh. There are two types of khatris, one for animals and washing purposes in which rain water is collected from the roof through pipes, and other used for human consumption in which rainwater is collected by seepage through rocks.

17, Kuhl – Kuhls are a traditional irrigation system in Himachal Pradesh- surface channels diverting water from natural flowing streams [khuds]. A typical community kuhl services six to 30 farmers, irrigating an area of 20 ha. The system consists of a temporary headwall across a khud for storage and diversion of the flow through a canal to the fields. By modern standards,

building kuhls was simple, with boulders and labour forming the major input. The kuhl was provided with moghas to draw out water and irrigate nearby terraced fields. The water would flow from field to field and surplus water, if and, would drain bac to the khud.

r, Zabo – The zabo [the word means ‘impounding runoff’] system is practiced in Nagaland in north eastern India. Also known as the ruza system, it combines water conservation with forestry, agriculture and animal care. The rain falls on a patch of protected forest on the hill top; as the water runoff 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 runoff ultimately meanders into.

18, Cheo-ozihi – The river Mezii flows along the Angami 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-ozihi, ozihi means water and Cheo was the person responsible for the laying of this 8 -10 km long channel with its numerous branches.

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

20, Ooranis – The tanks, in south Travancor, through numerous were in most cases Ooranis 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 the flat districts of the Tamil Nadu.

v, Bamboo Drip Irrigation – Meghalaya has an ingenious system of tapping of stream and spring water by using bamboo pipes to irrigate plantations. About 18 -20 litres of water entering the bamboo pipe system per minute gets transported over several hundred meters and finally gets reduced to 20 -80 drops per minute at the site of the plant. Bamboo pipes are used to divert perennial springs on the hilltops to the lower reaches by gravity. This 200 year old system is used by the tribal farmers of Khasi and Jaintia hills to drip irrigate their black pepper cultivation.

21, Apatani – This is a wet rice cultivation cum fish farming system practiced in elevated regions of about 1600 m and gentle sloping valleys, having an average annual rainfall about 1700 mm and also rich water resources like springs and streams. 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, valley 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 lowlying plot functions as an outlet of the high lying plot. Deeper channels connect the inlet point to 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.

22, 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. Now settled, they persist in using virdas.

Essentially, the structures use a technology that helps the Maldharis separate potable freshwater from un potable salt water. After rainwater infiltrates the soil, it gets stored at a level above the salty groundwater because of the difference in their density. A structure is built to reach down [about 1 m.] to this upper layer of accumulated rainwater. Between these two layers of sweet and saline water, there exists a zone of brackish water. As freshwater is removed, the brackish water moves upwards, and accumulates towards the bottom of the virda.

23, 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, mela, 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. A surangam is about 0.45 – 0.70 m. wide and about 1.8 – 2.0 m. high. The length varies from 3 – 300 m. Usually several subsidiary surangams are excavated inside the main one. If the surangam is very long, a number of vertical air shafts are provided to ensure atmospheric pressure inside.

24, Korambus – Korambus 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. Korambu is constructed to raise the water level in the canal and to divert the water into field channels.

Figure- Various traditional water recharging systems and conservation structures.


Jhalara


Talab/Bandhi


Bawari


Taanka


Ahar pynes


Johads


Flood irrigation


Panam keni


Khadin


Bhandara phad


Zing


Kuhls


Kund


Baoli


Nadi


Zabo


Bamboo Drip Irrigation


Jackwells


Ramtek Model


Pat System


Eri


Virdas


Bandhara


Khatris

CONCLUSION :-

With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilize water will be under further strain in future with the possibility of deepening water conflicts among different user groups. Its become necessary to avail water and utilization of rainwater through R.W.H. [Rainwater Harvesting] techniques.

Rain water is the main source for ground water recharge artificial recharging of ground water by rainwater harvesting is paved and unpaved area [open fields, parks, pavement landscape, etc.] can fulfill around 25 percent demand. Ground water recharging fulfills about 25 percent water demand. Roof top rain water harvesting meets another 25 percent water demand. Water losses in pipelines supply can be used for ground water augmentation. Which is about 25 percent of supplied water. The rain water recharging structures, trench can be used for recharging ground water by rain water or storm water runoff.

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